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# HIV-Related Stigma, Sexual and Gender Minority-Related Stigma, and Health Outcomes Among MSM Living With HIV: Measurement, Impact, and Intersectionality

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# HIV-Related Stigma, Sexual and Gender Minority-Related Stigma, and Health Outcomes among MSM Living with HIV: Measurement, Impact, and Intersectionality

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# DEDICATION

This work is dedicated to my loving parents, Li and Weidong, for being a constant source of encouragement and love, leading me through the valley of darkness with light of hope and support.

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# ABSTRACT

**Background:** Many men who have sex with men (MSM) living with human immunodeficiency virus (HIV) experience suboptimal health outcomes compared to non-MSM males living with HIV, including a faster decline in CD4 count before initiating antiretroviral therapy (ART), slower immune recovery after initiating ART, more mental health problems, suboptimal ART adherence, and lower retention in care. MSM living with HIV are often exposed to multiple layered stigmas, including, but not limited to, stigma related to being infected with HIV and stigma related to sexual and gender minority (SGM) status. Although various scales of HIV-related stigma have been frequently used for comparisons between MSM and non-MSM males, no evidence has shown that these scales measure the same constructs between the two groups. In addition, most studies of health disparities between MSM and non-MSM males and the role of intersectional stigma were cross-sectional studies conducted in the United States. This dissertation research examined the measurement invariance for scales of some common types of HIV-related stigma (i.e., internalized, anticipated, and enacted HIV-related stigma) between MSM and non-MSM males living with HIV, investigated longitudinal pattern of disparities in health outcomes between the two groups, and explored how HIV-related stigma and SGM-related stigma intersect to be associated with health outcomes among MSM living with HIV in resource-limited settings in China.

**Methods:** Data were derived from a prospective cohort study among 1,198 people living with HIV (772 men and 426 women) and a cross-sectional study among 402 MSM living

with HIV, both in Guangxi, China. Assessments were conducted at baseline from November 2017 to February 2018 and at 6-, 12-, 18-, 24-, 30-, and 36-month follow-ups for the prospective cohort study, and from August 2020 to May 2021 for the cross-sectional study. Demographic information, stigma, HIV-related characteristics, physical (e.g., CD4 count, viral load), psychological (e.g., depressive symptoms, anxiety symptoms), and behavioral (e.g., ART adherence) outcomes were collected in both studies. Confirmatory factor analyses, latent growth curve modeling, and latent moderated structural equations were employed to examine measurement invariance (i.e., configural, metric, scalar, and residual invariance) of HIV-related stigma scales between MSM and non-MSM males, disparities of health outcomes trajectories between the two groups, and the effect of intersectional stigma on health outcomes among MSM living with HIV, respectively.

**Results:** Configural and metric invariances were fully satisfied, and scalar invariance was partly satisfied for the internalized and enacted HIV-related stigma scales. Configural, metric, and scalar invariances were fully satisfied, and residual invariance was partly satisfied for the anticipated HIV-related stigma scale. Results provided evidence for acceptable measurement invariance for the HIV-related stigma scales between MSM and non-MSM males. The trajectories of CD4 count, viral load, and ART adherence differed between MSM and non-MSM males, but such differences disappeared after controlling for baseline sociodemographic covariates. The interactive effects between HIV-related stigma and SGM-related stigma on depressive and anxiety symptoms were significant among MSM living with HIV. When SGM-related stigma was low, the associations

between HIV-related stigma and depressive/anxiety symptoms were not significant; when SGM-related stigma was high, such associations were significantly positive.

**Conclusion:** This dissertation research suggested that the internalized, anticipated, and enacted HIV-related stigma scales should be used with caution for comparison studies between MSM and non-MSM males. Differences between MSM and non-MSM males in physical, psychological, and behavioral health trajectories provided important contributions to understanding the well-being of stigmatized minorities by highlighting intersectional stigma as a mechanism of adverse health outcomes and health inequities between MSM and non-MSM males in China. The studies will inform future stigma reduction interventions that consider the synthetic effects of multiple sources of stigma.

**Keywords:** HIV, MSM, measurement invariance, health outcomes, intersectional stigma, China

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# LIST OF ABBREVIATIONS

AACTG.....Adult AIDS Clinical Trials Group

AIDS .....Acquired Immunodeficiency Syndrome

ANOVA .....Analysis of Variance

AOR .....Adjusted Odds Ratio

ART..... Antiretroviral Therapy

CDC ..... Center for Disease Control and Prevention

CES-D 10 .....The 10-item Center for Epidemiologic Studies Depression Scale

CFA.....Confirmatory Factor Analyses

CFI ..... Comparative Fit Index

CI.....Confidence Interval

CNY .....Chinese Yuan

EM.....Expectation Maximization

HIV .....Human Immunodeficiency Virus

LGCM .....Latent Growth Curve Model

LMS ..... Latent Moderated Structural Equations Approach

MLWH..... Men Living with HIV

MSM .....Men Who Have Sex with Men

OR..... Odds Ratio

PLWH .....People Living with HIV

RMSEA..... Root Mean Square Error of Approximation

SEM .....Structural Equation Modeling

SD .....Standard Deviation

SRMR .....Standardized Root Mean Residual

UNAIDS .....The Joint United Nations Programme on HIV/AIDS

VIF .....Variance of Inflation

WHO .....World Health Organization

# CHAPTER 1

# INTRODUCTION

## 1.1 General introduction to HIV epidemic

Human immunodeficiency virus (HIV), which—if left untreated—causes Acquired Immunodeficiency Syndrome (AIDS), has emerged as one of the most serious health challenges around the world (Lozano et al., 2012; Murray et al., 2012; Ortblad et al., 2013; Vos et al., 2012). In 2020, there were 37.7 million people living with HIV (PLWH), 1.5 million new HIV infections, and 680,000 AIDS-related deaths worldwide (UNAIDS, 2021).

The Joint United Nations Programme on HIV/AIDS (UNAIDS) has launched the 90-90-90 targets for 2020 to reduce HIV-related morbidity and mortality (Marsh et al., 2019). The targets expected that by the year 2020, 90% of PLWH would know their HIV seropositive status; 90% of people who know their HIV seropositive status would have access to antiretroviral therapy (ART); and 90% of people on ART would have suppressed viral loads (UNAIDS, 2021). Yet, the 90-90-90 target was not achieved by the end of 2020, with only 84% of PLWH knowing their HIV seropositive status, 87% of people who knew their HIV seropositive status accessing ART, and 90% of people on ART being virally suppressed (UNAIDS, 2021). Therefore, the new 95-95-95 targets for 2030 have been launched, expecting that 95% of PLWH will know their HIV seropositive status, of whom 95% will have access to ART, of whom 95% will have suppressed viral loads by 2030 (UNAIDS, 2021).

China has made substantial progress toward the HIV prevention and treatment goals as of 2020 (Cao et al., 2020). In 2003, the "Four Frees and Once Care" policy was rolled out to ensure free HIV testing, counseling, treatment, and medication, which significantly promoted HIV treatment, care, management, and monitoring, especially for patients of low socioeconomic statuses (Zhang & Ma, 2019). Despite these intensified efforts, HIV incidence is still dramatically rising in China (Wu et al., 2019; Wu et al., 2021). In the past decade, the prevalence of HIV in China has steadily increased, resulting in more than 1.25 million cumulative cases by the end of 2018, with 80,000 new infections reported in 2018 (Wu et al., 2021).

Geographic disparities in the HIV epidemic exist across China (Wu et al., 2019). Guangxi Autonomous Region ("Guangxi"), a southwestern resource-limited province, is one of the HIV epicenters in China. By the end of 2011, Guangxi was estimated to have 70,000 PLWH and accounted for 9.0% of nationwide HIV cases in China, while representing less than 3.4% of the national population (Cui et al., 2017; Guangxi Center of Disease Control and Prevention [CDC], 2018). From 2011 to 2018, Guangxi experienced a 79% increase in the number of PLWH, reporting 124,282 cumulative HIV cases (CDC, 2018). In 2018, Guangxi ranked third in terms of the cumulative PLWH among all Chinese provinces (Wu et al., 2019). Progress on the 90-90-90 target was also slower in Guangxi than in most other regions in China (Zhao et al., 2019). In 2017, only 77% of PLWH were accessing ART, among whom 83% were virally suppressed (Yang et al., 2019). These statistics in Guangxi indicated potential barriers and obstacles toward optimal clinical outcomes where further investigations are urgently needed, especially among key populations, including men who have sex with men (MSM).

## 1.2 MSM living with HIV

The term MSM was introduced within the HIV field to emphasize the specific sexual behavior that places individuals at high risk of HIV infection, avoiding the complex social and cultural connotations of using other identity-centered terms such as "gay" or "homosexual" (Young & Meyer, 2005). Previously, the terms "gay" and "homosexual" were used to describe MSM by authorities (Zhang & Chu, 2005), while Carrillo and Hoffman (2016) argued the importance of considering that there may be inconsistency and ambiguity between a person's sexual identity and sexual behavior. On the one hand, an individual may engage in same-sex sexual behaviors and not necessarily link these behaviors to their own sexual identity (Khan, 2001). On the other hand, gay individuals may also make an active choice to conceal their sexual identity due to the challenges of living in a society where homophobia remains rampant and where strong social value is placed on heterosexuality (Dean, 2014). A survey study in the United States with a sample of 198 adolescent MSM revealed that although all the participants reported having at least one male anal sex partner, only 82.8% identified themselves as gay (Fisher et al., 2018). Similarly, two national cross-sectional surveys (in 2009 and 2016) among MSM in Brazil reported the proportions of individuals who self-identified as gay and/or homosexual were 59.3% in 2009 and 83.1% in 2016 (Guimaraes et al., 2018).

MSM have been disproportionately impacted by HIV compared to the general population or other sexual and gender minority subgroups (Beyrer et al., 2012). Globally, MSM are five times more likely to be HIV infected compared to the general population, and up to 20 times more likely in some low- and middle-income countries (Baral et al.,

2007; Hessou et al., 2019). In the United States, the estimated lifetime risk of HIV infection among MSM is one in six, compared with heterosexual men at one in 524 and heterosexual women at one in 253 (CDC, 2021b; Chan et al., 2014; Guimaraes et al., 2018; Kwakwa & Ghobrial, 2003). MSM are at increased risk for HIV due to complicated factors, including multiple partners, anonymous partners, concurrent partners, and higher rates of unprotected sex (Ackers et al., 2012; Koblin et al., 2006; Solomon et al., 2014). In addition, HIV transmission occurs more readily through receptive anal sex than penile-vaginal sex (CDC, 2021b).

From 2015 to 2019, MSM accounted for 70% of all HIV diagnoses in the United States and 44% of new HIV diagnoses in Asia and the Pacific (CDC, 2016; World Health Organization [WHO], 2021). In China, epidemiological studies assessing the prevalence of HIV among MSM were not conducted until 2000 (Gao et al., 2009). Still, various studies have shown that MSM play an increasingly important role in China's HIV epidemic. The percentages of HIV cases attributable to male-to-male sexual contact have shown a consistent upward trend, from 2.5% in 2006 to 17.4% in 2011 and 23.4% in 2016 (China Ministry of Health, 2011; Dong et al., 2019; Zeng et al., 2016).

MSM form a high-risk population for HIV infection. The HIV prevalence among MSM ranges from 5% in South-East Asia to 12.6% in Eastern and Southern Africa (WHO, 2021). In China, there were estimated to be over 21 million MSM in 2016, representing the population at the highest risk of HIV infection (Zhao et al., 2016). A recent large-scale systematic review suggested that the overall national prevalence of HIV among MSM in China was 6% (study prevalence rates ranging from 0 to 22.9%), with meta-regression analysis demonstrating an increased prevalence as time progressed

from 2001 to 2018 (Dong et al., 2019). A similar increasing trend of HIV prevalence among MSM was reported in Guangxi (Chen et al., 2019). In 2008, the annual survey among MSM in Guangxi demonstrated an HIV prevalence of 2.0%; however, such rate grew to 10.0% in 2017 (Lan et al., 2018) due in part to an increase in high-risk behaviors and broader use of the Internet to find partners (He et al., 2012; Qin et al., 2016).

### 1.3 Health outcomes among MSM living with HIV

Compared to non-MSM, MSM living with HIV have been shown to be at higher risk of experiencing negative physical (Hall et al., 2012; Yan et al., 2014b), psychological (Bogart et al., 2011; Comulada et al., 2010; Lowther et al., 2014a; Mills et al., 2004; Sun et al., 2020), and behavioral health outcomes (Hightow-Weidman et al., 2011; Sun et al., 2020) related to the HIV care.

Studies show a high incidence of comorbidities among MSM living with HIV, with an increasing prevalence of obesity and kidney disease and a persistently high prevalence of hypertension and metabolic syndrome (D'Souza et al., 2021). Compared to non-MSM, MSM living with HIV showed a faster progression from HIV infection to AIDS when not in HIV treatment, a faster decline in CD4 count before initiating ART, a slower immune recovery after ART initiation, a higher rate of viral mutation and antiretroviral drug resistance, and a lower survival rate (Lowther et al., 2014b; Yan et al., 2014b; Yan et al., 2014c).

The prevalence of mental health issues among MSM living with HIV is consistently high. Approximately half of this population across the globe were diagnosed with a psychiatric disorder during their lives (Crepaz et al., 2008). The most common mental health conditions include depressive mood disorder (14% to 48% vs. 6% to 37%

in the general population) and anxiety disorder (16% to 40% vs. 6% to 18% in the general population) (Arends et al., 2020; Baumeister & Härter, 2007; Crepaz et al., 2008; Myer et al., 2008; O'Cleirigh et al., 2015). Mental health issues further contribute to a lower quality of life and suboptimal adherence to ART in MSM living with HIV (Berg et al., 2004; Pence et al., 2007).

MSM living with HIV are also at risk for various maladaptive health behaviors. Previous literature showed estimates ranging from 9-66% of MSM living with HIV who report having unprotected sex (Chi et al., 2022; Crepaz et al., 2009; Hospers et al., 2005; van Kesteren et al., 2007). Regarding HIV treatment and care, MSM living with HIV have been shown to have less timely linkage to care, poorer retention in care, and poorer treatment adherence due to risk factors at both individual (e.g., lack of SGM identity disclosure and/or HIV status disclosure) and structural levels (e.g., stigma and discrimination) (Govindasamy et al., 2012b; Medley et al., 2013a; Sarna et al., 2014a).

### 1.4 HIV-related stigma and its impacts on health outcomes of PLWH

Stigma, a discrediting and tainting social label (Goffman, 2009), is a well-established barrier to the physical and mental well-being of PLWH as it inhibits health-seeking behaviors and socially isolates PLWH from acquiring support and resources (Courtenay–Quirk et al., 2006a; Dowshen et al., 2009). Similar to many other stigmatized characteristics, PLWH often learn about negative beliefs about HIV from people living without HIV (Earnshaw et al., 2013). According to the Health Stigma Framework, PLWH may experience internalized, anticipated, and enacted stigma when they perceive prejudice, stereotypes, and discrimination from others (Earnshaw & Chaudoir, 2009; Earnshaw et al., 2013). Internalized stigma refers to endorsing negative attitudes

associated with HIV and applying these beliefs to oneself, leading to a sense of self-blaming, guilt, and worthlessness (Earnshaw & Chaudoir, 2009). Anticipated stigma involves expectations of discrimination, stereotyping, and/or prejudice from others if one's HIV status is disclosed (Earnshaw et al., 2013). Enacted stigma refers to one's actual experiences of discrimination, stereotyping, and/or prejudice from others in the past or present due to HIV status (Earnshaw et al., 2013).

Internalized, anticipated, and enacted stigma are closely associated with each other and have been found to undermine the physical health, psychological well-being, and behavioral health of PLWH. A greater level of internalized stigma has been shown to be associated with decreased overall physical health (Wolitski et al., 2009). Anticipated and enacted stigma could accelerate HIV progression, indicated by a lower level of CD4 count, shorter time to AIDS diagnosis when untreated, and shorter time to HIV-related mortality (Cole et al., 1997). PLWH who have a greater level of internalized, anticipated, and enacted stigma have been shown to be more likely to experience depression, low self-esteem, and overall psychological distress (Berger et al., 2001; Chi et al., 2014; Quinn & Chaudoir, 2009). In addition, the three types of stigmas have strong associations with unhealthy behaviors such as suboptimal ART adherence (Sweeney & Vanable, 2016), insufficient healthcare utilization (Chesney & Smith, 1999), and concealment of HIV seropositive status (Rongkavilit et al., 2010). PLWH with greater anticipated and enacted stigma have been shown to report more concerns in healthcare settings, hindering them from utilizing healthcare resources and adhering to medications (Peitzmeier et al., 2015).

Different scales have been developed to measure the three types of HIV-related stigma. One measurement tool of internalized HIV-related stigma is the 8-item scale derived from the "negative self-image" session of the Berger HIV Stigma Scale, which is a reliable and valid instrument developed from a large, diverse sample of PLWH (Berger et al., 2001). Anticipated HIV-related stigma could be assessed by a 9-item scale derived from the Health Stigma Framework. This scale assessed participants' expectations of HIV-related stigma from family members, the community, and healthcare providers (Earnshaw et al., 2013). Enacted HIV-related stigma could be evaluated by the 16-item checklist derived from the PLWH Stigma Index. The checklist focuses on the actual experiences of being stigmatized due to HIV in the past six months (dos Santos et al., 2014).

The measurements of three types of HIV-related stigma were developed among PLWH rather than MSM specifically (Berger et al., 2001) and no evidence has shown that these scales measure the same constructs between the two groups. Given the potential differences in self-image, experiences of being discriminated against, or perceptions of social norms between MSM and non-MSM males (Yan et al., 2019), it is important to ensure that assessment tools used to measure HIV-related stigma are assessing the same underlying constructs for the two groups, which is a prerequisite for use as in comparison studies between MSM and non-MSM males.

### 1.5 SGM-related stigma and its impact on health outcomes

The term "sexual minority" typically refers to individuals with a minoritized sexual identity, such as lesbian, gay, asexual, pansexual or any other non-heterosexual identity; and "gender minority" refers to individuals who do not identify as cisgender

(Layland et al., 2020). Health disparities associated with stigma against sexual and gender minority (SGM) are widely recorded (Layland et al., 2020). SGM-related stigma has been associated with delayed diagnosis, poor linkage to care, suboptimal ART adherence, reduced medication self-efficacy, and mental health challenges (Andersson et al., 2020; Quinn & Voisin, 2020). Individuals who are SGM are more likely to experience physical illness (e.g., cardiovascular disease) (Hatzenbuehler et al., 2013a), psychological disorders (e.g., mood disorders) (Lee et al., 2016), and barriers to healthcare access (Bonvicini, 2017), compared to heterosexual or cisgender populations.

While MSM has been used to emphasize same-sex behavior among males, regardless of how they sexually identify themselves, MSM has been commonly designated as one of the sexual minority groups in both HIV and general health literature. MSM living with HIV perceive and experience various types of stigmas because of their multiple stigmatized identities, including but not limited to SGM status and HIV diagnosis (Aunon et al., 2020; Fitzgerald-Husek et al., 2017; Herek et al., 2009). A study of HIV prevention indicated that MSM tended to avoid or delay HIV-related care due to the fear of others suspecting their same-sex sexual behaviors (Bwambale et al., 2008).

Despite some sexual liberation in the past three decades, MSM in China still face a variety of social challenges associated with social norms and the pressure to have children (Zheng, 2018). Studies among MSM living with HIV in China suggested that higher levels of SGM-related stigma significantly increase the odds of any form of intimate partner violence (Wang et al., 2020) and were related to greater depression, greater anxiety, lower resilience, and lower quality of life (Yang et al., 2020).

# CHAPTER 2

# BACKGROUND AND SIGNIFICANCE

## 2.1 Introduction to HIV epidemic among MSM in China

As a subgroup of SGM population, MSM are disproportionately affected by HIV. Globally, MSM have been shown to be at 25 times higher risk of acquiring HIV compared to heterosexual adult men (UNAIDS, 2021). In Asia and the Pacific areas, MSM accounted for 44% of new HIV infections in 2019 (WHO, 2022).

In the past decades, China has made substantial progress in tackling the HIV epidemic by promoting HIV treatment and care and has significantly reduced HIV transmission from blood donation and injection drug use (Shang & Zhang, 2015). However, HIV infection among MSM is still dramatically rising in China (Wu et al., 2007; Zhang et al., 2013). The overall national prevalence of HIV among MSM in 2021 was estimated to be 6% (UNAIDS, 2021), with a notable trend of increase from 2001 to 2018 (Dong et al., 2019). The proportion of MSM among the newly diagnosed HIV cases has also increased, from 2.5% in 2006 to 23.3% in 2018 (Wu, 2015; Zhang, 2019).

Despite a rapidly expanding HIV epidemic among MSM in China, data are limited regarding how MSM status is associated with the HIV treatment cascade and other health outcomes among MSM living with HIV under the unique Chinese culture and social context.

## 2.2 Health disparities between MSM and non-MSM males living with HIV

Existing literature suggested that MSM living with HIV experienced poorer physical, psychological, and behavioral health outcomes compared to non-MSM males due to factors from micro to macro levels (Yan et al., 2014b). Living in a society where there is prevalent homophobia and where strong social value is placed on heterosexuality, individuals from SGM group are still stigmatized regardless of the achievements of sexual liberation movements (Dean, 2014). Individuals from SGM groups experience rejection from families, friends, and social institutions, including hospitals and schools (Bonvicini, 2017). A qualitative study described the stigma and shame experiences of HIV-negative MSM, where multiple participants reported their fear of being negatively labeled by their friends (Dubov et al., 2018). In another qualitative study about MSM's experiences of being rejected by families, participants reported broken relationships with parents and siblings and unsupportive responses from families when their sexual identities or behaviors were disclosed (Gourlay et al., 2017).

Discrimination toward SGM also exist in healthcare settings. More than 30% of medical or nursing school students did not believe that gay men should become parents (Chapman et al., 2012). In an online national survey among physicians from SGM groups, 65% had heard derogatory comments from healthcare providers about SGM patients, and 34% had witnessed discriminatory care towards SGM patients (Mansh et al., 2015). In a qualitative study among MSM, a participant reported that when he disclosed his sexual identity, a nurse called in panic (Helms et al., 2022). These experiences of being shamed and discriminated against due to one's SGM identity could predict sexual

risk behavior (e.g., unprotected sex), elevating the risk of acquiring HIV (Newcomb & Mustanski, 2011).

Although Chinese society has become relatively more tolerant toward MSM since homosexuality was removed from the Chinese Classification and Diagnostic Criteria of Mental Disorders in 2001 (Wu, 2003), same-sex marriage is still illegal, and discrimination based on sexual and/or gender identity is not prohibited by laws (Cao & Guo, 2016; Zhang & Chu, 2005). MSM are still expected to fulfill their family duty of a traditional marriage (i.e., heterosexual and cisgender) and to have children (Wu, 2003). Such stress from family and society could further lead to psychological distress and stress-sensitive illness (Sun et al., 2020).

MSM living with HIV and non-MSM males living with HIV may also differ in HIV clinical outcomes. High CD4 count and low viral load are important indicators of successful HIV care engagement and ART adherence (Andersson et al., 2020). CD4 count, the total number of CD4 T-cells in the human body, represents the body's immunologic functioning and ability to fight infections; and viral load, the amount of HIV virus in the body, is an indicator of infection stage (i.e., acute HIV infection, chronic HIV infection, AIDS) among PLWH (Center for Disease Control and Prevention, 2019). Disparities in disease progression and survival have been well-documented between MSM and non-MSM males. Compared to non-MSM, MSM living with HIV showed a faster progression from HIV infection to AIDS when not treated, a faster decline in CD4 count before initiating ART, a slower immune recovery after ART initiation, a higher rate of viral mutation and antiretroviral drug resistance, and a lower survival rate (Lowther et al., 2014b; Yan et al., 2014b; Yan et al., 2014c).

MSM living with HIV experience additional psychosocial burdens and may experience more mental health problems than non-MSM males (Sun et al., 2020). According to the minority stress theory, minority groups are exposed to both external stressors (e.g., discrimination) and internal stressors (e.g., concealment of identity), which in turn place them at risk for tremendous adverse mental health outcomes (Meyer, 2003). MSM have been shown to be at higher risk of depression and trauma compared to their non-sexual minority counterparts (Heywood & Lyons, 2016; Meyer, 2003; Yan et al., 2014a). A meta-analysis revealed that the pooled prevalence of depression among MSM living with HIV was 43% globally (Xiao et al., 2020) and was estimated to be 17% higher than heterosexual men living with HIV (MLWH) (Bogart et al., 2011; Comulada et al., 2010; Hatzenbuehler et al., 2008; Lowther et al., 2014a; Mills et al., 2004).

The emerging health disparities between MSM and non-MSM males living with HIV could be attributed to the stigma and discrimination associated with SGM identity (Putra et al., 2019). MSM living with HIV who experienced stigma and discrimination from other individuals and societal institutions were more likely to conceal their HIV seropositive status and SGM identity, and in turn, experienced delayed linkage to care, poorer retention in care, and suboptimal medication adherence (Yan et al., 2014b).

### 2.3 The main effects of HIV-related stigma and SGM-related stigma on health outcomes among MSM living with HIV

MSM living with HIV perceive and experience various types of stigma (i.e., layered stigma) because of their multiple stigmatized identities, including but not limited to SGM status and HIV status (Aunon et al., 2020; Fitzgerald-Husek et al., 2017; Herek et al., 2009). Both HIV- and SGM-related stigma could be associated with delayed

diagnosis, poor linkage to care, suboptimal ART adherence, reduced medication self-efficacy, and mental health challenges (Andersson et al., 2020; Quinn & Voisin, 2020).

HIV-related stigma is often considered a strong driver of increased physical and psychological distress in MSM living with HIV (Goldberg & Smith, 2011; Wohl et al., 2013). A cross-sectional study conducted among 456 MSM living with HIV demonstrated that 61% of participants reported perceived discrimination from the gay community because of their HIV seropositive status, and such perceived HIV stigma was associated with higher levels of depression, anxiety, loneliness, avoidant coping strategies, and suicidal ideation (Courtenay–Quirk et al., 2006b; Jeffries IV et al., 2015).

SGM-related stigma and discrimination have been shown to impede MSM living with HIV from timely linkage to healthcare and subsequently elicited additional psychological burdens, leading to poorer mental and clinical outcomes (Govindasamy et al., 2012a; Medley et al., 2013b; Sarna et al., 2014b). A study of HIV prevention indicated that MSM tended to avoid HIV-related care due to the fear of others suspecting them of same-sex sexual behavior (Bwambale et al., 2008). Such anticipated SGM-related stigma was further compounded by a fear of discriminatory treatment at healthcare facilities (Kim et al., 2018).

Both SGM identity and HIV diagnosis are considered undesirable in the Chinese societal context and heavily stigmatized (Shao et al., 2018). Despite some sexual liberation in the past three decades, MSM in China still face a variety of social challenges associated with social norms and the pressure to have offspring (Zheng, 2018). Studies among MSM living with HIV in China suggested that higher levels of both HIV- and SGM-related stigma could significantly increase the odds of any form of intimate partner

violence (Wang et al., 2020) and were related to depression, anxiety, resilience, and quality of life (Yang et al., 2020).

### 2.4 Intersectional stigma and health outcomes among MSM living with HIV

Intersectional stigma is a concept introduced to characterize the convergence of multiple stigmatized identities within a group (Bowleg, 2012). Instead of considering each stigmatized identity separately and simply summing the impacts, an intersectional perspective allows researchers to critically examine how oppressions and protective factors interact at social, community, interpersonal and individual levels to affect privileges and disadvantages (Bogard et al., 2017; Ingram et al., 2019; Turan et al., 2019).

Studies using the intersectionality framework suggest synthesized effects of social status or identities (e.g., HIV status, race/ethnicity, gender, sexual identity, socioeconomic status) on psychological distress and delayed treatment among PLWH (Arnold et al., 2014b; Bogart et al., 2011; English et al., 2018b; Mill et al., 2009). A cross-sectional study among 181 Black MSM living with HIV yielded a three-way interaction among three discrimination types (HIV seropositive status, race/ethnicity, and sexual identity), indicating that intersectional stigma was significantly associated with depressive symptoms (Bogart et al., 2011). Another longitudinal study among Black, Latino, and multiracial gay and bisexual men also indicated the importance of considering the interactive effect of racial discrimination and SGM-related stigma on the persistence of psychological and behavioral health inequities over time (English et al., 2018a). Results revealed a significant interactive effect, where the positive relationships between racial discrimination and depression and anxiety at six months, and higher levels

of heavy drinking at 12 months were strengthened by SGM-related stigma (English et al., 2018a). A qualitative study conducted in-depth interviews with 31 Black gay men and depicted the association between intersectional stigma and poorer HIV-related behavioral health outcomes (Arnold et al., 2014a). Participants experiencing HIV-related stigma, homophobia, and racial discrimination reported tendencies of risky sexual behavior, delay in linkage to care, low adherence to treatment, and fewer HIV disclosures to sexual partners (Arnold et al., 2014b). Intersectional stigma towards MSM living with HIV has also been documented in healthcare providers. A survey study among 332 healthcare providers and social service agencies in Jamaica showed that, although healthcare professionals responded to the survey claiming that MSM deserved quality care, they expressed higher levels of blame and more negative judgments towards MSM living with HIV, compared to HIV-negative MSM or heterosexual PLWH (Rogers et al., 2014).

Although many studies concluded that stigmas were very likely to exacerbate one another, counterintuitively, several studies reported inconsistent findings where some stigmatized characteristics might mitigate or have no influence on the effect of other stigmatized characteristics. A cross-sectional survey study among 203 PLWH suggested that the effect of HIV-related stigma on depression was lessened when participants endorsed experiences of sexual identity discrimination (Williams et al., 1997). Another study among 911 individuals of SGM suggested that although HIV-related stigma and SGM-related stigma were associated with a higher level of depression independently, no significant interactions were found between HIV-related stigma and SGM-related stigma, suggesting additive rather than exacerbating effects of different forms of stigmas (International Lesbian, 2017). Experience of being stigmatized might build resilience to

other stigmatized characteristics (Turan et al., 2019). Certain identities could also create community solidarity protective against other forms of discrimination (Turan et al., 2019).

**2.5 Knowledge gaps**

Although the collective knowledge has grown rapidly in terms of health outcomes among MSM living with HIV and potential health disparities between MSM and non-MSM males, several knowledge gaps exist.

*Although the internalized, anticipated, and enacted HIV-related stigma scales have been frequently used for comparisons between MSM and non-MSM males, no evidence has shown that these scales measure the same construct between the two groups*

Measurement invariance is a statistical property of measurement that indicates that the same construct is being measured across specified groups (Vandenberg & Lance, 2000). Four types of measurement invariance can be distinguished in the common factor model. Configural invariance refers to identical number of factors and the pattern of factor-indicator relationships across groups. Metric invariance refers to equal factor loadings across groups. Scalar invariance refers to equal intercepts/thresholds across groups when observed scores are regressed on each factor. Residual invariance refers to equal residual variances of the observed scores not accounted for by the factors across groups (Vandenberg & Lance, 2000). Measurement invariance for scales of the three types of HIV-related stigma is a prerequisite for use as in comparison studies between MSM and non-MSM males. The measurements of three types of HIV-related stigma were developed among PLWH generally instead of MSM living with HIV specifically (Berger et al., 2001). Given the potential differences in self-image, experiences of being

discriminated against, or perceptions of social norms between non-MSM males and MSM (Yan et al., 2019), it is important to ensure that assessment tools used to measure HIV-related stigma are assessing the same underlying construct between the two groups. If measurement invariances of HIV-related stigma scales are achieved between MSM and non-MSM males, observed group differences in HIV-related stigma could be attributed to true between-group discrepancies rather than measurement error (Vandenberg & Lance, 2000). If measurement invariances are not satisfied, the HIV-related stigma scales may fail to accurately capture the interested construct, and the observed group differences might be due to inconsistent understanding of certain key concepts or measurement deviations (Vandenberg & Lance, 2000). However, measurement invariances have not been tested for the internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males. Therefore, the appropriateness of using these tools in diverse subgroups was not determined.

*Lack of studies of health disparities between MSM and non-MSM males with large sample size and comprehensive health outcomes with longitudinal designs*

Findings of most existing studies about health disparities between MSM and non-MSM males have been limited by small sample sizes, non-representative samples, specific but limited domains of health outcomes, or cross-sectional data (Armoon et al., 2021; Gonzalez et al., 2009; Kang et al., 2005; Logie & Gadalla, 2009). Several longitudinal studies with multiple-wave assessments investigated the dynamic patterns of clinical outcomes among PLWH, but the intervals were relatively short (Logie & Gadalla, 2009). A large-scale systematic review of studies among MSM living with HIV in China reported that the majority of 355 studies had a sample size of less than 500 and

all of these were cross-sectional (Dong et al., 2019). Therefore, no study has comprehensively examined the disparities in physical, psychological, and behavioral health outcomes from a multidomain perspective with a relatively large sample size within a longitudinal design.

To foster a deeper understating of unique health vulnerabilities of MSM living with HIV, longitudinal studies are needed to investigate the differences in long-term health outcomes between MSM and non-MSM males living with HIV. Such studies are necessary to develop effective HIV treatment and care, improve health promotion interventions and benefit clinical practices.

*Lack of studies examining the effects of intersectional stigma on health outcomes among MSM living with HIV in low- and middle-income/resource-limited settings*

Although the effects of SGM- and HIV-related stigma on clinical and mental health outcomes among MSM living with HIV have been emphasized by public health literature (Bowleg, 2012; Hatzenbuehler et al., 2013b; Henkel et al., 2008), existing studies regarding multiple stigmas tended to focus on the parallel effects of different stigmas rather than the interactive effect of these stigmas through the framework of intersectionality (Bowleg, 2012). In addition, most studies of intersectional stigma among MSM living with HIV have been conducted in the United States (Quinn et al., 2017; Turan et al., 2017). Little is known regarding how SGM-related stigma and HIV-related stigma intersect to be associated with adverse physical, mental, and behavioral health outcomes in resource-limited settings in China. As China has experienced an increasing HIV prevalence among MSM, empirical studies focusing on the effect of intersectional stigma on health outcomes among MSM living with HIV are urgently needed.

## 2.6 Conceptual framework

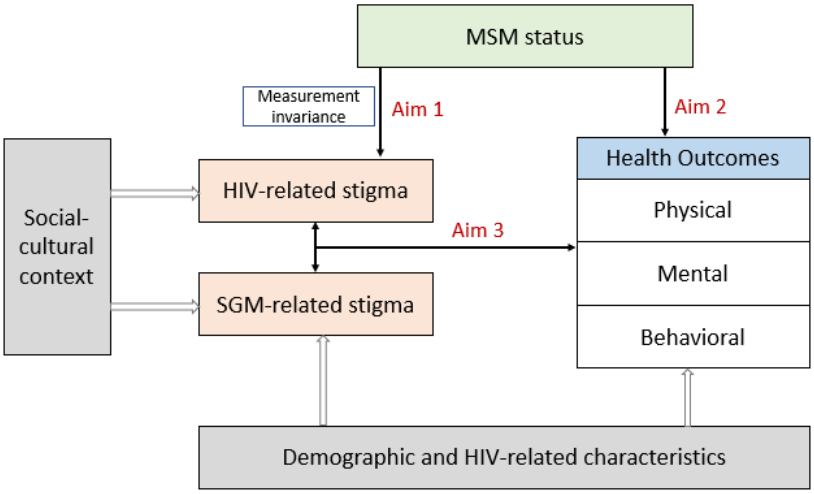


Figure 2.1 Conceptual framework

This dissertation research uses a conceptual framework (Figure 2.1) to address the aforementioned knowledge gaps. In this conceptual framework, primary outcomes include physical (CD4 count, viral load), mental (depressive symptoms, anxiety symptoms), and behavioral (ART adherence) health outcomes. Study 1 examined the measurement invariance of internalized, anticipated, and enacted HIV-related stigma instruments by MSM status (MSM vs non-MSM males). Study 2 quantified the health disparities in 3-year continual health outcomes by MSM status. Study 3 focused on the main and interactive effect of HIV- and SGM-related stigma on health outcomes among MSM living with HIV, determining whether the associations between HIV-related stigma and health outcomes varied by levels of SGM-related stigma.

In the conceptual framework, sociodemographic and HIV-related characteristics are taken into consideration as they were well-documented to be associated with health outcomes as well as HIV-related stigma among PLWH. For example, younger age among PLWH was associated with higher viral load, shorter time to viral rebound, and a greater

level of stigma compared with older age (Logie & Gadalla, 2009; Palmer et al., 2018). A study of psychiatric disorders among PLWH showed that psychiatric disorders in the past 12 months were more prevalent in those who were single, unemployed, and had low educational attainment (Shadloo et al., 2018). Also, internalized HIV stigma and perceived HIV-related discrimination were associated with lower household income and lower educational attainment (Crockett et al., 2019). Therefore, sociodemographic characteristics, including age, ethnicity, marital status, educational attainment, employment, monthly household income, and residence rurality, are considered in the framework.

Data for our studies were collected from Guangxi, China. Guangxi is an under-resourced province with poor healthcare infrastructure and lower average socioeconomic status among residents (Zhao et al., 2015), which might be associated with mental health distresses of MSM living with HIV (Sha et al., 2021).

### 2.7 Research aims

The purpose of this dissertation research was to investigate how MSM status was related to long-term physical, psychological, and behavioral health outcomes. Furthermore, the research specifically examined the association between intersectional stigma and health outcomes among MSM living with HIV in China. The dissertation addressed the knowledge gaps based on three specific aims and in the form of three studies.

**Aim 1. To examine the measurement invariance for internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males.**

Measurement invariance for three types of HIV-related stigma is a prerequisite for use as in comparison studies between MSM and non-MSM males. If latent factors are to be meaningfully compared between MSM and non-MSM males, the measurement structures of the latent factors and their indicators should be stable.

**Research question 1**: Do the internalized, anticipated, and enacted HIV-related stigma scales establish configural, metric, scalar, and residual invariance between MSM and non-MSM males?

**Aim 2. To quantify health disparities in 3-year continual trajectories of physical, psychological, and behavioral health outcomes between MSM and non-MSM males.**

Study 2 examined the disparities in health outcomes at baseline and across time between MSM and non-MSM males. Latent growth curve modeling was adopted for each health outcome, controlling for baseline sociodemographic covariates.

**Hypothesis 2a**: CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence were different between MSM and non-MSM malesat baseline.

**Hypothesis 2b**: CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence among MSM deteriorated, and the health disparities between MSM and non-MSM males widened over time.

**Aim 3. To examine the main effect and interactive effect of HIV-related stigma and SGM-related stigma on physical, psychological, and behavioral health outcomes among MSM living with HIV.**

**Hypothesis 3a**: Both HIV-related and SGM-related were associated with CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence.

**Hypothesis 3b**: The interactive effects between HIV-related stigma and SGM-related stigma on CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence were significant. Specifically, the relationships between HIV-related stigma and CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence were aggravated among MSM who reported higher SGM-related stigma.

# CHAPTER 3

# METHODOLOGY

Data used in study 1 was derived from a prospective cohort study initiated in November 2017 among 1,198 PLWH (including 193 MSM and 579 non-MSM males) and a cross-sectional survey study initiated in August 2020 among 402 MSM living with HIV, both in Guangxi, China. Data used in studies 2 was derived from the prospective cohort study. Data used in study 3 was derived from the cross-sectional survey study.

## 3.1 The prospective cohort study

*Overview*

The prospective cohort study, funded by the National Institute of Health/National Institute of Mental Health (Grant No. R01MH0112376), was designed to investigate the association between HIV-related stigma and clinical outcomes and the potential physical, psychological, and behavioral mechanisms underlying such associations among PLWH. In collaboration with Guangxi Center for Disease Control and Prevention (Guangxi CDC), six major public hospitals/clinics with the largest volume of HIV patients under care in five cities (i.e., Nanning, Guilin, Liuzhou, Guigang, and Qinzhou) were selected as study sites. HIV patient numbers at each study site at the time of baseline assessment can be found in Table 3.1.

Table 3.1 Number of PLWH and MSM in each study site at the time of baseline assessment (November 2017-February 2018)

| Study sites | Number of PLWH | Number of MSM |
|---|---|---|
| Guangxi CDC | 2,705 | 787 |
| Nanning | 7,389 | 712 |
| Liuzhou | 7,216 | 158 |
| Guilin | 2,803 | 287 |
| Guigang | 1,386 | 43 |
| Qinzhou | 2,051 | 30 |

Eligible PLWH were randomly selected to participate in the study following a systematic sampling approach. Case managers in each site picked an arbitrary number (e.g., the date of the month) to identify the first case from the eligible patient pool, and calculated the interval, *n*, for each sampling iteration (*n* = the ratio of the target sample size to the total amount of eligible patients in the system). From the first case identified, every $n^{th}$ case was selected until the target sample size (n=~200) was achieved at each clinic.

*Participants*

Eligible cases for the cohort study were PLWH who: (1) were aged 18 to 60 years, (2) had a confirmed diagnosis of HIV, and (3) had no plan to relocate outside of the Guangxi province in the next 12 months. PLWH were excluded if they were: (1) physically or mentally incapable of responding to survey questions, and (2) currently incarcerated or institutionalized for drug use or commercial sex. A total of 1,198 PLWH were recruited in the cohort study, of which 64.4% (n=772) were men. Because studies 1 and 2 aimed to explore the potential disparities between MSM and non-MSM males, a subset of the final sample consisting of 193 MSM (who self-reported having acquired HIV via same-sex sexual behavior) and 579 non-MSM males were included in the analyses.

*Data collection procedure*

Before data collection, research associates from the local CDC and hospitals/clinics received a three-day training course. The course covered topics on research ethics, assessment methodology, and survey skills. Prior to each of the follow-up assessments, research associates were given an additional one-day booster training session, which briefly reiterated research ethics and survey skills. After eligible PLWH were randomly selected from the system, local CDC staff contacted the patients to confirm their eligibility, discussed with them the benefits and risks of the study, and invited them to participate. After obtaining written informed content, questionnaire-oriented face-to-face interviews were conducted in private rooms of the local hospitals/clinics.

Baseline assessment was conducted from November 2017 to February 2018, with follow-ups at 6-, 12-, 18-, 24-, 30-, and 36- months. All data were collected and merged by November 2021. The attrition rate was less than 5% for each follow-up assessment. Each participant received a small gift (e.g., household items) equivalent to US$5.00 (1 USD≈6.5 Chinese Yuan at the time of the survey) upon the completion of each assessment. The research protocol was approved by the Institutional Review Boards at both the University of South Carolina in the United States and Guangxi CDC in China.

**3.2 The cross-sectional survey study**

*Overview*

The cross-sectional survey study, funded by the National Institute of Health/National Institute of Mental Health (Grant No. R01MH0112376-4S1), was designed to explore the intersectional stigma of SGM status and HIV status on HIV-

related health outcomes among MSM living with HIV. Data collection was initiated in August 2020 and finished in May 2021. In collaboration with Guangxi CDC, four major public hospitals/clinics with the largest cumulative number of MSM living with HIV in three cities in Guangxi (i.e., Nanning, Guilin, and Liuzhou) were selected as study sites. A purposive sampling method was used to recruit participants. Medical staff or case managers from each study site screened all the HIV patients in their clinical records and invited all eligible patients to participate in the study.

*Participants*

Eligible participants were men who: (1) aged 18-60 years; (2) had a confirmed diagnosis of HIV; (3) self-reported having sex with men in the last six months. MSM were excluded if they: (1) were physically or mentally incapable of responding to survey questions; (2) were currently incarcerated or institutionalized for drug use or commercial sex; and (3) had already participated in the aforementioned prospective cohort study. After excluding individuals who were not eligible, 402 MSM were included in the final sample.

*Survey procedure*

With the assistance and collaboration of Guangxi CDC, an interviewer-administered questionnaire was used for quantitative data collection. After obtaining participants' written informed consent, local research team members conducted surveys in private offices in community health centers or HIV clinics where participants received regular medical care. The entire survey took around 60 minutes. Each participant received a gift equivalent to US$5 upon the completion of the questionnaire. The research

protocol was approved by Institutional Review Boards at both the University of South Carolina and Guangxi CDC in China.

### 3.3 Key measures

Primary outcomes in this dissertation include CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence. Key predictors include MSM status, internalized, anticipated, and enacted HIV-related and SGM-related stigma. Sociodemographic and HIV-related characteristics were included in the analyses as covariates. Outcomes and key predictors used for each study can be found in Table 3.2.

Table 3.2 Outcomes and key independent variables for each study

| Studies | Outcomes | Key predictors |
|---|---|---|
| Study 1 | Measurement invariance of HIV-related internalized, anticipated, and enacted stigma instruments | MSM status (MSM vs. non-MSM males) |
| Study 2 | Physical health outcomes: CD4 count, viral load<br>Psychological health outcomes: depressive symptoms, anxiety symptoms<br>Behavioral health outcomes: ART adherence | MSM status (MSM vs. non-MSM males) |
| Study 3 | Physical health outcomes: CD4 count, viral load<br>Psychological health outcomes: depressive symptoms, anxiety symptoms<br>Behavioral health outcomes: ART adherence | Internalized, anticipated, and enacted HIV- and SGM-related stigma |

*Physical health outcomes*

**CD4 count** of each participant at baseline, 6-, 12-, 18-, 24-, 30- and 36-month follow-ups were retrieved from the patient's lab results at each hospital. According to the guidelines for ART in adults and adolescents with HIV (U.S. Department of Health and Human Services & Panel on Antiretroviral Guidelines for Adults and Adolescents, 2017), the cutoff of 500 cells/$mm^3$ has clinical implications in evaluating the normal immunologic functioning. Therefore, CD4 count was categorized into a binary variable: CD4 count<500 cells/$mm^3$ and CD4 count≥500 cells/$mm^3$ for the purpose of data analysis in this dissertation.

**Viral load** of each participant at baseline, 6-, 12-, 18-, 24-, 30- and 36-month follow-ups were collected from the electronic health record (EHR) system of Guangxi CDC. Viral suppression was defined as HIV RNA less than or equal to 50 copies/ml in PLWH's plasma (CDC & National Center for HIV/AIDS, Viral Hepatitis, and T.B. Prevention 2018). As viral suppression indicates the treatment efficacy, it was used as one of the primary outcomes rather than the original continuous value of viral load. Viral load was categorized into a binary variable: viral load<50 copies/ml and viral load≥50 copies/ml.

*Psychological health outcomes*

**Depressive symptoms** were assessed with the 10-item Center for Epidemiologic Studies Depression (CES-D 10) Scale (Kohout et al., 1993). The Chinese version of CES-D 10 has been validated in both the clinical and non-clinical populations in China (Yu et al., 2013). It captured depressed affect (3 items), somatic symptoms (5 items), and positive affect (2 items). The response options ranged from 0 ("rarely or none of the time") to 3 ("all of the time"). The sum scores of CES-D 10 ranged from 0 to 30, with higher scores indicating a greater level of depression. The scale exhibited an acceptable internal consistency in our study (Cronbach's alpha=0.85).

**Anxiety symptoms** were assessed with the 20-item Self-rating Anxiety Scale (Zung, 1971) to quantify the level of anxiety for patients experiencing anxiety-related symptoms. The Chinese version scale has been validated in the Chinese populations (Zhang et al., 2015). Items assess psychological and physiological symptoms in the past week, and each item is scored on a scale of 1 ("none or a little of the time") to 4 ("most of the time"). Sample items are "I feel easily upset or panicked" and "I experience headache

and a sore neck." The sum scores of the scale ranged from 20 to 80, with higher scores indicating a greater level of anxiety. The scale exhibited an acceptable internal consistency in our study (Cronbach's alpha=0.80).

*Behavioral health outcomes*

**ART adherence** was assessed with a multiple-item approach to minimize the self-report bias (Mi et al., 2020). Five items derived from the Adult AIDS Clinical Trials Group (AACTG) adherence instrument were adapted to our studies (Chesney et al., 2000). The first item asked participants if they had missed any dose ever before. Responses were recorded to reflect ART adherence (1=not missed, 0=missed). The other four items inquired about the total number of prescribed doses and the number of doses that participants actually took within four specific time windows (i.e., past three weekdays, past weekend, past two weeks, and past month). The responses to each of these items were first converted into a percentage of doses taken as scheduled and then dichotomized into 1 (≥95% of prescribed doses) or 0 (<95%). The threshold of 95% is used in the current study as the existing literature suggested 95% as the optimal level of adherence to sustain viral suppression (Paterson et al., 2000) and avoid the evolution of drug-resistant viruses (Raffa et al., 2008). An adherence index score was generated by summing the dichotomous scores of the five items to reflect an optimal adherence (score=5) or suboptimal adherence (score<5) (Mi et al., 2020). Such measure of ART adherence has been validated under various cultural contexts (Chesney et al., 2000; Reynolds et al., 2007) and was considered a robust instrument for evaluating ART adherence behaviors among PLWH.

*HIV-related stigma*

**Internalized HIV-related stigma** was assessed with an 8-item scale derived from the "negative self-image" subscale of the Berger HIV Stigma Scale (Berger et al., 2001). Participants were asked to respond to each statement on a 4-point scale from 1 ("strongly disagree") to 4 ("strongly agree"). Sample statements are "I feel I'm not as good as others because I have HIV" and "I feel guilty because I have HIV." A sum score of the eight items was calculated with a higher score indicating a higher level of internalized HIV stigma. The scale exhibited a Cronbach's α of .94 in our study.

**Anticipated HIV-related stigma** was assessed with a 9-item scale derived from the Health Stigma Framework (Earnshaw et al., 2013). This scale assessed participants' expectations of HIV-related stigma coming from family members, community, and healthcare providers. Sample items are "Family members will avoid touching me," "Community managers will refuse to provide me with social services," and "Healthcare providers will treat me with less respect." Each item was rated on a scale of 1 ("definitely not") to 5 ("definitely"). A sum score of the nine items was calculated, ranging from 9 to 45, with a higher score indicating higher levels of anticipated HIV stigma. The Cronbach's alpha of this scale was 0.92 in our study.

**Enacted HIV-related stigma** was evaluated using the 16-item checklist adapted from a previous study (dos Santos et al., 2014). PLWH were asked whether they had some actual experiences of being stigmatized due to HIV in the past six months, including "Being excluded from social gatherings or activities," "Being excluded from family activities," and "Being physically assaulted." Participants who answered "yes (1)" were considered to have the experience of being stigmatized, while those who answered

"no (0)" were considered to have no such experience. The total score of the 16 items was used as a composite score, with a higher score indicating more experiences of being stigmatized in the last six months. The enacted stigma scale also showed good reliability at baseline (Cronbach's alpha=0.89).

*SGM-related stigma*

**Internalized SGM-related stigma** was assessed with 14 items derived from the Chinese version internalized homophobia scale (Ren & Hood, 2018) and the internalized homophobia and perceived stigma scale (Puckett et al., 2017). The scale was conducted on SGM to quantify negative feelings and homophobic attitudes towards themselves. Sample items are “if I were a heterosexual, I would be happier” and “sometimes I feel ashamed of my sexual orientation.” Each statement was rated on a scale of 1 ("strongly disagree") to 4 ("strongly agree"). A sum score of the 14 items was calculated with a higher score indicating higher levels of internalized SGM-related stigma. The reliability of this scale was acceptable (Cronbach's alpha=0.87).

**Anticipated SGM-related stigma** was assessed with 17 items derived from the internalized homophobia and perceived stigma scale (Puckett et al., 2017) and the homosexuality-related stigma scale (Ha et al., 2013) to describe the stigma refers to an MSM’s perception of how others respond if they know about his same-sex behaviors. The researchers introduced an additional item to better fit the Chinese context (“same-sex behavior doesn’t match with the traditional Chinese culture”). Other sample items are “many employers would underestimate a man due to his homosexuality regardless of his qualifications for the job” and “many people do not see gay men as real men.” Each statement was rated on a scale from 1 ("strongly disagree") to 4 ("strongly agree"). A sum

score of the 17 items was calculated with a higher score indicating higher levels of anticipated SGM-related stigma. The Cronbach's alpha of this scale was 0.95 in our study.

**Enacted SGM-related stigma** was assessed with 14 items derived from the China MSM stigma scale (Neilands et al., 2008) and the homosexuality-related stigma scale (Ha et al., 2013) to depict the actual experiences of prejudice and discrimination that occur to a man because of his same-sex behaviors. Participants were asked to rate the frequency of encountering a series of negative life events due to their MSM identity from 1 ("never") to 4 ("often"). Sample life events are "being hit or beaten up for being homosexual" and "being kicked out of school for being homosexual." A sum score of the 14 items was calculated with a higher score indicating higher levels of enacted SGM-related stigma. The reliability of this scale was acceptable (Cronbach's alpha=0.85).

*Covariates*

**Sociodemographic characteristics** included age (18-24, 25-34, 35-44, 45 or older), ethnicity (Han, other), marital status (single, married/life partner, divorced/separated/widowed), educational attainment (middle school or below, high school, college and above), employment (fulltime employed, parttime employed, unemployed), monthly household income (1,999 Chinese Yuan [CNY] or below, 2,000-3,999 CNY, 4,000 CNY or above), residence rurality (city, county, rural), and sexual identity (gay/bisexual, straight, unsure).

### 3.4 Data analysis

*Overall analytic considerations*

Prior to data analysis specific to each study, some analytic issues associated with appropriate analysis were carefully assessed and considered in data management and cleaning. These issues included collinearity, missing data, outliers, and multiple comparisons. In the longitudinal data analysis, trajectory patterns (e.g., linear, quadratic, cubic) were evaluated and considered.

Collinearity might exist in the data analysis and influence parameter estimation. The collinearity among independent variables of interest was tested using two widely used indices: variance of inflation (VIF) and value of tolerance, with criteria of collinearity being: (1) VIF larger than 10; and/or (2) value of tolerance less than 0.2 or 0.1 (Wicklin, 2020). If collinearity existed among several variables, which indicates similar conceptual meaning and strong correlations, only one variable with the highest correlation with each outcome was included in the final models.

Missing data/attrition could be an issue in both longitudinal and cross-sectional data analyses. During the three years of follow-up, 62 (out of 1,198) participants dropped from the longitudinal study. Preliminary analyses revealed that the attrition rate was less than 5% for each follow-up in the 7-wave longitudinal datasets, and the maximum percentage of missing responses for any single variable was less than 5% in the cross-sectional dataset. As the percentage of missing data was low, missing at random (MAR) was assumed. Expectation Maximization (E.M.) algorithm was therefore used to impute missing data (Dempster et al., 1977).

Multivariable linear regression was conducted to examine the outliers among all continuous variables. Scatter plot, residual plot, Cook's distance, and Mahalanobis distance will be used to detect the outliers among variables of interest. Observations with Cook's distance larger than 1 or with a greater Mahalanobis distance from the rest of the sample population ($p<.001$) were considered outliers or influential cases (Cousineau & Chartier, 2010; Penny, 1996). If evidence showed outliers or influential cases, observations were double-checked for any mistakes in data cleaning, coding, and management. Outliers/influential cases without any mistakes were kept for further analysis. Otherwise, they were recoded as missing values.

As several hypotheses were simultaneously tested for multiple outcome measurements in studies 2 and 3, the statistical probability of incorrectly rejecting a true H0 (Type I error) would inflate (Chen et al., 2017). Bonferroni adjustment was adopted to control the increasing Type I error due to multiple comparisons (Bland & Altman, 1995). For the number of simultaneously tested hypotheses *m*, the significance level was adjusted as $\alpha' = \alpha/m$, where the original significance level $\alpha = 0.05$.

*Data analysis for study 1*

Study 1 aimed to examine the measurement invariance for internalized, anticipated, and enacted HIV-related stigma instruments between MSM and non-MSM males. Four levels of measurement invariance were tested: configural, metric, scalar, and residual invariance. These levels of invariance build on one another, following a measurement invariance ladder from the least stringent to the most stringent (Vandenberg & Lance, 2000). Configural invariance refers to that the number of factors and pattern of loadings are the same across groups. Metric invariance refers to that the factor loadings

are the same across groups. Scalar invariance means that item intercepts (for continuous response items) or item thresholds (for categorical response items) are equivalent across groups. Residual invariance means that the residual variance, such as measurement errors, are similar across groups (Putnick & Bornstein, 2016).

For Study 1, descriptive analysis was conducted to describe participants' sociodemographic characteristics using mean (standard deviation [SD]) for continuous variables and frequency (percentage [%]) for categorical variables. Internal consistencies, means, standard deviations, skewness, and kurtosis of the sum scores for each scale in each MSM and non-MSM were examined. Data was considered normally distributed if skewness is between -2 to +2 and kurtosis is between -7 to +7 (Hair et al., 2010). Internal consistency above .7 was considered good, and above .8 was considered great (Cortina, 1993).

The measurement invariance analyses were conducted following the procedure described and developed by Vandenberg and Lance (2000) and Schulte et al. (2013). Multi-group comparisons in the context of CFA were conducted with the software program M*plus* 8.4 (Muthén & Muthen, 2017). The step-up approach was used to add a series of increasingly stringent equality constraints to the models (Brown, 2015). First, configural invariance of the baseline model was tested with multiple group comparisons, where no equality constraints were imposed. Second, metric invariance was examined by constraining factor loadings of indicators to be equal across groups. Third, scalar invariance was examined. For internalized and anticipated HIV-related stigma scale, of which item responses were continuous, scalar invariance was tested by constraining intercepts of indicators to be equal across groups. For HIV-related enacted stigma scale,

of which item responses were dichotomous, scalar invariance was tested by constraining item thresholds to be equivalent across groups. Item thresholds are specifically relevant for binary indicators (e.g., 0=No, 1=Yes), referring to the level of the latent trait (e.g., enacted stigma) that is associated with transitioning from being negative on the indicator to being positive on the indicator (Brown, 2015). Fourth, residual invariance was tested. For internalized and anticipated HIV-related stigma scale, residual invariance was examined by constraining item residual variances to be equal between groups. For HIV-related enacted stigma scale, residual invariance was examined by further constraining the residual variances to 1 in both groups.

In case full measurement invariance could not be established, partial invariance was further examined (Byrne et al., 1989). By means of modification indices, a modified model for checking partial invariance by releasing the equality constraints for misspecified items was subsequently examined. To establish the certain level of partial measurement invariance, at least the loadings/intercepts/thresholds/residuals of two items should be equal across groups (Byrne et al., 1989).

*Data analysis for study 2*

Study 2 aimed to examine potential health disparities in longitudinal trajectories of physical, psychosocial, and behavioral health outcomes between MSM and non-MSM males. First, baseline sociodemographic characteristics were described with frequency (column percent) and compared between non-MSM males and MSM using Chi-square tests or Fisher's exact tests as appropriate. Second, trends of physical, psychological, and behavioral health outcomes over time were examined. Trends of continuous outcomes (i.e., depressive symptoms, anxiety symptoms) were tested with repeated measure

analysis of variance (ANOVA). Trends of categorical outcomes (i.e., CD4 count, viral load, ART adherence) were tested with Cochran-Armitage trend tests.

Third, associations between sociodemographic characteristics and longitudinal physical, psychological, and behavioral health outcomes were conducted with univariate generalized linear mixed model (GLMM) for categorical outcomes and repeated measure ANOVA for continuous outcomes.

Fourth, latent growth curve model (LGCM) was adopted to estimate the inter-individual variability in intra-individual change patterns through two latent factors - the intercept (the initial value of variables of interest) and the slope (the change rate of variables of interest) (Curran, Obeidat, & Losardo, 2010; Duncan & Duncan, 2004). LGCM could be applied to investigate the trajectories for both continuous and categorical variables (Wang & Wang, 2019). For each outcome of interest, an LGCM was adopted to depict the trajectories in each group, and to examine the potential difference between trajectories by MSM status. Baseline sociodemographic covariates were introduced as time-invariant variables, including included age, ethnicity, marital status, education, employment, monthly household income, and residence rurality.

*Data analysis for study 3*

First, descriptive analysis was conducted to describe participants' sociodemographic characteristics using frequency (percentage [%]). Second, bivariate analyses between sociodemographic characteristics and categorical outcomes (i.e., CD4 count, viral load, ART adherence) were conducted with Chi-square tests or Fisher's exact tests as appropriate. Bivariate analyses between sociodemographic characteristics and

continuous outcomes (i.e., depressive symptoms, anxiety symptoms) were conducted with ANOVA or t-tests as appropriate.

Interactive effects between HIV- and SGM-related stigma on physical, psychological, and behavioral health outcomes were tested with a structural equation model (SEM) using the latent moderated structural equations (LMS) approach (Klein & Moosbrugger, 2000). Existing literature suggests that LMS has good performance with the nonlinearity induced by interaction terms (Kelava et al., 2011). The procedure for estimating LMS using the XWITH command in M*plus* 8.4 software (Muthén & Muthen, 2017) followed the guideline of Maslowsky et al. (2014). Prior to testing the hypothesized model, the three types of HIV-related stigma and the three types of SGM-related stigma were treated as indicators of a latent stigma construct, respectively, namely HIV-related stigma and SGM-related stigma. A measurement model was estimated to ensure the goodness of fit prior to estimating structural models. Structural models are estimated in two steps (Klein & Muthén, 2007; Muthén & Muthen, 2017). In the first step, structural models without the latent interaction term were estimated, henceforth referred to as Model 0. In the second step, structural models with the latent interaction were estimated, henceforth referred to as Model 1. Results of Model 1 provided coefficients and indicated whether the latent interaction was significant.

Across all three studies, the use of model fit indices followed Hu and Bentler (1999) recommendations. In addition to the Chi-square statistic, which can be inflated by large sample sizes and moderate discrepancies from normality, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker-Lewis Index (TLI) were also used to evaluate model fit.

RMSEA of .08 or less, SRMR of .08 or less, CFI and TLI of .95 or greater indicate adequate fit (Browne & Cudeck, 1992; Hu & Bentler, 1999; Weiber & Mühlhaus, 2014).

Descriptive statistics and bivariate analyses were performed with SPSS 28.0 (IBM Corp). Cochran-Armitage trend tests were conducted with SAS 9.4. CFA (Cary, NC: SAS Institute Inc.), LGCM, and LMS were performed using M*plus* 8.4 (Muthen & Muthen, Los Angeles, CA).

# CHAPTER 4

## MEASUREMENT INVARIANCE OF SCALES ASSESSING INTERNALIZED, ANTICIPATED, AND ENACTED HIV-RELATED STIGMA BY MSM STATUS

### 4.1 Abstract

**Background:** Measurement invariance is the extent to which scales have the same meaning across groups and is a prerequisite for use in comparison studies. As HIV-related stigma scales are increasingly used in HIV studies for comparisons between different subgroups, such as men who have sex with men (MSM) and non-MSM males, it is necessary to assess the measurement equivalence between groups. This study examined the measurement invariance for internalized, anticipated, and enacted HIV-related stigma instruments between MSM and non-MSM males.

**Methods:** Data derived from a prospective cohort study and a cross-sectional survey study was used in this study. By merging two data sources, a combined sample of 595 MSM (193 from the prospective cohort study and 402 from the cross-sectional survey study) and 579 non-MSM males (only from the prospective cohort study) were used in the current analysis. Participants completed the 8-item internalized HIV-related stigma scale, the 9-item anticipated HIV-related stigma scale, and the 16-item checklist of enacted HIV-related stigma scale. Confirmatory factor analyses in a step-up approach were used to test the between-group measurement invariance by adding a series of increasingly stringent equality constraints to the models.

**Results:** Configural and metric invariances for the internalized HIV-related stigma scale were fully satisfied. Scalar measurement invariance was partly satisfied for the internalized HIV-related stigma scale by allowing the intercepts of items 2, 3, and 6 to vary between groups ($\chi^2$=89.32, *df*=43; CFI=.986; TLI=.981; RMSEA=.043, 95% CI [.030, .056]; SRMR=.033), indicating that the zero points of item 2 ("I feel ashamed of having HIV"), item 3 ("Having HIV makes me feel unclean"), and item 6 ("I feel guilty because I have HIV") were different between MSM and non-MSM males. Configural, metric, scalar invariances for the anticipated HIV-related stigma scale were fully satisfied. Partial residual measurement invariance was established for the anticipated HIV-related stigma scale by allowing the residual of item 2 ("Family members will look down on me") to vary by MSM status ($\chi^2$=93.57, *df*=66; CFI=.994; TLI=.993; RMSEA=.027, 95% CI [.012, .038]; SRMR=.022), indicating that the item variance that could not be explained by the factor was different between MSM and non-MSM males. Configural and metric invariances for the enacted HIV-related stigma scale were fully satisfied. Partial scalar measurement invariance was established for the enacted HIV-related stigma by allowing the threshold of item 7 ("stress from spouse/partner") to vary between groups ($\chi^2$=314.74, *df*=219; CFI=.987; TLI=.986; RMSEA=.027, 95% CI [.020, .034]; SRMR=.088), indicating that the threshold of item 7 was different between MSM and non-MSM males.

**Conclusion:** This study provided evidence for acceptable measurement invariance for internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males. However, the comparisons of certain stigma measures across groups should be interpreted with caution since the constraints of some items vary across groups. This

study provided evidence and support for future studies using these scales to assess HIV-related stigma between MSM and non-MSM males, which could be a basis for future intervention in stigma reduction.

## 4.2 Introduction

HIV-related stigma, known as a discrediting and tainting social label (Goffman, 2009), is well-documented as a barrier to physical and psychological well-being and healthcare access for people living with HIV (PLWH) (Courtenay–Quirk et al., 2006a; Dowshen et al., 2009). According to the Health Stigma Framework, PLWH may experience internalized, anticipated, and enacted stigma when they perceive prejudice, stereotypes, and discrimination from others (Earnshaw & Chaudoir, 2009; Earnshaw et al., 2013). Internalized stigma refers to endorsing negative attitudes associated with HIV and applying these beliefs to themselves, leading to a sense of self-blaming, feelings of guilt, and feelings of worthlessness (Earnshaw & Chaudoir, 2009). Anticipated stigma involves expectations of discrimination, stereotyping, and/or prejudice from others if their HIV status is disclosed (Earnshaw et al., 2013). Enacted stigma refers to actual experiences of discrimination, stereotyping, and/or prejudice due to HIV from others in the past or present (Center for Disease Control and Prevention, 2021a; Earnshaw et al., 2013).

The three types of HIV-related stigma are closely associated with each other and have been well-established to undermine the physical, psychological, and behavioral health of PLWH (Cole et al., 1997). Physically, HIV-related stigma could accelerate HIV progression, resulting in a lower level of CD4 count, a higher level of viral load, and a shorter time to AIDS diagnosis when untreated (Cole et al., 1997; Lyons et al., 2020).

Psychologically, HIV-related stigma contributes to mental disorders among PLWH, including depression, anxiety, emotional distress, and suicidal ideation or attempts (Bogart et al., 2010; Capron et al., 2012; Carrico, 2010; Gonzalez et al., 2009; Kang et al., 2005; Lee et al., 2002; Siegel et al., 2005). A systematic review also showed that HIV-related stigma was associated with maladaptive health behaviors such as suboptimal ART adherence (Sweeney & Vanable, 2016).

Different scales have been developed to measure the three types of HIV-related stigma. One measurement tool of internalized HIV-related stigma is the 8-item scale derived from the "negative self-image" session of the Berger HIV Stigma Scale, which is a reliable and valid instrument developed from a large, diverse sample of PLWH (Berger et al., 2001). Anticipated HIV-related stigma could be assessed by a 9-item scale derived from the Health Stigma Framework. This scale assessed participants' expectations of HIV-related stigma from family members, the community, and healthcare providers (Earnshaw et al., 2013). Enacted HIV-related stigma could be evaluated by the 16-item checklist derived from the PLWH Stigma Index. The checklist focuses on the actual experiences of being stigmatized due to HIV in the past six months (dos Santos et al., 2014).

As the measurements of three types of HIV-related stigma were developed among PLWH rather than MSM specifically (Berger et al., 2001), measurement invariance for scales of the three types of HIV-related stigma is a prerequisite for use as in comparison studies between MSM and non-MSM males. Given the potential differences in self-image, experiences of being discriminated against, or perceptions of social norms between non-MSM males and MSM (Yan et al., 2019), it is important to ensure that

assessment tools used to measure HIV-related stigma are assessing the same underlying constructs by MSM status. If measurement invariances of HIV-related stigma scales are achieved between MSM and non-MSM males, observed group differences in HIV-related stigma could be attributed to true between-group discrepancies rather than measurement error (Vandenberg & Lance, 2000). If measurement invariances are not satisfied, the HIV-related stigma scales may fail to accurately capture the interested construct, and the observed group differences might be due to inconsistent understanding of certain key concepts or measurement deviations (Vandenberg & Lance, 2000).

As measurement invariances have not been tested for the internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males, the appropriateness of using these tools for comparison between diverse subgroups was not determined. This study aimed to assess measurement invariance for these three HIV-related stigma scales between non-MSM males and MSM in China using multi-group comparisons in the context of confirmatory factor analyses.

## 4.3 Methods

*Study setting and participants*

Data in the current study were derived from a prospective cohort study and a cross-sectional survey study. The prospective cohort study was designed to investigate the association between HIV-related stigma and clinical outcomes, and the potential physical, mental and behavioral mechanisms underlying such associations among PLWH in Guangxi, China. Baseline assessment was conducted from November 2017 to February 2018. In collaboration with Guangxi Center for Disease Control and Prevention (Guangxi CDC), six major public hospitals/clinics with the largest volume of HIV patients under

care in five cities were selected as study sites. Eligible cases for the cohort study were PLWH who: (1) aged between 18 and 60 years old, (2) had a confirmed diagnosis of HIV, and (3) had no plan to relocate outside of the Guangxi province in the next 12 months. A total of 1,198 PLWH were recruited in the cohort study, of which 64.4% (n=772) were men, including 193 MSM and 579 non-MSM males.

The cross-sectional survey study was designed to explore the association between intersectional stigma and HIV-related health outcomes among MSM living with HIV. Data collection was initiated in August 2020 and finished in May 2021. In collaboration with Guangxi CDC, four major public hospitals/clinics with the largest cumulative number of MSM living with HIV in three cities were selected as study sites. Eligible participants were men who: (1) aged 18-60 years; (2) had a confirmed diagnosis of HIV/AIDS; (3) self-reported having sex with men in the last six months. MSM were excluded if they had already participated in the aforementioned prospective cohort study. After excluding participants that were not eligible, 402 MSM were involved in the study.

A subset of the prospective cohort study sample consisting of 193 MSM and 579 non-MSM males, and the 402 MSM recruited from the cross-sectional survey study were included in the current study.

*Assessment Instruments*

*Internalized HIV-related stigma scale*

Internalized HIV-related stigma was assessed with an 8-item scale derived from the subscale of "negative self-image" of the Berger HIV Stigma Scale (Berger et al., 2001). Participants were asked to respond to each statement on a 4-point scale from 1 ("strongly disagree") to 4 ("strongly agree"). Sample statements are "I feel I'm not as

good as others because I have HIV" and "I feel guilty because I have HIV." A sum score of the eight items was calculated with a higher score indicating a higher level of internalized HIV stigma. The scale exhibited a Cronbach's α of .95 in our study.

*Anticipated HIV-related stigma*

Anticipated HIV-related stigma was assessed with a 9-item scale derived from the Health Stigma Framework (Earnshaw et al., 2013). This scale assessed participants' expectations of HIV-related stigma coming from family members, community, and healthcare providers. Sample items are "Family members will avoid touching me," "Community managers will refuse to provide me with social services," and "Healthcare providers will treat me with less respect." Each item was rated on a scale of 1 ("definitely not") to 5 ("definitely"). A sum score of the nine items was calculated, ranging from 9 to 45, with a higher score indicating higher levels of anticipated HIV stigma. The Cronbach's alpha of this scale was 0.93 in our study.

*Enacted HIV-related stigma*

Enacted HIV-related stigma was evaluated using a 16-item checklist adapted from a previous study (dos Santos et al., 2014). PLWH were asked whether they had experienced actual incidents of being stigmatized due to HIV in the past six months, including "Being excluded from social gatherings or activities," "Being excluded from family activities," and "Being physically assaulted." Participants who answered "yes (1)" were considered to have the experience of being stigmatized, while those who answered "no (0)" were considered to have no such experience. The total score of the 16 items was used as a composite score, with a higher score indicating more experiences of being

stigmatized in the last six months. The enacted stigma scale also showed good reliability at baseline (Cronbach's alpha=0.86).

*Statistical analysis*

First, descriptive analysis was conducted to describe participants' sociodemographic characteristics using mean (standard deviation [SD]) for continuous variables and frequency (percentage [%]) for categorical variables. Second, internal consistencies, means, standard deviations, skewness, and kurtosis of the sum scores for each scale among MSM and non-MSM were examined. Data were considered normally distributed if skewness is between -2 to +2 and kurtosis is between -7 to +7 (Hair et al., 2010). Internal consistency above .7 was considered good, and above .8 was considered great (Cortina, 1993).

Third, measurement invariance analysis was conducted according to the procedure described by Vandenberg and Lance (Vandenberg & Lance, 2000). Multi-group comparisons in the context of CFA were conducted with the software program M*plus* 8.4 (Muthén & Muthen, 2017). The step-up approach was used to add a series of increasingly stringent equality constraints to the models (Brown, 2015): 1) configural invariance of the baseline model was tested with multiple group comparisons, where no equality constraints were imposed; 2) metric invariance was examined by constraining factor loadings of indicators to be equal across groups. The factor variance(s) were fixed to 1 in non-MSM males and were free in MSM; 3) scalar invariance was examined. For internalized and anticipated HIV-related stigma scale, of which item responses were continuous, scalar invariance was tested by constraining intercepts of indicators to be equal across groups. For enacted HIV-related stigma scale, of which item responses were

dichotomous, scalar invariance was tested by constraining item thresholds to be equivalent across groups. Item thresholds are specifically relevant for binary indicators (e.g., 0=No, 1=Yes), referring to the level of the latent trait (e.g., enacted stigma) that is associated with transitioning from being negative on the indicator to being positive on the indicator (Brown, 2015). The factor mean(s) were fixed to 1 in the non-MSM males group and were free in the MSM group; and 4) residual invariance was tested. For internalized and anticipated HIV-related stigma scale, residual invariance was examined by constraining item residual variances to be equal between groups. For HIV-related enacted stigma scale, residual invariance was examined by further constraining the residual variances to 1 in both groups.

In case full measurement invariance could not be established, partial invariance was further examined (Byrne et al., 1989). By means of modification indices, a modified model for checking partial invariance by releasing the equality constraints for misspecified items was subsequently examined. To establish partial measurement invariance, at least the loadings/intercepts/thresholds/residuals of half of the scale items should be equal across groups (Byrne et al., 1989).

For internalized and anticipated HIV-related stigma scales, of which item responses were continuous, estimations were done with the M*plus* MLR estimator, which corrects the estimated standard errors for deviations from multivariate normality. For enacted HIV-related stigma scale, of which item responses were dichotomous, estimations were done with the M*plus* weighted least squares mean and variance adjusted (WLSMV) estimator (Hansson & Gustafsson, 2013).

Following Hu and Bentler (1999) recommendations, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative fit index (CFI), and Tucker-Lewis Index (TLI) were also used to evaluate model fit, in addition to the Chi-square statistic, which can be inflated by large sample sizes and moderate discrepancies from normality. RMSEA of .08 or less, SRMR of .08 or less, CFI and TLI of .95 or greater indicate adequate fit (Browne & Cudeck, 1992; Hu & Bentler, 1999; Weiber & Mühlhaus, 2014).

Decision of whether a model was accepted or rejected was based on Chi-square difference tests (Hu & Bentler, 1999). Across steps, Chi-square difference statistic test was used to determine if the additional constraints significantly degraded fit (Bryant et al., 1997). For internalized and anticipated HIV-related stigma scales, with MLR estimator, the ordinary Chi-square difference test does not yield a $\chi^2$ distributed test, which requires the application of Satorra-Bentler scaled Chi-square difference test to obtain the correct results (Satorra & Bentler, 2010). The test statistic, T, was calculated with the following equation, where c0 refers to the scaling correction factor for the null model; c1 refers to the scaling correction factor for the alternative model; d0 refers to the degrees of freedom for the null model; d1 refers to the degrees of freedom for the alternative model; SB0 refers to the Satorra-Bentler scaled Chi-square value for the null model; SB1 refers to the Satorra-Bentler scaled Chi-square value for the alternative model. T is $\chi^2$ distributed with degrees of freedom (d0 - d1) (Satorra & Bentler, 2010).

$$T = \frac{(\mathrm{SB0} \times \mathrm{c0} - \mathrm{SB1} \times \mathrm{c1}) \times (\mathrm{d0} - \mathrm{d1})}{\mathrm{d0} \times \mathrm{c0} - \mathrm{d1} \times \mathrm{c1}}$$

For HIV-related enacted stigma scales, with WLSMV estimator, Chi-square difference tests were carried out using the M*plus* DIFFTEST option (Muthén & Muthen, 2017).

Scalar invariance is considered necessary and sufficient evidence for measurement invariance (Muthén & Muthen, 2017).

### 4.4 Results

*Descriptive statistics*

The sociodemographic characteristics of non-MSM males and MSM are summarized in Table 4.1. More than half of the 1,174 MLWH were MSM (n=595, 50.7%), 35-44 years old (n=454, 38.7%), Han ethnicity (n=766, 65.2%), single (n=636, 54.2%), with a degree of middle school or below (n=479, 40.8%), having a fulltime job (n=786, 67.0%) with monthly household income between 2,000 and 3,999 CNY (n=583, 49.7%), having a CD4 count<500 cells/$mm^3$ (n=622, 53.0%) and viral load less than 50 copies/ml (n=1,022, 87.1%).

Table 4.2 shows the internal consistencies, means, standard deviations, skewness, and kurtosis of the sum scores for each stigma scale in each group. Based on the criteria of Hair et al. (2010) (normality: skewness≤2; kurtosis≤7), internalized stigma and anticipated stigma were normally distributed, while enacted stigma was not normally distributed. The internal consistency was great for internalized stigma and anticipated stigma (alpha>.8) and good for enacted stigma scale (alpha>.7). Item 7 of the enacted stigma scale "stress from spouse/partner" showed small correlations (<.2) with most of the other items of the scale in both non-MSM males and MSM.

*Measurement invariance of internalized HIV-related stigma scale by MSM status*

The results of multi-group tests of measurement invariance of internalized HIV-related stigma scale are presented in Table 4.3. Model fit indices of the baseline model of

the scale were in line with configural measurement invariance ($\chi^2$=66.00, *df*=31; CFI=.989; TLI=.980; RMSEA=.044, 95% CI [.029, .059]; SRMR=.017).

In the model imposing metric measurement invariance, item loadings were constrained to be equal by MSM status. Model fit indices revealed satisfied fit ($\chi^2$=79.18, *df*=38; CFI=.987; TLI=.980; RMSEA=.043, 95% CI [.030, .056]; SRMR=.025). A comparison of the metric model with the configural model using a Satorra-Bentler scaled chi-square difference test showed that the more restrictive model with equal factor loadings was not significantly worse than the configural model (T=10.57, Δ*df*=7, *p*=.16), suggesting that the fit of metric invariance was satisfied.

To examine scalar invariance, intercepts of indicators were also constrained to be equal between the two groups. The fit of scalar measurement invariance was good ($\chi^2$=104.84, *df*=45; CFI=.981; TLI=.976; RMSEA=.048, 95% CI [.036, .060]; SRMR=.028). A comparison of the scalar model with the metric model using a Satorra-Bentler scaled chi-square difference test showed that the scalar model was significantly worse than the metric model (T=36.75, Δ*df*=7, *p*<.001), suggesting that the fit of scalar invariance was not satisfied. Partial scalar measurement invariance was established by allowing the intercepts of item 2, 3, and 6 to vary between groups ($\chi^2$=89.32, *df*=43; CFI=.986; TLI=.981; RMSEA=.043, 95% CI [.030, .056]; SRMR=.033). Satorra-Bentler scaled chi-square difference test showed that the partial scalar model was not significantly worse than the metric model (T=8.84, Δ*df*=4, *p*=.07), supporting partial scalar invariance between MSM and non-MSM males.

In addition to item slopes and intercepts, equivalence of the item residuals was constrained between the two groups to examine residual invariance. Because the criteria

were only met for partial scalar measurement invariance by allowing the intercepts of items 2, 3, and 6 to vary between groups, partial residual invariance was tested with residual item variances constrained to be equal between groups, except for the residual variance of item 2, 3, and 6. The fit of partial residual measurement invariance was good ($\chi^2$=92.29, *df*=47; CFI=.986; TLI=.983; RMSEA=.041, 95% CI [.028, .053]; SRMR=.040). Satorra-Bentler scaled chi-square difference test showed that the partial residual model was not significantly worse than the partial scalar model (T=5.79, $\Delta df$=5, *p*=.33), supporting partial residual invariance between MSM and non-MSM males.

*Measurement invariance of anticipated HIV-related stigma scale by MSM status*

The results of multi-group tests of measurement invariance of anticipated HIV-related stigma scale are presented in Table 4.4. Model fit indices of the baseline model of the scale were in line with configural measurement invariance ($\chi^2$=74.69, *df*=46; CFI=.994; TLI=.990; RMSEA=.033, 95% CI [.018, .046]; SRMR=.019).

In the model imposing metric measurement invariance, item loadings were constrained to be equal between the two groups. Model fit indices revealed satisfied fit ($\chi^2$=82.00, *df*=52; CFI=.993; TLI=.991; RMSEA=.031, 95% CI [.017, .043]; SRMR=.021). A comparison of the metric model with the configural model using a Satorra-Bentler scaled chi-square difference test showed that the more restrictive model with equal factor loadings was not significantly worse than the configural model (T=5.17, $\Delta df$=6, *p*=.52), suggesting that the fit of metric invariance was satisfied.

To examine scalar invariance, intercepts of indicators were also constrained to be equal between the two groups. The fit of scalar measurement invariance was good ($\chi^2$=90.27, *df*=58; CFI=.993; TLI=.991; RMSEA=.031, 95% CI [.017, .043];

SRMR=.021). A comparison of the scalar model with the metric model using a Satorra-Bentler scaled chi-square difference test showed that the scalar model was not significantly worse than the metric model (T=7.41, Δ*df*=6, *p*=.28), suggesting that the fit of scalar invariance was satisfied.

In addition to item slopes and intercepts, equivalence of the item residuals was constrained between the two groups to examine residual invariance. The fit of residual measurement invariance was good ($\chi^2$=113.20, *df*=67; CFI=.990; TLI=.989; RMSEA=.034, 95% CI [.023, .045]; SRMR=.022). Satorra-Bentler scaled chi-square difference test showed that the partial residual model was significantly worse than the partial scalar model (T=17.85, Δ*df*=9, *p*=.04), suggesting that the fit of residual invariance was not satisfied. Therefore, residual of item 2 was allowed to vary between the two groups to establish partial residual invariance ($\chi^2$=93.57, *df*=66; CFI=.994; TLI=.993; RMSEA=.027, 95% CI [.012, .038]; SRMR=.022). Satorra-Bentler scaled chi-square difference test showed that the partial residual model was not significantly worse than the scalar model (T=8.44, Δ*df*=8, *p*=.39), supporting partial residual invariance between MSM and non-MSM males.

*Measurement invariance of enacted HIV-related stigma scale by MSM status*

The results of multi-group tests of measurement invariance of enacted HIV-related stigma scale are presented in Table 4.5. Model fit indices of the baseline model of the scale were in line with configural measurement invariance ($\chi^2$=312.24, *df*=196; CFI=.984; TLI=.980; RMSEA=.032, 95% CI [.025, .038]; SRMR=.087).

In the model imposing metric measurement invariance, item loadings were constrained to be equal between the two groups. Model fit indices revealed satisfied fit

($\chi^2$=301.23, *df*=208; CFI=.987; TLI=.985; RMSEA=.028, 95% CI [.020, .034]; SRMR=.088). A comparison of the metric model with the configural model using the chi-square value for WLSMV difference test showed that the more restrictive model with equal factor loadings was not significantly worse than the configural model (*p*=.73), suggesting that the fit of metric invariance was satisfied.

To examine scalar invariance, item thresholds were also constrained to be equal between the two groups. The fit of scalar measurement invariance was good ($\chi^2$=319.74, *df*=220; CFI=.986; TLI=.985; RMSEA=.028, 95% CI [.021, .034]; SRMR=.088). A comparison of the metric model with the configural model using the chi-square value for WLSMV difference test showed that the scalar model was significantly worse than the metric model (*p*=.02), suggesting that the fit of scalar invariance was not satisfied. Partial scalar measurement invariance was established by allowing the threshold of item 7 to vary between groups ($\chi^2$=314.74, *df*=219; CFI=.987; TLI=.986; RMSEA=.027, 95% CI [.020, .034]; SRMR=.088). Chi-square value for WLSMV difference test showed that the partial scalar model was not significantly worse than the metric model (*p*=.16), supporting partial scalar invariance between MSM and non-MSM males.

Residual invariance was tested by constraining residual variance to 1 in both groups. Because the criteria were only met for partial scalar measurement invariance by allowing the threshold of item 7 to vary between groups, partial residual invariance was tested with residual variances constrained to be 1 in both groups, except for the residual variance of item 7. The fit of partial residual measurement invariance was good ($\chi^2$=316.41, *df*=204; CFI=.985; TLI=.982; RMSEA=.031, 95% CI [.024, .037]; SRMR=.087). Chi-square value for WLSMV difference test showed that the partial

residual model was not significantly worse than the partial scalar model ($p$=.55), supporting partial residual invariance between MSM and non-MSM males.

### 4.5 Discussion

This study used multi-group CFA to examine the configural, metric, scalar, and residual measurement invariance of the internalized, anticipated, and enacted HIV-related stigma scales between 595 MSM and 579 non-MSM males living with HIV. Measurement invariance is a prerequisite for using these scales to assess internalized, anticipated, and enacted HIV-related stigma in between-group comparisons. The anticipated HIV-related stigma scale had the same factor loadings and intercepts, and similar item residual variances in the two groups and achieved partial residual invariance. The internalized and enacted HIV-related stigma scales had the same factor loadings and similar intercepts in the two groups and achieved partial scalar invariance. Scalar invariance is considered the minimum requirement for meaningfully comparing latent factor means across groups (Muthén & Muthen, 2017). This study suggested that the measurement invariance of all three HIV-related stigma scales was satisfied.

The multi-group tests of measurement invariance of the internalized HIV-related stigma scale suggested that both configural and metric invariances were fully satisfied between MSM and non-MSM males, indicating that the scale intervals are the same across groups, allowing for comparing unstandardized regression coefficients and/or covariances across groups (Pirralha, 2020). The scalar invariance was only partially satisfied by freeing the constraint of intercepts of item 2 (“I feel ashamed of having HIV”), item 3 (“Having HIV makes me feel unclean”), and item 6 (“I feel guilty because I have HIV”) across groups. These results indicated that the zero points of these items

were different between MSM and non-MSM males. That is, MSM were more likely to feel "ashamed," "unclean," and "guilty," but the increased levels of these feelings were not related to increased levels of internalized HIV-related stigma among MSM. In line with a qualitative study describing stigma related to pre-exposure prophylaxis (PrEP) uptake among HIV-negative MSM, participants reported that they felt a loss of respect, guilt and shame about using PrEP due to their SGM identities, while their straight friends were not ashamed to talk about HIV (Dubov et al., 2018). MSM often face social disapproval of sexual deviance from the "normal" sexual identity, producing the feeling of shame (Fortenberry et al., 2002; Herek, 2004). Even though such a feeling of shame does not result from HIV, it could predict risky sexual behavior (e.g., unprotected sex), which elevates the risk of acquiring HIV (Newcomb & Mustanski, 2011).

The measurement invariance analysis of the anticipated HIV-related stigma scale between MSM and non-MSM males showed that the first three levels of measurement invariance, including configural, metric, and scalar invariances were satisfied. Residual invariance was partially satisfied by freeing the constraint of residual variance of item 2 ("Family members will look down on me") across groups. This result indicated that the item variance that could not be explained by the factor was different between MSM and non-MSM males. For MSM, besides HIV-related stigma, the fear of negative responses from family members might also be explained by their SGM identities. A qualitative study about HIV disclosure reported that only 57.1% of MSM (vs. 72.2% of straight MLWH) disclosed their HIV seropositive status to family members (Ko et al., 2007). Compared to non-MSM males, MSM had more concern about explaining to their family how they got this disease (Ko et al., 2007). Another qualitative study among MSM about

disclosing their sexual identities to family members reported that responses from family members could be supportive, denial, confused, or unsupportive (Gyamerah et al., 2019). Whether or not the family was supportive, silence around the MSM's sexual identity was prevalent within families (Gyamerah et al., 2019).

Similar to internalized HIV-related stigma, the multi-group tests of measurement invariance of the enacted HIV-related stigma scale suggested that both configural and metric invariances were satisfied between MSM and non-MSM males. The scalar invariance was partially satisfied by freeing the constraint of intercept of item 7 ("stress from spouse/partner") between two groups. This result indicated that the threshold of item 7 was different between MSM and non-MSM males. That is, MSM were more likely to experience "stress from spouse/partner," but this was not related to increased levels of enacted HIV-related stigma among MSM. For MSM, internalized homophobia and homophobic discrimination were both established to have significant associations with sexual partner violence (Finneran & Stephenson, 2014). Although Chinese society has become relatively more tolerant toward MSM since homosexuality was removed from the Chinese Classification and Diagnostic Criteria of Mental Disorders in 2001 (Wu, 2003), same-sex marriage is still illegal, and discrimination based on sexual and/or gender identity is not prohibited by laws (Cao & Guo, 2016; Zhang & Chu, 2005). MSM are still expected to fulfill their family duty of traditional marriage (i.e., heterosexual and cisgender) and are expected to produce children (Wu, 2003). Such stress from the society, spouse or partner, and the disclosure issue could further lead to psychological distress and stress-sensitive illness (Sun et al., 2020).

From methodological perspectives, study results indicated that the three HIV-related stigma scales were all acceptable for use in between-group comparisons. Previous studies have validated the internal consistency and factor structure of the internalized HIV-related stigma scale among MSM living with HIV (Valle et al., 2015) and its short version in adolescents living with HIV (Wanjala et al., 2021). This study further provided evidence for the generalizability of this scale by directly comparing the measurement structure between MSM and non-MSM males. Although the current study reported satisfied measurement invariance for the anticipated HIV-related stigma scale between MSM and non-MSM males, the reliability and validity of this scale were controversial (Brown et al., 2021; Reinius et al., 2018). Reinius et al. (2018) suggested that the scale should be revised when a very high proportion of PLWH were under efficient treatment. Future studies are needed to confirm these findings and provide evidence for the valid use of the anticipated HIV-related stigma scale. Similarly, although the enacted HIV-related stigma index has been used in 61 countries worldwide (Global Network of People Living with HIV, 2022) and has been used among MSM and female sex workers (Gottert et al., 2019; Gottert et al., 2020; Lo Hog Tian et al., 2021; Yam et al., 2020), limited studies provided evidence on its reliability, validity, and measurement invariance across groups of this scale. This study made new contributions to the measurement invariance of the enacted HIV-related stigma scale, supporting its use in comparative studies between MSM and non-MSM males.

This study is one of the very few studies comprehensively examining the measurement invariance of internalized, anticipated, and enacted HIV-related stigma between MSM and non-MSM males. All four levels of measurement invariance (i.e.,

configural, metric, scalar, residual) were tested compared to a previous study that only tested the first three levels of measurement invariance (Miller & Sheu, 2008). Several limitations should be noted. First, as the sample was limited to MSM and non-MSM males in China, findings may not be generalizable to MLWH in other areas. Second, differences in sociodemographic characteristics between MSM and non-MSM males existed. MSM were more likely to be younger, single, have a college degree or above, and fulltime employed with higher household income. Therefore, the result should be interpreted with caution. Future studies may consider propensity score matching when comparing samples possessing different characteristics. Third, as self-reported questionnaires were used in this study, the recall bias and social desirability could not be ignored.

### 4.6 Conclusion

Overall, this study presented acceptable measurement invariance for internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males. The invariance across groups should be interpreted with caution since the constraints of some items varied across groups. This study provided evidence and support for future studies using these scales to assess HIV-related stigma between MSM and non-MSM males.

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Table 4.1 Sociodemographic characteristics by MSM status

| Variables | Overall (N=1,177) | Non-MSM males (n=579) | MSM (n=595) | *p*-value |
|---|---|---|---|---|
| **Age group** | | | | **<.001** |
| 18-24 | 164 (14.0%) | 13 (2.2%) | 151 (25.4%) | |
| 25-34 | 454 (38.7%) | 139 (24.0%) | 315 (52.9%) | |
| 35-44 | 320 (27.3%) | 228 (39.4%) | 92 (15.5%) | |
| 45+ | 235 (20.0%) | 198 (34.2%) | 37 (6.2%) | |
| **Ethnicity** | | | | .99 |
| Han | 766 (65.2%) | 378 (65.3%) | 388 (65.2%) | |
| Minority | 408 (34.8%) | 201 (34.7%) | 207 (34.8%) | |
| **Marital status** | | | | **<.001** |
| Single | 636 (54.2%) | 134 (23.1%) | 502 (84.4%) | |
| Married/life partner | 404 (34.4%) | 356 (61.5%) | 48 (8.1%) | |
| Divorced/separated/widowed | 134 (11.4%) | 89 (15.4%) | 45 (7.6%) | |
| **Education** | | | | **<.001** |
| Middle school and below | 479 (40.8%) | 393 (67.9%) | 86 (14.5%) | |
| High school | 259 (22.1%) | 111 (19.2%) | 148 (24.9%) | |
| College and above | 435 (37.1%) | 74 (12.8%) | 361 (60.7%) | |
| **Employment** | | | | **<.001** |
| Fulltime | 786 (67.0%) | 374 (64.6%) | 412 (69.2%) | |
| Parttime | 191 (16.3%) | 117 (20.2%) | 74 (12.4%) | |
| Unemployed/retired | 189 (16.1%) | 81 (14.0%) | 108 (18.2%) | |
| **Monthly household income (CNY)** | | | | **<.001** |
| <2,000 | 297 (25.3%) | 191 (33.0%) | 106 (17.8%) | |
| 2,000-4,000 | 583 (49.7%) | 298 (51.5%) | 285 (47.9%) | |
| 4,000 or above | 294 (25.0%) | 90 (15.5%) | 204 (34.3%) | |
| **CD4 count** | | | | **<.001** |
| <500 cells/$mm^3$ | 622 (53.0%) | 369 (63.7%) | 253 (42.5%) | |
| ≥500 cells/$mm^3$ | 552 (47.0%) | 210 (36.3%) | 342 (57.5%) | |
| **Viral load** | | | | **.02** |
| <50 copies/ml | 1022 (87.1%) | 522 (90.2%) | 500 (84.0%) | |
| ≥50 copies/ml | 140 (11.9%) | 56 (9.7%) | 84 (14.1%) | |

*Note:* Bivariate analyses between MSM status and sociodemographic characteristics were tested using Chi-square test or Fisher's exact test as appropriate.

Table 4.2 Internal consistencies, means, standard deviations, skewness and kurtosis of the sum scores for each HIV-related stigma scale by MSM status

| Scale | Non-MSM males | | | | | MSM | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **M** | **SD** | **Skew** | **Kurt** | **α** | **M** | **SD** | **Skew** | **Kurt** | **α** |
| Internalized | 16.14 | 5.49 | .36 | .20 | .94 | 17.32 | 6.01 | .10 | -.50 | .96 |
| Anticipated | 23.13 | 7.80 | .11 | -.28 | .93 | 23.41 | 7.92 | .12 | -.15 | .93 |
| Enacted | .95 | 2.15 | 3.64 | -.28 | .86 | .69 | 1.83 | 4.33 | 23.96 | .86 |

Table 4.3 Summary of fit indices from invariance analyses by MSM status for HIV-related internalized stigma scale

| Model | RMSEA (95% CI) | SRMR | CFI | TLI | $\chi^2$ | *df* | T | Δ*df* | *p*-value[a] | Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| Configural | .044 (.029, .059) | .017 | .989 | .980 | 66.00 | 31 | | | | |
| Metric | .043 (.030, .056) | .025 | .987 | .980 | 79.18 | 38 | 10.57 | 7 | .16 | Accept |
| Scalar | .048 (.036, .060) | .028 | .981 | .976 | 104.84 | 45 | 36.75 | 7 | <.001 | Reject |
| Partial scalar (free items 2, 3, & 6)[b] | .043 (.030, .056) | .033 | .986 | .981 | 89.32 | 43 | 8.84 | 4 | .07 | Accept |
| Partial residual (free items 2, 3, & 6)[b] | .041 (.028, .053) | .040 | .986 | .983 | 92.29 | 47 | 5.79 | 5 | .33 | Accept |

*Note:* [a]*p*-value indicates the significance of Satorra-Bentler scaled chi-square difference test. [b]Detailed statement of the items can be found in Appendix A.

Table 4.4 Summary of fit indices from invariance analyses by MSM status for HIV-related anticipated stigma scale

| Model | RMSEA | SRMR | CFI | TLI | $\chi^2$ | *df* | T | Δ*df* | *p*-value[a] | Decision |
|---|---|---|---|---|---|---|---|---|---|---|
| Configural | .033 (.018, .046) | .019 | .994 | .990 | 74.69 | 46 | | | | |
| Metric | .031 (.017, .044) | .021 | .993 | .991 | 82.00 | 52 | 5.17 | 6 | .52 | Accept |
| Scalar | .031 (.017, .043) | .021 | .993 | .991 | 90.27 | 58 | 7.41 | 6 | .28 | Accept |
| Residual | .034 (.023, .045) | .022 | .990 | .989 | 113.20 | 67 | 17.85 | 9 | .04 | Reject |
| Partial residual (free I2) | .027 (.012, .038) | .022 | .994 | .993 | 93.57 | 66 | 8.44 | 8 | .39 | Accept |

*Note:* [a]*p*-value indicates the significance of Satorra-Bentler scaled chi-square difference test

Table 4.5 Summary of fit indices from invariance analyses by MSM status for HIV-related enacted stigma scale

| Model | RMSEA | SRMR | CFI | TLI | $\chi^2$ | *df* | *p*-value[a] | Decision |
|---|---|---|---|---|---|---|---|---|
| Configural | .032 (.025, .038) | .087 | .984 | .980 | 312.24 | 196 | | |
| Metric | .028 (.020, .034) | .088 | .987 | .985 | 301.23 | 208 | .73 | Accept |
| Scalar | .028 (.021, .034) | .088 | .986 | .985 | 319.74 | 220 | .02 | Reject |
| Partial scalar (free I7) | .027 (.020, .034) | .088 | .987 | .986 | 314.74 | 219 | .16 | Accept |
| Partial residual (free I7) | .031 (.024, .037) | .087 | .985 | .982 | 316.41 | 204 | .55 | Accept |

*Note:* [a]*p*-value indicates the significance of chi-square value for ULSMV difference testing, which was done using the DIFFTEST option in *Mplus* 8.

# CHAPTER 5

# HEALTH DISPARITIES IN 3-YEAR CONTINUAL TRAJECTORIES OF PHYSICAL, PSYCHOLOGICAL, AND BEHAVIORAL HEALTH OUTCOMES BETWEEN MSM AND NON-MSM MALES

## 5.1 Abstract

**Background:** Men who have sex with men (MSM) living with HIV are at higher risk of experiencing negative physical, psychological, and behavioral health outcomes related to the HIV care continuum compared to non-MSM males. However, findings of most existing studies about health outcomes among MSM living with HIV are limited by use of cross-sectional data, failing to capture the temporal trends over time. This study quantified the physical, psychological, and behavioral health disparities at baseline and over time between MSM and non-MSM males living with HIV.

**Methods:** This prospective cohort study was designed to investigate the association between HIV-related stigma and clinical outcomes among people living with HIV in Guangxi, China. Eligible participants were individuals aged between 18 and 60 years old and had a confirmed diagnosis of HIV, including 772 men living with HIV (193 MSM and 579 non-MSM males) in the current analyses. Assessments were conducted at baseline and 6-, 12-, 18-, 24-, 30-, and 36-month follow-ups. Latent growth curve modeling in a two-group approach was employed to estimate the inter-individual variability in intra-individual change patterns of CD4 count, viral load, depressive

symptoms, anxiety symptoms, and ART adherence, through two latent factors—the intercept and the slope, controlling for baseline sociodemographic characteristics.

**Results:** At baseline assessment, compared to non-MSM males, MSM had lower odds of having CD4 count <500 cells/mm$^3$ (MSM: *OR*=.34, 95% CI [.15, .78], *p*=.01; non-MSM males: *OR*=10.88, 95% CI [5.27, 22.44], *p*<.001; Wald test *p*<.001) and suboptimal ART adherence (MSM: *OR*=.39, 95% CI [.17, .90], *p*=.03; non-MSM males: *OR*=16.23, 95% CI [8.42, 31.28], *p*<.001; Wald test *p*<.001) but had higher odds of having viral load≥50 copies/ml (MSM: *OR*=.12, 95% CI [.04, .33], *p*<.001; non-MSM males: *OR*=2.3E-05, 95% CI [9.41E-08, .01], *p*<.001; Wald test *p*<.001). During follow-ups, the trajectories of viral load were significantly different between MSM and non-MSM males in a quadratic pattern. Yet, these differences in health outcomes at baseline or over time were no longer significant after controlling for baseline sociodemographic characteristics.

**Conclusion:** The study reported higher odds of detectable viral load but lower odds of having CD4 count <500 cells/mm$^3$ and suboptimal ART adherence at baseline in MSM, compared to non-MSM males. These differences were very likely due to the different distributions of sociodemographic characteristics between MSM and non-MSM males. Such studies could enrich scientific evidence regarding the unique health vulnerability and needs of MSM living with HIV.

## 5.2 Introduction

Men who have sex with men (MSM) are disproportionately affected by HIV. Globally, MSM have been shown to be at 25 times higher risk of acquiring HIV compared to heterosexual adult men (UNAIDS, 2021). In Asia and the Pacific areas, MSM accounted for 44% of new HIV infections in 2019 (WHO, 2022). In the past

decades, China has made substantial progress in tackling the HIV epidemic by promoting HIV treatment and care and has significantly reduced HIV transmission through blood donation and injection drug use (Shang & Zhang, 2015). However, HIV infection among MSM is dramatically rising in China (Wu et al., 2007; Zhang et al., 2013). The proportion of MSM among the newly diagnosed HIV cases has increased from 2.5% in 2006 to 23.3% in 2018 (Wu, 2015; Zhang, 2019). There were estimated to be over 21 million MSM in 2016 in China, representing the population at the highest risk of HIV (Zhao et al., 2016). Despite of tremendous research efforts in this population, MSM living with HIV experienced poor clinical outcomes.

MSM living with HIV experienced poorer physical, mental, and behavioral health outcomes than non-MSM males (Yan et al., 2014b). Compared to non-MSM males living with HIV, MSM showed a faster progression from HIV infection to AIDS when not treated, a faster decline in CD4 count before initiating ART, a slower immune recovery after ART initiation, a higher rate of viral mutation and antiretroviral drug resistance, and a lower survival rate (Lowther et al., 2014b; Yan et al., 2014b; Yan et al., 2014c).

MSM living with HIV experience additional psychosocial burdens and may experience more mental health problems than non-MSM males (Shufang Sun, 2020). According to the minority stress theory, minority groups are exposed to both external stressors (e.g., discrimination) and internal stressors (e.g., concealment of identity), which in turn places them at risk for tremendous adverse mental health outcomes (Meyer, 2003). A meta-analysis revealed that the pooled prevalence of depression among MSM living with HIV was 43% globally (Xiao et al., 2020) and was estimated to be 17% higher than heterosexual MLWH (Bogart et al., 2011; Comulada et al., 2010;

Hatzenbuehler et al., 2008; Lowther et al., 2014a; Mills et al., 2004). Approximately half of MSM living with HIV across the globe are diagnosed with a psychiatric disorder during their lives (Crepaz et al., 2008). The most common mental health conditions include depressive mood disorder (14% to 48% vs. 6% to 37% in the general population) and anxiety disorder (16% to 40% vs. 6% to 18% in the general population) (Arends et al., 2020; Baumeister & Härter, 2007; Crepaz et al., 2008; Myer et al., 2008; O'Cleirigh et al., 2015). Mental health issues could further contribute to a lower quality of life and suboptimal ART adherence among MSM living with HIV (Berg et al., 2004; Pence et al., 2007).

Regarding HIV treatment cascade, MSM living with HIV have been shown to have less timely linkage to care, poorer retention in care, and poorer treatment adherence due to risk factors at both individual (e.g., concealment of SGM identity and/or HIV status) and structural levels (e.g., stigma and discrimination) (Govindasamy et al., 2012b; Medley et al., 2013a; Sarna et al., 2014a).

Although health disparities between MSM and non-MSM males are well-established, most previous studies have used cross-sectional design (Armoon et al., 2021; Gonzalez et al., 2009; Kang et al., 2005; Logie & Gadalla, 2009). Several longitudinal studies with multiple-wave assessments investigated the dynamic patterns of clinical outcomes among PLWH with only relatively short follow-up (Logie & Gadalla, 2009). In addition, only a few studies have explored the health outcomes of MSM living with HIV in resource-limited settings in China (Yang et al., 2020). Guangxi Autonomous Region (“Guangxi”), a southwestern resource-limited province, is one of the HIV epicenters in China. The underdeveloped healthcare infrastructure and conservative social norms in

Guangxi might be associated with a depraved mental well-being of MSM living with HIV (Sha et al., 2021). Using data from a prospective cohort study in Guangxi, China, the current study aimed to quantify health disparities in 3-year continual trajectories of physical, psychological, and behavioral health outcomes between MSM and non-MSM males living with HIV.

## 5.3 Methods

*Study setting and participants*

Data was derived from a prospective cohort study designed to investigate the association between HIV-related stigma and clinical outcomes, and the potential physical, mental and behavioral mechanisms underlying such associations among PLWH in Guangxi, China. In collaboration with Guangxi Center for Disease Control and Prevention (Guangxi CDC), six major public hospitals/clinics with the largest volume of HIV patients under care in five cities (i.e., Nanning, Guilin, Liuzhou, Guigang, and Qinzhou) were selected as study sites. Eligible participants were PLWH who: (1) aged 18 to 60 years, (2) had a confirmed diagnosis of HIV, and (3) had no plan to relocate outside of the Guangxi province in the next 12 months. PLWH were excluded if they were: (1) physically or mentally incapable of responding to survey questions, and (2) currently incarcerated or institutionalized for drug use or commercial sex. A total of 1,198 PLWH were recruited in the cohort study, of which 64.4% (n=772) were men, including 193 MSM and 579 non-MSM males. A subset of 772 MLWH was included in the current study.

*Data collection*

After eligible PLWH were randomly selected from the system, local CDC staff contacted the patients to confirm their eligibility, discussed with them the benefits and risks of the study, and invited them to participate. After obtaining written informed content, questionnaire-oriented face-to-face interviews were conducted in private rooms of the local hospitals/clinics.

Baseline assessment was conducted from November 2017 to February 2018, with follow-ups at 6-, 12-, 18-, 24-, 30-, and 36- months. All the data collections have been finished and merged by November 2021. The attrition rate was less than 5% for each follow-up assessment. Each participant received a small gift (e.g., household items) equivalent to US$5.00 (1 USD≈6.5 Chinese CNY at the time of the survey) upon the completion of each assessment. The research protocol was approved by the Institutional Review Boards at both the University of South Carolina in the United States and Guangxi CDC in China.

*Measures*

*Physical health outcomes*

**CD4 count** of each participant at baseline, 6-, 12-, 18-, 24-, 30- and 36-month follow-ups were retrieved from the patient's lab results at each hospital. According to the guidelines for ART in adults and adolescents with HIV (U.S. Department of Health and Human Services & Panel on Antiretroviral Guidelines for Adults and Adolescents, 2017), the cutoff of 500 cells/$mm^3$ has clinical implications in evaluating the normal immunologic functioning. Therefore, instead of using the original continuous measure of

CD4 count, CD4 count was categorized into a binary variable: CD4 count<500 cells/$mm^3$ and CD4 count≥500 cells/$mm^3$ for the purpose of data analysis in this dissertation.

**Viral load** of each participant at baseline, 6-, 12-, 18-, 24-, 30- and 36-month follow-ups were collected from the EHR system of Guangxi CDC. Viral suppression was defined as HIV RNA less than or equal to 50 copies/ml in PLWH's plasma (CDC & National Center for HIV/AIDS, Viral Hepatitis, and T.B. Prevention 2018). As viral suppression indicates the treatment efficacy, it was used as one of the primary outcomes rather than the original continuous value of viral load. Viral load was categorized into a binary variable: viral load<50 copies/ml and viral load≥50 copies/ml.

*Mental health outcomes*

**Depressive symptoms** were assessed with the 10-item Center for Epidemiologic Studies Depression (CES-D 10) Scale (Kohout et al., 1993). The Chinese version of CES-D 10 has been validated in both the clinical and non-clinical populations in China (Yu et al., 2013). It captured depressed affect (3 items), somatic symptoms (5 items), and positive affect (2 items). The response options ranged from 0 ("rarely or none of the time") to 3 ("all of the time"). The sum scores of CES-D 10 range from 0 to 30, with higher scores indicating more severe depressive symptoms. The scale exhibited an acceptable internal consistency in our study (Cronbach's alpha=0.85).

**Anxiety symptoms** were assessed with the 20-item Self-rating Anxiety Scale (Zung, 1971) to quantify the level of anxiety for patients experiencing anxiety-related symptoms. The Chinese version scale has been validated in the Chinese populations (Zhang et al., 2015). Items tap psychological and physiological symptoms in the past week, and each item is scored on a scale of 1 ("none or a little of the time") to 4 ("most of

the time"). Sample items are "I feel easily upset or panicked" and "I experience headache and a sore neck." The sum scores of the scale range from 20 to 80, with higher scores indicating more severe anxiety symptoms. The scale exhibited an acceptable internal consistency in our study (Cronbach's alpha=0.80).

*Behavioral health outcomes*

**ART adherence** was assessed with a multiple-item approach to minimize the self-report bias (Mi et al., 2020). Five items were derived from the Adult AIDS Clinical Trials Group (AACTG) adherence instrument were adapted to our studies (Chesney et al., 2000). The first two items asked participants if they had missed any dose in the past weekend/ever before. Responses were recorded to reflect ART adherence (1=not missed, 0=missed). The other three items inquired about the total number of prescribed doses and the number of doses that participants actually took within three specific time windows (i.e., past three days, past weekend, and past month). The responses to each of these items were first converted into a percentage of doses taken as scheduled and then dichotomized into 1 (≥ 95% of prescribed doses) or 0 (< 95%). The threshold of 95% is used in the current study as the existing literature suggested 95% as the optimal level of adherence to sustain viral suppression (Paterson et al., 2000) and avoid the evolution of drug-resistant viruses (Raffa et al., 2008). An adherence index score was generated by summing the dichotomous scores of the five items to reflect an optimal adherence (score=5) or suboptimal adherence (score < 5) (Mi et al., 2020). Such a measure of ART adherence has been validated under various cultural contexts (Chesney et al., 2000; Reynolds et al., 2007) and was considered a robust instrument for evaluating ART adherence behaviors among PLWH.

*Covariates*

**Sociodemographic characteristics** included age (18-24, 25-34, 35-44, 45 or older), ethnicity (Han, other), marital status (single, married/life partner, divorced/separated/widowed), education (middle school or below, high school, college and above), employment (fulltime employed, parttime employed, unemployed), monthly household income (1,999 CNY or below, 2,000-3,999 CNY, 4,000 CNY or above), and residence rurality (city, county, rural).

*Data analysis*

First, baseline sociodemographic characteristics were described with frequency (column percent) and compared between non-MSM males and MSM using Chi-square test or Fisher's exact test as appropriate.

Second, trends of physical, psychological, and behavioral health outcomes over time were examined. Trends of continuous outcomes (i.e., depressive symptoms, anxiety symptoms) were tested with repeated measure analysis of variance (ANOVA). Trends of categorical outcomes (i.e., CD4 count, viral load, ART adherence) were tested with Cochran-Armitage trend tests.

Third, bivariate analyses between sociodemographic characteristics and longitudinal physical, psychological, and behavioral health outcomes were conducted with univariate generalized linear mixed model (GLMM) for categorical outcomes and repeated measure ANOVA for continuous outcomes.

At last, the longitudinal trajectories of CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence were examined using the latent growth curve modeling (LGCM) method, a multivariate statistical method based on the

framework of structural equational modeling (SEM) to estimate growth patterns over time (Bollen & Curran, 2006) in three steps. First, the unadjusted trends over seven waves of all health outcomes were plotted to determine the type of growth. Linear growths were modeled for CD4 count, depressive symptoms, anxiety symptoms, and ART adherence, and quadratic growth was modeled for viral load. Second, unconditional models of CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence were fit separately for non-MSM males and MSM to assess overall growth in these constructs over time. The baseline levels (means of intercept) and changes (means of slope) in health outcomes over seven assessment points, between-individual variability at baseline (variances of intercept) and over time (variances of slopes), and correlations between intercept and slope were estimated unadjusted for the influence of covariates. Third, conditional growth models were built by adding baseline sociodemographic characteristics to the LGCM, which might explain the varying health outcomes' growth trajectories. For continuous variables, estimates were interpreted as linear regression coefficients ($\beta$) and their corresponding 95% confidence intervals (95% CI) explaining the expected change in growth parameters associated with each wave change. For categorical outcomes, means of intercept and slope were interpreted as logistic regression coefficients and transferred into Odds Ratios (*OR*) or adjusted Odds Ratios (*aOR*) and their corresponding 95% CI. For both unconditional and conditional models, Wald-tests were conducted between the two groups to demonstrate if growth parameters (i.e., mean of intercept, mean of slope, variance of intercept, variance of slope, correlation between intercept and slope) varied between groups.

Descriptive analyses and bivariate analyses were conducted with SPSS 28.0 (Chicago, IL, USA). Cochran-Armitage trend tests were conducted with SAS 9.4. LGCM was conducted with M*plus* 8.4.

**5.4 Results**

*Descriptive statistics*

As shown in Table 5.1, at baseline assessment (November 2017 to February 2018), the majority of the 772 MLWH were non-MSM males (n=571, 74.0%), aged 35-44 years (n=240, 31.1%), Han ethnicity (n=511, 66.2%), married or cohabited (n=369, 47.8%), with a middle school education or below (n=410, 53.1%), having a fulltime job (n=518, 67.1%) with a monthly household income between 2,000 and 3,999 CNY (n=379, 49.1%), and living in city areas (n=363, 47.0%).

For baseline physical health outcomes, 448 (58.0%) MLWH had a CD4 count<500 cells/$mm^{3,}$ but only 108 (14.0%) MLWH had viral load≥50 copies/ml. In regard to psychological factors, the baseline mean scores of depressive symptoms and anxiety symptoms were 6.60 (SD=4.24) and 30.34 (SD=6.72), respectively, indicating that participants experienced depressive or anxiety symptoms *rarely or none of the time* (less than one day per week). For the behavioral factor, more than half of MLWH (n=466, 60.4%) reported suboptimal adherence to ART.

*Changes in physical, psychological, and behavioral health outcomes*

Across the six follow-ups, the attrition rates were less than 5.0% (Table 5.2). The changes in physical (i.e., CD4 count and viral load), psychological (i.e., depressive symptoms and anxiety symptoms), and behavioral health outcomes (i.e., ART adherence) were significant except for ART adherence. As shown in Table 5.2 and Figure 5.1, the

percentage of MLWH who had a CD4 count<500 cells/mm$^3$ significantly decreased from 58.0% at baseline to 50.4% at 36-month follow-up (z=-2.95, *p*=.003). The percentage of MLWH who had viral load≥50 copies/ml significantly decreased from 14.0% at baseline to 2.1% at 18-month follow-up and increased to 9.7% at 36-month follow-up (Figure 5.2), showing a statistically significant upward trend (z=5.23, *p*<.001). For psychological health outcomes, the mean scores of depressive symptoms increased from 6.60 at baseline to 7.66 at 6-month follow-up and decreased to 6.60 again at 36-month follow-up (Figure 5.3) (*F*=23.84, *p*<.001). The average level of anxiety symptoms slightly increased from 6.72 at baseline to 7.07 at the 36-month follow-up (Figure 5.4) (*F*=56.05, *p*<.001). For behavioral health outcome, change in the percentage of MLWH reporting suboptimal ART adherence was not significant (z=1.06, *p*=.29), although the percentage increased slightly from 60.4% at baseline to 60.9% at 36-month follow-up (Figure 5.5).

*Associations between sociodemographic characteristics and physical, psychological, and behavioral health outcomes over time*

As shown in Table 5.3, MLWH who were MSM (compared to non-MSM males, *OR*=.18, 95% CI [.09, .35], *p*<.001) and ethnic minority (compared to Han ethnicity, *OR*=.44, 95% CI [.23, .84], *p*=.01) had lower odds of CD4 count<500 cells/mm$^3$. MLWH who were 45 years old or older (compared to 24 years of age or younger, *OR*=4.60, 95% CI [1.42, 14.89], *p*=.01), married or cohabited (compared to single MLWH, *OR*=2.62, 95% CI [1.38, 4.99], *p*=.003), had a degree of middle school or below (compared to college degree or above, *OR*=4.13, 95% CI [2.03, 8.39], *p*<.001), unemployed or retired (compared to fulltime employment, *OR*=2.83, 95% CI [1.15, 6.95], *p*=.01), had monthly household income less than 2000 CNY (compared to 4000 CNY or above, *OR*=3.93,

95% CI [1.67, 9.24], $p$=.002) or between 2000 and 3,999 CNY (compared to 4000 CNY or above, *OR*=3.34, 95% CI [1.56, 7.14], $p$=.002), and living in rural areas (compared to city residence, *OR*=6.13, 95% CI [3.08, 12.18], $p$<.001) had higher odds of CD4 count<500 cells/$mm^3$.

On the contrary, as shown in Table 5.4, MLWH who were MSM (compared to non-MSM males, *OR*=6.74, 95% CI [2.98, 15.28], $p$<.001) had higher odds of viral load≥50 copies/ml. MLWH who were married (compared to single MLWH, *OR*=.14, 95% CI [.06, .33], $p$<.001) or divorced (compared to single MLWH, *OR*=.23, 95% CI [.07, .82], $p$=.02), had a degree of middle school or below (compared to college degree or above, *OR*=.24, 95% CI [.10, .59], $p$=.002), had monthly household income less than 2000 CNY (compared to 4000 CNY or above, *OR*=.16, 95% CI [.06, .46], $p$<.001) or between 2000 and 3,999 CNY (compared to 4000 CNY or above, *OR*=.29, 95% CI [.12, .71], $p$=.007), and living in county (compared to city residence, *OR*=.32, 95% CI [.10, .97], $p$=.04) or rural areas (compared to city residence, *OR*=.18, 95% CI [.08, .43], $p$<.001) had lower odds of viral load≥50 copies/ml.

Monthly household income was the only demographic characteristic associated with depressive symptoms. Compared to MLWH who had a monthly household income of 4,000 CNY or above, MLWH who had a monthly household income less than 2,000 CNY (mean difference=.85, $p$=.006) or between 2,000 and 4,000 CNY (mean difference=.88, $p$=.002) experienced significantly more severe depressive symptoms (Table 5.5).

As shown in Table 5.6, MLWH who were 45 years of age or older (compared to 24 years of age or younger, mean difference=-1.25, $p$=.04) or ethnic minority (compared

to Han ethnicity, mean difference=-.73, $p$=.03) reported significantly slighter anxiety symptoms. While MLWH who were part-time employed (compared to fulltime employment, mean difference=1.11, $p$=.01) or unemployed (compared to fulltime employment, mean difference=1.19, $p$=.01), had monthly household income less than 2,000 CNY (compared to 4000 CNY or above, mean difference=1.48, $p$=.001) or between 2,000 and 4,000 CNY (compared to 4000 CNY or above, mean difference=1.07, $p$=.01) reported significantly more severe anxiety symptoms.

As shown in Table 5.7, MLWH who were MSM (compared to non-MSM males, *OR*=.11, 95% CI [.05, .22], $p$<.001) had lower odds of suboptimal ART adherence. MLWH who were 35-44 years old (compared to 24 years of age or younger, *OR*=10.40, 95% CI [3.20, 33.85], $p$<.001) or 45 years old or older (compared to 24 years of age or younger, *OR*=8.44, 95% CI [2.51, 28.39], $p$<.001), married (compared to single MLWH, *OR*=3.99, 95% CI [2.05, 7.77], $p$<.001), had a degree of middle school or below (compared to college degree or above, *OR*=9.57, 95% CI [4.62, 19.82], $p$<.001) or high school (compared to college degree or above, *OR*=7.69, 95% CI [3.07, 19.22], $p$<.001), had monthly household income less than 2000 CNY (compared to 4000 CNY or above, *OR*=3.68, 95% CI [1.53, 8.82], $p$=.004), and living in rural areas (compared to city residence, *OR*=4.39, 95% CI [2.20, 8.76], $p$<.001) had higher odds of suboptimal ART adherence.

*Unconditional and conditional latent growth curve models among non-MSM males and MSM*

*CD4 count*

Parameter estimates from LGCM of CD4 are displayed in Table 5.8. In the unconditional models, the mean intercept was significantly higher (Wald test $p<.001$) for non-MSM males (*OR*=10.88, 95% CI [5.27, 22.44], $p<.001$) than MSM (*OR*=.34, 95% CI [.15, .78], $p=.01$), indicating that non-MSM males had higher baseline odds of having CD4 count less than 500 cells/mm$^3$ compared to MSM. The mean slope was not significant for non-MSM males (*OR*=.90, 95% CI [.78, 1.04], $p=.14$) but significantly negative for MSM (*OR*=.69, 95% CI [.54, .87], $p=.002$), reflecting an average decrease in the odds of having CD4 count less than 500 cells/mm$^3$ per wave. The variance of intercept was significant for both non-MSM males ($\beta$=38.99, 95% CI [22.06, 55.93], $p<.001$) and MSM ($\beta$=17.07, 95% CI [6.54, 27.61], $p=.001$), and the variance of slope was significant for both non-MSM males ($\beta$=.58, 95% CI [.22, .94], $p=.002$) and MSM ($\beta$=.73, 95% CI [.21, 1.24], $p=.005$), indicating that the baseline and the change of CD4 count significantly varied across individuals for both non-MSM males and MSM. The correlations between intercept and slope were not significant for either non-MSM males ($\beta$=-.04, 95% CI [-.43, .34], $p=.83$) or MSM ($\beta$=.16, 95% CI [-.28, .60], $p=.49$), suggesting that the baseline CD4 count were not related to the change of CD4 count over time.

In the conditional models (Figure 5.6), the mean slope was not significant for either non-MSM males (*OR*=.49, 95% CI [.22, 1.08], $p=.08$) or MSM (*OR*=.66, 95% CI [.39, 1.13], $p=.13$), suggesting that CD4 count did not change substantially over time

after adjustment for the influence of baseline sociodemographic covariates for both non-MSM males and MSM. Similar to the unconditional models, the variance of intercept was significant for both non-MSM males ($\beta$=31.98, 95% CI [18.33, 45.64], $p$<.001) and MSM ($\beta$=14.52, 95% CI [5.68, 23.36], $p$=.001), and the variance of slope was significant for both non-MSM males ($\beta$=.49, 95% CI [.26, .72], $p$<.001) and MSM ($\beta$=.53, 95% CI [.12, .94], $p$=.01), indicating that there were significant interindividual variations in both baseline level and change of CD4 count over time that was not fully explained by the baseline sociodemographic covariates. The correlations between intercept and slope were not significant for either non-MSM males ($\beta$=-.04, 95% CI [-.43, .35], $p$=.85) or MSM ($\beta$=.24, 95% CI [-.22, .69], $p$=.31), suggesting that the baseline CD4 count were not related to the change of CD4 count over time. After the adjustment of sociodemographic covariates, the patterns of CD4 trends over time were not significantly different between non-MSM males and MSM.

*Viral suppression*

Parameter estimates from LGCM of viral load are displayed in Table 5.9. In the unconditional models, the means of intercept, slope, and the quadratic term were significantly different between non-MSM males and MSM (Wald tests $p$<.001). The mean intercept was lower in non-MSM males (*OR*=2.3E-05, 95% CI [9.41E-08, .01], $p$<.001) than in MSM (*OR*=.12, 95% CI [.04, .33], $p$<.001), indicating that MSM had higher baseline odds of viral load≥50 copies/ml compared to non-MSM males. The means of slope (*OR*=1.19, 95% CI [.57, 2.45], $p$=.65) and quadratic term (*OR*=.90, 95% CI [.77, 1.04], $p$=.16) were not significant in MSM, indicating that viral suppression status did not change substantially over time among MSM. The means of slope

(*OR*=64.65, 95% CI [3.03, 1380.22], *p*=.008) and quadratic term (*OR*=.47, 95% CI [.29, .76], *p*=.002) were significant among non-MSM males, indicating that viral suppression status changed over time in a quadratic pattern among non-MSM males. The variances of intercept ($\beta$=81.59, 95% CI [-40.39, 203.58], *p*=.19), slope ($\beta$=20.59, 95% CI [-13.86, 54.98], *p*=.24), and quadratic term ($\beta$=.49, 95% CI [-.24, 1.22], *p*=.19) among non-MSM males were not significant, suggesting a relative homogeneity of non-MSM males participants in terms of viral suppression. Yet, the variances of intercept ($\beta$=12.44, 95% CI [.35, 24.52], *p*=.04) and quadratic term ($\beta$=.16, 95% CI [.01, .31], *p*=.04) among MSM were significant, suggesting that the change of viral suppression status significantly varied across MSM individuals.

In the conditional models (Figure 5.7), the means of slope and quadratic terms were not significant for either non-MSM males (mean of slope: *OR*=.17, 95% CI [.001, 21.61], *p*=.48; mean of quadratic term: *OR*=1.22, 95% CI [.53, 2.81], *p*=.48) or MSM (mean of slope: *OR*=.81, 95% CI [.25, 2.68], *p*=.73; mean of quadratic term: *OR*=1.05, 95% CI [.84, 1.30], *p*=.68), suggesting that viral suppression status did not change substantially over time after adjustment for the influence of baseline sociodemographic covariates for both non-MSM males and MSM. The variances of intercept, slope, and quadratic terms were significant for non-MSM males (variance of intercept: $\beta$=56.11, 95% CI [11.25, 100.97], *p*=.01; variance of slope: $\beta$=14.01, 95% CI [.82, 27.19], *p*=.04; variance of quadratic term: $\beta$=.36, 95% CI [.03, .69], *p*=.03), indicating that there were significant interindividual variations in both baseline level and change of viral suppression status over time that were not fully explained by the baseline sociodemographic covariates. Only the variance of intercept was significant for MSM

($\beta$=10.87, 95% CI [.85, 20.90], $p$=.03), indicating that there were significant interindividual variations in the baseline level of viral suppression status not fully explained by the baseline sociodemographic covariates. After the adjustment of sociodemographic covariates, the patterns of viral suppression status over time were not significantly different between non-MSM males and MSM.

*Depressive symptoms*

Parameter estimates from LGCM of depressive symptoms are displayed in Table 5.10. In the unconditional models, the means of slope were significantly negative for both non-MSM males ($\beta$=.33, 95% CI [-.42, -.24], $p$<.001) and MSM ($\beta$=-.24, 95% CI [-.35, -.12], $p$=.04), reflecting an average decrease of.42 and .24 in depressive symptoms per wave for non-MSM males and MSM, respectively. The variances of intercept ($\beta$=9.21, 95% CI [6.62, 11.19], $p$<.001) and slope ($\beta$=.18, 95% CI [.08, .27], $p$=.001) among non-MSM males were significant, suggesting interindividual variations in both baseline level and trend of depressive symptoms over time for non-MSM males. Only the variances of intercept ($\beta$=8.82, 95% CI [6.03, 11.62], $p$<.001) among MSM were significant, suggesting interindividual variations in the baseline level of depressive symptoms for MSM. The correlations between intercept and slope were significant for non-MSM males ($\beta$=-.65, 95% CI [-.81, -.50], $p$<.001) but not significant for MSM ($\beta$=.25, 95% CI [-.26, .76], $p$=.33), suggesting that the baseline depressive symptoms was negatively associated with depressive symptoms change over time among non-MSM males but not associated with depressive symptoms change over time among MSM.

In the conditional models (Figure 5.8), the means of slope were significantly negative for MSM ($\beta$=-.36, 95% CI [-.62, -.10], $p$=.01) but not for non-MSM males ($\beta$=-

.25, 95% CI [-.66, -17], $p$=.24), reflecting an average decrease of .36 in depressive symptoms per wave for MSM after adjustment of covariates but no substantial change of depressive symptoms over time for non-MSM males. The variances of intercept ($\beta$=8.09, 95% CI [5.67, 10.51], $p$<.001) and slope ($\beta$=.12, 95% CI [.03, .22], $p$=.01) among non-MSM males were significant, suggesting interindividual variations in both baseline level and trend of depressive symptoms over time not fully explained by the baseline sociodemographic covariates for non-MSM males. Only the variances of intercept ($\beta$=8.03, 95% CI [5.33, 10.72], $p$<.001) among MSM were significant, suggesting interindividual variations in the baseline level of depressive symptoms not fully explained by the baseline sociodemographic covariates for MSM. The correlations between intercept and slope were significant for non-MSM males ($\beta$=-.66, 95% CI [-.84, -.47], $p$<.001) but not significant for MSM ($\beta$=.41, 95% CI [-.43, 1.25], $p$=.34), suggesting that the baseline depressive symptoms were negatively associated with depressive symptoms change over time among non-MSM males but not associated with depressive symptoms change over time among MSM.

*Anxiety symptoms*

Parameter estimates from LGCM of anxiety symptoms are displayed in Table 5.11. In the unconditional models, the means of slope were significantly negative for both non-MSM males ($\beta$=-.20, 95% CI [-.32, -.08], $p$=.001) and MSM ($\beta$=-.19, 95% CI [-.33, -.04], $p$=.01), reflecting an average decrease of .20 and .19 in anxiety symptoms per wave for non-MSM males and MSM, respectively. The variances of intercept ($\beta$=22.35, 95% CI [13.25, 31.46], $p$<.001) and slope ($\beta$=.65, 95% CI [.34, .96], $p$<.001) among non-MSM males were significant, suggesting interindividual variations in both baseline level

and trend of anxiety symptoms over time for non-MSM males. Only the variance of intercept ($\beta$=16.26, 95% CI [11.35, 21.17], $p$<.001) among MSM was significant, suggesting interindividual variation in initial anxiety symptoms for MSM. The correlations between intercept and slope were significant for non-MSM males ($\beta$=-.66, 95% CI [-.82, -.51], $p$<.001) but not significant for MSM ($\beta$=.34, 95% CI [-.76, 1.44], $p$=.54), suggesting that the baseline anxiety symptoms were negatively associated with anxiety symptoms change over time among non-MSM males but not associated with anxiety symptoms change over time among MSM.

In the conditional models (Figure 5.9), the means of slope were significantly negative for MSM ($\beta$=-.34, 95% CI [-.64, -.04], $p$=.02) but not for non-MSM males ($\beta$=.05, 95% CI [-.60, .70], $p$=.88), reflecting an average decrease of .34 in anxiety symptoms per wave for MSM after adjustment of covariates, but no substantial change of anxiety symptoms over time for non-MSM males. The variances of intercept ($\beta$=20.36, 95% CI [12.08, 28.65], $p$<.001) and slope ($\beta$=.54, 95% CI [.24, .84], $p$<.001) among non-MSM males were significant, suggesting interindividual variations in both baseline level and anxiety symptoms trend over time not fully explained by the baseline sociodemographic covariates for non-MSM males. Only the variances of intercept ($\beta$=13.80, 95% CI [9.39, 18.20], $p$<.001) among MSM were significant, suggesting interindividual variations in the baseline level of anxiety symptoms not fully explained by the baseline sociodemographic covariates for MSM. The correlations between intercept and slope were significant for non-MSM males ($\beta$=-.68, 95% CI [-.84, -.52], $p$<.001) but not significant for MSM ($\beta$=.64, 95% CI [-.11, 1.39], $p$=.10), suggesting that the baseline anxiety symptoms were negatively associated with depressive symptoms change over

time among non-MSM males but not associated with anxiety symptoms change over time among MSM.

*ART adherence*

Parameter estimates from LGCM of ART adherence are displayed in Table 5.12. In the unconditional models, the mean intercept was higher in non-MSM males (*OR*=16.23, 95% CI [8.42, 31.28], *p*<.001) than in MSM (*OR*=.39, 95% CI [.17, .90], *p*=.03), indicating that non-MSM males had higher baseline odds of suboptimal ART adherence compared to MSM. The mean slope was significant in non-MSM males (*OR*=.84, 95% CI [.74, .94], *p*=.003) but not significant in MSM (*OR*=.95, 95% CI [.84, 1.07], *p*=.38), reflecting an average decrease in the odds of suboptimal ART adherence per wave among non-MSM males but no substantial change in suboptimal ART adherence over time among MSM. The variances of intercept ($\beta$=28.01, 95% CI [18.52, 37.50], *p*<.001) and slope ($\beta$=.23, 95% CI [.10, .36], *p*=.001) among non-MSM males were significant, suggesting that both initial ART adherence and change of ART adherence significantly varied across non-MSM males individuals. Only the variance of intercept was significant for MSM ($\beta$=25.75, 95% CI [8.74, 42.76], *p*=.003), suggesting significant interindividual variations in initial ART adherence among MSM. The correlation between intercept and slope was significant for non-MSM males ($\beta$=-.78, 95% CI [-.99, -.57], *p*<.001) but not for MSM ($\beta$=.07, 95% CI [-1.04, 1.17], *p*=.91), suggesting that the baseline ART adherence was negatively related to the change of ART adherence over time for non-MSM males but not for MSM.

In the conditional models (Figure 5.8), the means of slope were not significant for either non-MSM males (*OR*=1.11, 95% CI [.73, 1.70], *p*=.62) or MSM (*OR*=1.00, 95%

CI [.76, 1.32], $p$=.99), indicating that ART adherence did not change substantially over time after adjustment for the influence of baseline sociodemographic covariates for both non-MSM males and MSM. The variances of intercept ($\beta$=26.25, 95% CI [17.36, 35.15], $p$<.001) and slope ($\beta$=.20, 95% CI [.07, .33], $p$=.002) were significant for non-MSM males, indicating that there were significant interindividual variations in both baseline level and change of ART adherence over time that were not fully explained by the baseline sociodemographic covariates. Only the variance of intercept was significant for MSM ($\beta$=24.22, 95% CI [8.85, 39.60], $p$=.002), indicating that there were significant interindividual variations in the baseline level of ART adherence not fully explained by the baseline sociodemographic covariates. After the adjustment of sociodemographic covariates, the patterns of ART adherence change over time were not significantly different between non-MSM males and MSM.

**5.5 Discussion**

This study used LGCM to empirically estimate the change in physical, psychological, and behavioral health outcomes over time and examined the disparities in health outcomes trajectories between MSM and non-MSM males with data from a prospective cohort study. At baseline assessment, MSM had lower odds of having CD4 count<500 cells/$mm^3$ and suboptimal ART adherence but had higher odds of having viral load≥50 copies/ml compared to non-MSM males. During follow-ups, the trajectories of viral suppression status were significantly different between MSM and non-MSM males in a quadratic pattern. Yet, these differences in health outcomes at baseline and over time were no longer significant after controlling for baseline sociodemographic characteristics.

At baseline, a higher risk of having CD4 count<500 cells/$mm^3$ was observed among non-MSM males compared to MSM. Multiple studies across different geographical regions reported similar results where CD4 count in early infection were lower in non-MSM males than in MSM (Cascade Collaboration, 2003; Frentz et al., 2014; Gupta et al., 2000; James & Dixit, 2022; Robertson et al., 2020; Tang et al., 2014). A study in China reported that the average CD4 count at diagnosis were 370 cells/$mm^3$ for MSM and 270 cells/$mm^3$ for non-MSM males (Tang et al., 2014). A study in the United States showed a similar result, that the CD4 count at diagnosis were 400 cells/$mm^3$ in MSM and 300 cells/$mm^3$ in non-MSM males (Robertson et al., 2020). According to the European CDC, the average CD4 count at diagnosis of around 120,000 patients across 21 countries were approximately 440 cells/$mm^3$ in MSM and only 300 cells/$mm^3$ in non-MSM males (European Centre for Disease Prevention and Control, 2019). A potential explanation could be the tolerance to transmitted/founder (T/F) strains (James & Dixit, 2022). T/F virus refers to a single or very few viral variant(s) that establish productive infection within a host (Ashokkumar et al., 2020). According to the stringent population bottleneck theory, T/F virus were under greater positive selection in non-MSM males in whom the penile-vaginal mode predominates, than MSM in whom anal intercourse predominates (James & Dixit, 2022; Owen et al., 2015; Tully et al., 2016). Therefore, due to different modes of transmission, T/F virus is more virulent in non-MSM males than in MSM (James & Dixit, 2022). However, as the baseline difference in CD4 count disappeared after sociodemographic covariates were adjusted, such difference might be attributed sociodemographic characteristics, especially age. Participants who were MSM were significantly younger than those who were non-MSM

males in the current study. Previous studies and reports revealed that MSM were usually diagnosed at a younger age than non-MSM males (European Centre for Disease Prevention and Control, 2019; Frentz et al., 2014). More than 60% of MSM living with HIV are aged 29 years old or younger in China (Dong et al., 2019). Also, the prevalence of HIV in young MSM was significantly increasing in the United States with an annual newly diagnosed HIV infection increased by 3% among MSM ages 13-29 when the HIV prevalence in other age groups were declining (Mitsch et al., 2018). Younger age is associated with a stronger immune system, which leads to higher CD4 count at diagnosis and faster increase in CD4 count after ART initiation (Lewis et al., 2012).

MSM had a higher risk of viral load≥50 copies/ml at baseline and a more rapid change at follow-ups than non-MSM males. However, after adjusting the baseline sociodemographic covariates, both viral suppression status at baseline and the change patterns over time were no longer different between MSM and non-MSM males, indicating that sociodemographic covariates could explain these differences. Previous studies also found that sociodemographic variables were related to viral suppression (Burch et al., 2016; Chakraborty et al., 2015; Crepaz et al., 2018; Haider et al., 2021; Hussen et al., 2018; Saracino et al., 2016; Xia et al., 2017). Older age, fulltime employment, higher educational attainment, and lower income were associated with elevated odds of achieving viral suppression (<100 viral copies/ml) (Feng et al., 2010; Haider et al., 2021). A savings-led economic empowerment intervention for young PLWH was found effective in achieving a tenfold increase in successful viral suppression (Bermudez et al., 2018). Rurality was also reported to be related to viral suppression. PLWH living in rural areas were less likely to be viral suppressed (46.2 %) compared to

PLWH living in metropolitan areas (54.5%) or urban areas (50.2%) (Nelson et al., 2018). In the current study, MSM had lower unconditional probability of viral load≥50 copies/ml but higher probability of CD4 count<500 cells/$mm^3$ at baseline, which was counterintuitive. Viral load is a marker of response to ART and provide information about the probability of disease progression, which monitors the effectiveness of ART after initiation (Clinical info, 2014). CD4 cell count provides information on the overall immune function of PLWH, which is critical in assessing the urgency to initiate ART (Clinical info, 2014). In this study, MSM was younger than non-MSM. and a younger age is associated with a better immune system but elevated odds of viral load≥50 copies/ml (Feng et al., 2010; Haider et al., 2021)..

In terms of trajectories of depressive and anxiety symptoms, although the baseline level and the change over time were not different between groups after adjusting for sociodemographic characteristics, the correlations between baseline level and change over time were different between MSM and non-MSM males even after adjusting for covariates. Inverse relationships between baseline level and change over time of depressive and anxiety symptoms were observed among non-MSM males but not among MSM. This finding suggested that the higher baseline levels of depressive and anxiety symptoms were, the faster they reduced over time among non-MSM males but not among MSM. Such group difference was not due to the differences in sociodemographic characteristics between groups. Instead, this difference could be attributed to less social support and multi-layered stigma associated with MSM (Arends et al., 2020; Parsons et al., 2017; Rzeszutek, 2018; Shao et al., 2018). It has been well documented in both longitudinal studies and cross-sectional studies that social support was positively linked

to better mental functioning among PLWH (Abramowitz et al., 2009; Ashton et al., 2005; Hansen et al., 2009). By contrast, a lack of social support and social isolation could exacerbate HIV-related psychological problems, especially depressive symptoms (Rzeszutek, 2018). Compared to non-MSM males, MSM living with HIV experienced social rejection from families, friends, and social institutions, including hospitals and schools, and in turn, lack of social support (Bonvicini, 2017). As for stigma, studies among MSM living with HIV in China suggested that higher levels of both HIV- and SGM-related stigma were related to increased symptoms of depression and anxiety, as well as deterioration in quality of life (Yang et al., 2020). Therefore, although the baseline levels of depressive/anxiety symptoms were high in both non-MSM males and MSM, only non-MSM males showed a faster reduction that correlated to the high baseline depressive/anxiety symptoms during follow-ups.

MSM showed more optimal ART adherence than non-MSM males at baseline, while this difference disappeared after controlling for sociodemographic characteristics. In previous studies, the association between ART adherence and sociodemographic characteristics among PLWH has been controversial. A large-scale review suggested that higher income, higher level of educational attainment, fulltime employment, and older age were positively related to more optimal ART adherence (Azmach et al., 2019). A longitudinal study indicated that living in urban areas, higher income, and younger age of PLWH were positively correlated with optimal ART adherence. Further longitudinal studies on a large scale are still needed to confirm the findings. Mixed findings also suggested the possible existence of moderators underlying the associations between sociodemographic characteristics and ART adherence.

This study provided several implications for future studies, clinical interventions, and policymakers. Sociodemographic factors played an important and complex role in the health outcome of PLWH, which still needs further investigations (Frentz et al., 2014). In addition, the inverse correlations between intercept and slope of depressive and anxiety symptoms were only found in non-MSM males but not MSM. Typically, MSM are exposed to more risk factors of psychological distress than non-MSM males, such as a lack of social support and multiple stigmas associated with HIV diagnosis and SGM identities, which might necessitate clinical interventions and social care. In addition, economic interventions could potentially improve ART adherence and help individuals achieve viral suppression (Bermudez et al., 2018).

The current study has some limitations that should be acknowledged. First, recall bias is common when using self-reported questionnaires, especially for optimal ART adherence, which is often overestimated by participating PLWH (Stirratt et al., 2015). Second, participants in the current study were recruited from hospitals or clinics. These participants were more likely to have better health outcomes, such as optimal ART adherence, higher CD4 count, and lower viral load, compared to PLWH who were not engaged in care. The generalizability of these findings was therefore limited. Future studies are needed to confirm these results in other areas and among other subgroups. Despite these limitations, the study compared the trajectories of health outcomes over time between non-MSM males and MSM, which were considered hard-to-reach populations. The seven-wave longitudinal study collected both self-reported survey data and clinical laboratory test results for each participant and examined multiple HIV-related health outcomes including CD4 count, viral load, mental health status such as

depression and anxiety, and ART adherence. With data from seven waves, this study demonstrated the change patterns of health outcomes dynamically over time.

## 5.6 Conclusion

Chinese MSM in the current study were at a higher risk of having detectable viral load but at a lower risk of having CD4 count <500 cells/$mm^3$. Future studies are needed to examine such inconsistency between CD4 count and viral suppression among MSM. The higher baseline levels of depressive and anxiety symptoms were, the faster they reduced over time among non-MSM males but not among MSM, necessitating clinical interventions and social care among MSM.

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Table 5.1 Sociodemographic characteristics of men living with HIV at baseline assessment (n=772)

| Variables | Overall | Non-MSM males (n=571) | MSM (n=193) | *p*-value |
|---|---|---|---|---|
| **Age group** | | | | **<.001** |
| 18-24 | 64 (8.3%) | 13 (2.3%) | 51 (26.4%) | |
| 25-34 | 240 (31.1%) | 137 (24.0%) | 102 (52.8%) | |
| 35-44 | 262 (33.9%) | 225 (39.5%) | 34 (17.6%) | |
| 45+ | 204 (26.4%) | 195 (34.2%) | 6 (3.1%) | |
| **Ethnicity** | | | | .48 |
| Han | 511 (66.2%) | 377 (66.0%) | 133 (68.9%) | |
| Minority | 261 (33.8%) | 194 (34.0%) | 60 (31.1%) | |
| **Marital status** | | | | **<.001** |
| Single | 299 (38.7%) | 134 (23.9%) | 165 (85.5%) | |
| Married/life partner | 369 (47.8%) | 350 (62.4%) | 13 (6.7%) | |
| Divorced/separated/widowed | 93 (12.0%) | 77 (13.7%) | 15 (7.8%) | |
| **Education** | | | | **<.001** |
| Middle school and below | 410 (53.1%) | 389 (68.1%) | 17 (8.8%) | |
| High school | 156 (20.2%) | 108 (18.9%) | 45 (23.3%) | |
| College and above | 205 (26.6%) | 74 (13.0%) | 131 (67.9%) | |
| **Employment** | | | | **.004** |
| Fulltime | 518 (67.1%) | 372 (65.8%) | 144 (74.6%) | |
| Parttime | 136 (17.6%) | 115 (20.4%) | 19 (9.8%) | |
| Unemployed/retired | 111 (14.4%) | 78 (13.8%) | 30 (15.5%) | |
| **Monthly household income (CNY)** | | | | **<.001** |
| <2,000 | 215 (27.8%) | 188 (33.0%) | 24 (12.5%) | |
| 2,000-4,000 | 379 (49.1%) | 295 (51.8%) | 81 (42.2%) | |
| 4,000 or above | 174 (22.5%) | 86 (15.1%) | 87 (45.3%) | |
| **Residence rurality** | | | | **<.001** |
| City | 363 (47.0%) | 202 (35.4%) | 159 (82.4%) | |
| County | 129 (16.7%) | 106 (18.6%) | 21 (10.9%) | |
| Rural | 280 (36.3%) | 263 (46.1%) | 13 (6.7%) | |

*Note:* Bivariate analyses between sociodemographic characteristics and MSM status were conducted with Chi-square test or Fisher's exact test as appropriate

Table 5.2 Descriptive statistics of physical, psychological, and behavioral health outcomes across the seven waves

| | **Baseline** | **Wave 2 (6-month)** | **Wave 3 (12-month)** | **Wave 4 (18-month)** | **Wave 5 (24-month)** | **Wave 6 (30-month)** | **Wave 7 (36-month)** | ***p*-value** |
|---|---|---|---|---|---|---|---|---|
| Sample sizes (n, %) | 772 | 769 | 751 | 749 | 743 | 743 | 735 | |
| Attrition rates (n, %) | - | 3 (0.4%) | 21 (2.7%) | 23 (3.0%) | 29 (3.8%) | 29 (3.8%) | 37 (4.8%) | |
| **Physical health outcomes** | | | | | | | | |
| CD4 count | | | | | | | | **.003** |
| <500 cells/mm$^3$ | 448 (58.0%) | 443 (57.4%) | 419 (54.3%) | 397 (51.4%) | 388 (50.3%) | 398 (51.6%) | 389 (50.4%) | |
| ≥500 cells/mm$^3$ | 323 (41.8%) | 325 (42.1%) | 321 (41.6%) | 348 (45.1%) | 355 (46.0%) | 345 (44.7%) | 346 (44.8%) | |
| Viral load | | | | | | | | **<.001** |
| <50 copies/ml | 663 (85.9%) | 640 (82.9%) | 663 (85.9%) | 732 (94.8%) | 710 (92.0%) | 686 (88.9%) | 659 (85.4%) | |
| ≥50 copies/ml | 108 (14.0%) | 95 (12.3%) | 78 (10.1%) | 16 (2.1%) | 32 (4.1%) | 56 (7.3%) | 75 (9.7%) | |
| **Psychological health outcomes** | | | | | | | | |
| Depressive symptoms (Mean, SD) | 6.60 (4.24) | 7.66 (5.08) | 7.15 (4.78) | 7.11 (4.89) | 5.75 (4.20) | 5.99 (4.71) | 6.60 (4.71) | **<.001** |
| Anxiety symptoms (Mean, SD) | 30.34 (6.72) | 34.64 (6.35) | 32.93 (5.60) | 34.42 (6.10) | 32.32 (5.40) | 32.66 (6.78) | 34.12 (7.07) | **<.001** |
| **Behavioral health outcome** | | | | | | | | |
| ART adherence (n, %) | | | | | | | | .29 |
| Optimal | 306 (39.6%) | 298 (38.6%) | 292 (37.8%) | 286 (37.0%) | 300 (38.9%) | 338 (43.8%) | 302 (39.1%) | |
| Suboptimal | 466 (60.4%) | 474 (61.4%) | 480 (62.2%) | 486 (63.0%) | 472 (61.1%) | 434 (56.2%) | 470 (60.9%) | |

*Note:* Trends of continuous outcomes (i.e., depressive symptoms, anxiety symptoms) were tested with repeated measure analysis of variance (ANOVA); categorical outcomes (i.e., CD4 count, viral load, ART adherence) were tested with Cochran-Armitage trend tests.

Table 5.3 Bivariate analyses between sociodemographic characteristics and longitudinal CD4 count

| | CD4 count (<500 cells/mm$^3$ vs. ≥500 cells/mm$^3$) Frequency (percentage) | | | | | | | OR (95% CI) | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Wave 2** | **Wave 3** | **Wave 4** | **Wave 5** | **Wave 6** | **Wave 7** | | |
| **MSM status** | | | | | | | | | |
| Non-MSM males | 365 (63.92%) | 363 (63.80%) | 346 (62.68%) | 336 (60.65%) | 331 (59.96%) | 329 (59.82%) | 322 (59.08%) | Reference | |
| MSM | 79 (40.93%) | 76 (39.58%) | 70 (38.46%) | 57 (30.81%) | 54 (29.19%) | 65 (34.95%) | 64 (34.78%) | .18 (.09, .35) | **<.001** |
| **Age group** | | | | | | | | | |
| 18-24 | 31 (48.44%) | 27 (42.19%) | 22 (35.48%) | 21 (32.81%) | 20 (31.25%) | 22 (34.38%) | 17 (26.56%) | Reference | |
| 25-34 | 121 (50.42%) | 109 (45.80%) | 103 (45.58%) | 91 (40.09%) | 89 (38.36%) | 102 (43.97%) | 103 (44.78%) | .75 (.24, 2.32) | .62 |
| 35-44 | 150 (57.25%) | 156 (59.54%) | 143 (56.97%) | 142 (55.91%) | 138 (55.65%) | 136 (54.62%) | 130 (53.72%) | 1.44 (.47, 4.42) | .52 |
| 45+ | 145 (71.08%) | 150 (73.89%) | 150 (75.00%) | 142 (71.36%) | 140 (70.71%) | 136 (69.39%) | 138 (69.70%) | 4.60 (1.42, 14.89) | **.01** |
| **Ethnicity** | | | | | | | | | |
| Han | 305 (59.69%) | 295 (57.84%) | 282 (57.09%) | 264 (53.33%) | 256 (52.24%) | 255 (52.15%) | 248 (51.13%) | Reference | |
| Minority | 143 (55.00%) | 148 (57.36%) | 137 (55.69%) | 133 (53.20%) | 132 (52.17%) | 143 (56.30%) | 141 (56.40%) | .44 (.23, .84) | **.01** |
| **Marital status** | | | | | | | | | |
| Single | 155 (51.84%) | 146 (48.99%) | 129 (45.26%) | 121 (41.58%) | 115 (39.79%) | 129 (44.48%) | 121 (42.46%) | Reference | |
| Married/life partner | 235 (63.69%) | 240 (65.40%) | 232 (65.35%) | 223 (62.99%) | 224 (62.92%) | 219 (61.69%) | 214 (60.45%) | 2.62 (1.38, 4.99) | **.003** |
| Divorced/separated/widowed | 53 (56.99%) | 52 (55.91%) | 53 (58.89%) | 49 (54.44%) | 45 (51.14%) | 45 (51.72%) | 50 (57.47%) | 1.34 (.49, 3.63) | .57 |
| **Education** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Middle school and below | 269 (65.61%) | 269 (65.77%) | 262 (65.66%) | 247 (61.90%) | 239 (60.20%) | 241 (60.86%) | 241 (61.32%) | 4.13 (2.03, 8.39) | **<.001** |
| High school | 82 (52.56%) | 83 (53.90%) | 74 (51.39%) | 76 (51.35%) | 77 (51.33%) | 74 (49.66%) | 68 (46.26%) | 1.69 (.70, 4.08) | .24 |
| College and above | 97 (47.32%) | 91 (44.39%) | 83 (42.13%) | 74 (37.37%) | 72 (36.73%) | 82 (41.62%) | 80 (41.03%) | Reference | |
| **Employment** | | | | | | | | | |
| Fulltime | 288 (55.60%) | 290 (56.09%) | 267 (53.51%) | 248 (49.70%) | 243 (48.60%) | 257 (51.61%) | 252 (51.01%) | Reference | |
| Parttime | 83 (61.03%) | 76 (56.30%) | 81 (62.31%) | 77 (57.46%) | 72 (55.38%) | 74 (56.49%) | 72 (55.81%) | 1.43 (.64, 3.20) | .38 |
| Unemployed/retired | 74 (66.67%) | 74 (67.27%) | 68 (64.76%) | 70 (66.04%) | 71 (66.36%) | 64 (59.81%) | 63 (59.43%) | 2.83 (1.15, 6.95) | **.02** |
| **Monthly household income (CNY)** | | | | | | | | | |
| <2,000 | 143 (66.51%) | 136 (63.85%) | 131 (63.59%) | 132 (63.16%) | 130 (62.20%) | 131 (62.68%) | 132 (63.46%) | 3.93 (1.67, 9.24) | **.002** |
| 2,000-4,000 | 225 (59.37%) | 232 (61.38%) | 217 (59.29%) | 198 (54.40%) | 192 (52.60%) | 198 (54.40%) | 195 (53.87%) | 3.34 (1.56, 7.14) | **.002** |
| 4,000 or above | 78 (44.83%) | 73 (41.95%) | 69 (41.82%) | 65 (38.46%) | 64 (38.55%) | 66 (39.76%) | 60 (37.04%) | Reference | |
| **Residence rurality** | | | | | | | | | |
| City | 178 (49.04%) | 177 (49.03%) | 157 (45.51%) | 147 (41.64%) | 145 (41.31%) | 150 (42.74%) | 144 (41.26%) | Reference | |
| County | 66 (51.16%) | 68 (53.13%) | 68 (55.28%) | 63 (51.22%) | 59 (47.97%) | 70 (56.91%) | 71 (58.68%) | .57 (.25, 1.34) | .20 |
| Rural | 204 (73.12%) | 198 (70.97%) | 194 (71.32%) | 187 (69.52%) | 184 (68.40%) | 178 (66.17%) | 174 (65.66%) | 6.13 (3.08, 12.18) | **<.001** |

*Note:* Bivariate analyses between socio-demographic characteristics and longitudinal CD4 count were conducted with univariate generalized linear mixed model (GLMM).

Table 5.4 Bivariate analyses between sociodemographic characteristics and longitudinal viral load

| | Viral load (≥50 copies/ml vs. <50 copies/ml) Frequency (percentage) | | | | | | | Odds Ratio (95% CI) | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Wave 2** | **Wave 3** | **Wave 4** | **Wave 5** | **Wave 6** | **Wave 7** | | |
| **MSM status** | | | | | | | | | |
| Non-MSM males | 55 (9.63%) | 49 (8.93%) | 34 (6.15%) | 9 (1.62%) | 19 (3.45%) | 31 (5.65%) | 35 (6.43%) | Reference | |
| MSM | 52 (26.94%) | 44 (24.58%) | 44 (24.18%) | 7 (3.78%) | 13 (7.03%) | 24 (12.90%) | 40 (21.74%) | 6.74 (2.98, 15.28) | **<.001** |
| **Age group** | | | | | | | | | |
| 18-24 | 15 (23.44%) | 10 (15.87%) | 15 (23.44%) | 1 (1.56%) | 2 (3.13%) | 8 (12.50%) | 19 (29.69%) | Reference | |
| 25-34 | 46 (19.17%) | 43 (19.20%) | 38 (16.89%) | 8 (3.48%) | 16 (6.90%) | 22 (9.48%) | 25 (10.87%) | 3.10 (.83, 11.54) | .09 |
| 35-44 | 26 (9.92%) | 23 (9.27%) | 19 (7.54%) | 7 (2.76%) | 9 (3.63%) | 13 (5.22%) | 21 (8.68%) | .44 (.11, 1.72) | .24 |
| 45+ | 21 (10.29%) | 19 (9.55%) | 6 (3.02%) | 0 (.00%) | 5 (2.53%) | 13 (6.63%) | 10 (5.05%) | .80 (.19, 3.38) | .76 |
| **Ethnicity** | | | | | | | | | |
| Han | 65 (12.72%) | 64 (13.01%) | 43 (8.74%) | 8 (1.61%) | 25 (5.10%) | 33 (6.75%) | 47 (9.69%) | Reference | |
| Minority | 43 (16.54%) | 31 (12.76%) | 35 (14.06%) | 8 (3.19%) | 7 (2.78%) | 23 (9.09%) | 28 (11.24%) | 1.74 (.80, 3.81) | .16 |
| **Marital status** | | | | | | | | | |
| Single | 66 (22.07%) | 55 (19.30%) | 51 (17.83%) | 8 (2.75%) | 16 (5.54%) | 27 (9.31%) | 44 (15.44%) | Reference | |
| Married/life partner | 31 (8.40%) | 32 (9.04%) | 19 (5.34%) | 6 (1.68%) | 10 (2.82%) | 22 (6.21%) | 25 (7.08%) | .14 (.06, .33) | **<.001** |
| Divorced/separated/widowed | 11 (11.83%) | 8 (9.30%) | 8 (8.99%) | 2 (2.22%) | 6 (6.82%) | 7 (8.05%) | 6 (6.90%) | .23 (.07, .82) | **.02** |
| **Education** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Middle school and below | 36 (8.78%) | 35 (8.91%) | 28 (7.04%) | 9 (2.24%) | 12 (3.02%) | 21 (5.30%) | 19 (4.83%) | .24 (.10, .59) | **.002** |
| High school | 21 (13.46%) | 23 (15.75%) | 15 (10.27%) | 3 (2.01%) | 7 (4.67%) | 12 (8.05%) | 19 (12.93%) | .35 (.12, 1.00) | .05 |
| College and above | 51 (24.88%) | 37 (18.88%) | 35 (17.77%) | 4 (2.02%) | 13 (6.67%) | 23 (11.73%) | 37 (19.07%) | Reference | |
| **Employment** | | | | | | | | | |
| Fulltime | 79 (15.25%) | 63 (12.83%) | 55 (11.00%) | 10 (2.00%) | 22 (4.41%) | 43 (8.65%) | 56 (11.36%) | Reference | |
| Parttime | 14 (10.29%) | 17 (12.98%) | 17 (12.98%) | 3 (2.24%) | 7 (5.38%) | 7 (5.34%) | 9 (6.98%) | .85 (.31, 2.33) | .75 |
| Unemployed/retired | 13 (11.71%) | 13 (12.04%) | 5 (4.81%) | 2 (1.87%) | 3 (2.80%) | 6 (5.61%) | 9 (8.49%) | .81 (.26, 2.53) | .71 |
| **Monthly household income (CNY)** | | | | | | | | | |
| <2,000 | 21 (9.77%) | 24 (11.82%) | 15 (7.28%) | 6 (2.86%) | 11 (5.26%) | 17 (8.13%) | 20 (9.62%) | .16 (.06, .46) | **<.001** |
| 2,000-4,000 | 49 (12.93%) | 42 (11.38%) | 37 (10.11%) | 5 (1.37%) | 13 (3.56%) | 25 (6.87%) | 31 (8.56%) | .29 (.12, .71) | **.007** |
| 4,000 or above | 37 (21.26%) | 29 (18.13%) | 26 (15.66%) | 5 (2.96%) | 8 (4.85%) | 14 (8.48%) | 24 (14.91%) | Reference | |
| **Residence rurality** | | | | | | | | | |
| City | 70 (19.28%) | 59 (17.20%) | 49 (14.16%) | 6 (1.70%) | 17 (4.86%) | 29 (8.29%) | 46 (13.22%) | Reference | |
| County | 13 (10.08%) | 11 (9.09%) | 13 (10.48%) | 4 (3.23%) | 2 (1.63%) | 6 (4.88%) | 10 (8.26%) | .32 (.10, .97) | **.04** |
| Rural | 25 (8.96%) | 25 (9.23%) | 16 (5.90%) | 6 (2.21%) | 13 (4.83%) | 21 (7.81%) | 19 (7.17%) | .18 (.08, .43) | **<.001** |

*Note:* Bivariate analyses between socio-demographic characteristics and longitudinal viral load were conducted with univariate generalized linear mixed model (GLMM).

Table 5.5 Bivariate analyses between sociodemographic characteristics and depressive symptoms

| | Depressive symptoms Mean (SD) | | | | | | | Mean difference | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Wave 2** | **Wave 3** | **Wave 4** | **Wave 5** | **Wave 6** | **Wave 7** | | |
| **MSM status** | | | | | | | | | |
| Non-MSM males | 6.14 (4.13) | 7.71 (5.15) | 7.16 (4.84) | 7.05 (4.93) | 5.56 (4.14) | 5.90 (4.72) | 6.57 (4.59) | Reference | |
| MSM | 7.89 (4.34) | 7.67 (4.91) | 7.23 (4.63) | 7.33 (4.81) | 6.33 (4.36) | 6.30 (4.72) | 6.70 (5.08) | .48 | .06 |
| **Age group** | | | | | | | | | |
| 18-24 | 7.92 (4.56) | 7.27 (4.54) | 7.09 (4.14) | 6.27 (4.41) | 5.88 (3.69) | 6.27 (4.23) | 6.78 (4.84) | Reference | |
| 25-34 | 6.90 (4.64) | 8.18 (5.29) | 7.50 (5.17) | 7.26 (5.08) | 5.91 (4.27) | 6.06 (4.83) | 6.77 (5.01) | .16 | .71 |
| 35-44 | 6.28 (4.04) | 7.44 (5.03) | 6.85 (4.61) | 7.45 (4.98) | 5.97 (4.51) | 5.98 (4.80) | 6.77 (4.45) | -.10 | .81 |
| 45+ | 6.23 (3.79) | 7.46 (5.06) | 7.18 (4.73) | 6.75 (4.68) | 5.25 (3.82) | 5.85 (4.64) | 6.13 (4.64) | -.38 | .39 |
| **Ethnicity** | | | | | | | | | |
| Han | 6.57 (4.09) | 7.94 (5.17) | 7.15 (4.80) | 7.32 (4.96) | 5.65 (4.30) | 6.19 (4.91) | 6.87 (4.72) | Reference | |
| Minority | 6.66 (4.53) | 7.12 (4.86) | 7.15 (4.77) | 6.69 (4.75) | 5.95 (3.99) | 5.62 (4.27) | 6.08 (4.65) | -.35 | .14 |
| **Marital status** | | | | | | | | | |
| Single | 6.97 (4.37) | 7.50 (4.89) | 6.84 (4.72) | 7.19 (4.92) | 5.74 (4.07) | 6.03 (4.69) | 6.73 (4.82) | Reference | |
| Married/life partner | 6.19 (3.96) | 7.82 (5.17) | 7.36 (4.85) | 6.85 (4.65) | 5.70 (4.29) | 5.98 (4.67) | 6.53 (4.64) | -.08 | .73 |
| Divorced/separated/widowed | 7.32 (4.69) | 7.68 (5.51) | 7.53 (4.85) | 7.98 (5.67) | 6.01 (4.35) | 5.90 (5.04) | 6.48 (4.61) | .27 | .46 |
| **Education** | | | | | | | | | |
| Middle school and below | 5.95 (3.74) | 7.79 (5.29) | 7.10 (4.94) | 7.21 (5.03) | 5.64 (4.26) | 6.03 (4.81) | 6.86 (4.72) | -.24 | .37 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| High school | 6.81 | 7.49 | 7.36 | 6.72 | 5.77 | 5.63 | 6.04 | -.35 | .29 |
| | (4.73) | (4.21) | (4.53) | (4.34) | (3.90) | (4.54) | (4.24) | | |
| College and above | 7.74 | 7.52 | 7.11 | 7.20 | 5.97 | 6.21 | 6.50 | Reference | |
| | (4.55) | (5.29) | (4.67) | (5.02) | (4.32) | (4.67) | (5.01) | | |
| **Employment** | | | | | | | | | |
| Fulltime | 6.53 | 7.59 | 7.26 | 7.03 | 5.70 | 5.74 | 6.20 | Reference | |
| | (3.96) | (4.72) | (4.68) | (4.83) | (4.02) | (4.42) | (4.54) | | |
| Parttime | 6.38 | 7.74 | 6.75 | 7.09 | 5.52 | 6.65 | 7.44 | .22 | .46 |
| | (4.26) | (6.16) | (4.97) | (5.02) | (4.47) | (5.34) | (4.79) | | |
| Unemployed/retired | 7.18 | 7.86 | 7.00 | 7.32 | 6.09 | 6.32 | 7.40 | .45 | .16 |
| | (5.33) | (5.28) | (5.00) | (4.99) | (4.61) | (5.20) | (5.18) | | |
| **Monthly household income (CNY)** | | | | | | | | | |
| <2,000 | 6.66 | 7.83 | 7.12 | 7.61 | 6.01 | 6.07 | 6.88 | .85 | **.006** |
| | (5.07) | (5.65) | (4.90) | (5.43) | (4.61) | (5.23) | (4.84) | | |
| 2,000-4,000 | 6.45 | 8.19 | 7.69 | 7.30 | 5.91 | 6.18 | 6.65 | .88 | **.002** |
| | (3.78) | (4.80) | (4.68) | (4.53) | (4.10) | (4.48) | (4.68) | | |
| 4,000 or above | 6.88 | 6.34 | 6.10 | 6.10 | 5.10 | 5.54 | 6.17 | Reference | |
| | (4.07) | (4.76) | (4.72) | (4.84) | (3.79) | (4.55) | (4.64) | | |
| **Residence rurality** | | | | | | | | | |
| City | 6.92 | 7.36 | 6.85 | 6.85 | 5.86 | 6.14 | 6.62 | Reference | |
| | (4.56) | (5.12) | (4.68) | (4.79) | (4.40) | (4.81) | (4.84) | | |
| County | 6.15 | 6.98 | 6.02 | 6.62 | 5.20 | 5.50 | 6.74 | -.49 | .12 |
| | (3.96) | (5.24) | (4.79) | (4.89) | (4.23) | (5.05) | (4.79) | | |
| Rural | 6.39 | 8.37 | 8.07 | 7.67 | 5.87 | 6.03 | 6.53 | .33 | .17 |
| | (3.91) | (4.88) | (4.76) | (4.99) | (3.89) | (4.42) | (4.52) | | |

*Note:* Bivariate analyses between socio-demographic characteristics and longitudinal depressive symptoms were conducted with repeated measure analysis of variance (ANOVA).

Table 5.6 Bivariate analyses between sociodemographic characteristics and anxiety symptoms

| | Anxiety symptoms Mean (SD) | | | | | | | Mean difference | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Wave 2** | **Wave 3** | **Wave 4** | **Wave 5** | **Wave 6** | **Wave 7** | | |
| **MSM status** | | | | | | | | | |
| Non-MSM males | 29.98 | 34.73 | 32.69 | 34.47 | 32.15 | 32.52 | 34.36 | Reference | |
| | (6.97) | (6.51) | (5.40) | (6.22) | (5.34) | (6.92) | (7.29) | | |
| MSM | 31.66 | 33.78 | 33.65 | 34.17 | 32.78 | 32.98 | 33.50 | .23 | .54 |
| | (6.23) | (5.57) | (6.35) | (5.61) | (5.53) | (6.14) | (6.52) | | |
| **Age group** | | | | | | | | | |
| 18-24 | 31.38 | 35.13 | 33.95 | 34.25 | 32.79 | 33.46 | 34.74 | Reference | |
| | (6.36) | (5.70) | (6.27) | (5.29) | (5.02) | (5.53) | (6.45) | | |
| 25-34 | 30.67 | 34.89 | 33.38 | 34.00 | 32.33 | 33.05 | 34.43 | -.42 | .49 |
| | (7.49) | (6.49) | (6.29) | (5.80) | (5.10) | (6.60) | (6.94) | | |
| 35-44 | 29.92 | 34.54 | 32.87 | 35.10 | 32.70 | 32.27 | 34.62 | -.52 | .38 |
| | (6.98) | (6.75) | (5.46) | (6.42) | (5.98) | (7.60) | (7.45) | | |
| 45+ | 30.29 | 33.71 | 32.07 | 33.96 | 31.61 | 32.27 | 33.04 | -1.25 | **.04** |
| | (5.91) | (5.68) | (4.79) | (6.12) | (4.97) | (6.08) | (7.01) | | |
| **Ethnicity** | | | | | | | | | |
| Han | 30.43 | 34.80 | 32.84 | 34.69 | 32.33 | 32.97 | 34.81 | Reference | |
| | (6.83) | (6.43) | (5.58) | (6.10) | (5.62) | (7.11) | (7.36) | | |
| Minority | 30.26 | 33.81 | 33.02 | 33.76 | 32.23 | 31.90 | 32.79 | -.73 | **.03** |
| | (6.79) | (6.01) | (5.79) | (5.97) | (4.86) | (5.86) | (6.38) | | |
| **Marital status** | | | | | | | | | |
| Single | 30.69 | 34.35 | 33.06 | 34.12 | 32.16 | 32.95 | 33.92 | Reference | |
| | (6.73) | (5.99) | (6.03) | (5.85) | (4.89) | (6.62) | (6.57) | | |
| Married/life partner | 30.00 | 34.83 | 32.68 | 34.60 | 32.37 | 32.32 | 34.42 | -.01 | .98 |
| | (6.37) | (6.68) | (5.45) | (6.13) | (5.70) | (6.79) | (7.53) | | |
| Divorced/separated/widowed | 31.36 | 33.31 | 33.18 | 34.38 | 32.21 | 32.40 | 33.69 | -.11 | .85 |
| | (8.70) | (5.96) | (5.36) | (6.61) | (5.64) | (6.98) | (7.22) | | |
| **Education** | | | | | | | | | |
| Middle school and below | 29.74 | 34.78 | 32.64 | 34.66 | 32.22 | 32.55 | 34.87 | .001 | .99 |
| | (6.24) | (6.67) | (5.64) | (6.43) | (5.57) | (7.33) | (7.74) | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| High school | 30.62 | 34.42 | 32.79 | 34.10 | 32.15 | 32.43 | 33.45 | -.22 | .65 |
| | (7.52) | (6.01) | (4.88) | (5.55) | (4.71) | (5.95) | (5.77) | | |
| College and above | 31.50 | 33.85 | 33.52 | 34.01 | 32.57 | 32.88 | 33.14 | Reference | |
| | (7.25) | (5.72) | (6.17) | (5.66) | (5.47) | (5.99) | (6.50) | | |
| **Employment** | | | | | | | | | |
| Fulltime | 30.06 | 34.11 | 32.62 | 34.21 | 31.84 | 32.16 | 33.40 | Reference | |
| | (5.94) | (5.77) | (5.21) | (6.23) | (4.72) | (6.47) | (6.67) | | |
| Parttime | 30.32 | 35.44 | 33.33 | 34.59 | 32.59 | 33.73 | 36.13 | 1.11 | **.01** |
| | (7.44) | (7.14) | (5.93) | (5.61) | (5.51) | (7.28) | (7.57) | | |
| Unemployed/retired | 32.04 | 35.02 | 33.35 | 34.48 | 33.79 | 33.16 | 34.84 | 1.19 | **.01** |
| | (9.22) | (7.43) | (7.02) | (5.67) | (7.36) | (7.01) | (7.99) | | |
| **Monthly household income (CNY)** | | | | | | | | | |
| <2,000 | 31.59 | 35.04 | 33.30 | 34.77 | 33.24 | 32.69 | 34.39 | 1.48 | **.001** |
| | (9.07) | (7.28) | (6.36) | (6.19) | (6.49) | (6.97) | (7.17) | | |
| 2,000-4,000 | 29.96 | 34.93 | 33.12 | 34.77 | 32.30 | 32.68 | 34.39 | 1.07 | **.01** |
| | (5.70) | (5.85) | (5.23) | (6.05) | (4.89) | (6.74) | (7.21) | | |
| 4,000 or above | 29.87 | 32.79 | 31.95 | 33.12 | 31.15 | 32.42 | 33.38 | Reference | |
| | (5.49) | (5.70) | (5.53) | (5.82) | (4.64) | (6.50) | (6.80) | | |
| **Residence rurality** | | | | | | | | | |
| City | 30.77 | 33.92 | 32.84 | 33.97 | 32.38 | 32.72 | 33.75 | Reference | |
| | (6.84) | (6.04) | (5.84) | (5.81) | (5.56) | (6.40) | (6.59) | | |
| County | 28.76 | 33.56 | 32.14 | 33.74 | 31.63 | 31.84 | 34.89 | -.54 | .24 |
| | (6.45) | (6.12) | (5.23) | (5.42) | (4.99) | (7.20) | (7.88) | | |
| Rural | 30.60 | 35.54 | 33.31 | 35.18 | 32.49 | 32.82 | 34.28 | .55 | .12 |
| | (6.86) | (6.58) | (5.57) | (6.58) | (5.31) | (6.93) | (7.36) | | |

*Note:* Bivariate analyses between socio-demographic characteristics and longitudinal anxiety symptoms were conducted with repeated measure analysis of variance (ANOVA).

Table 5.7 Bivariate analyses between sociodemographic characteristics and longitudinal ART adherence

| | ART adherence (suboptimal vs. optimal) Frequency (percentage) | | | | | | | OR (95% CI) | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | **Baseline** | **Wave 2** | **Wave 3** | **Wave 4** | **Wave 5** | **Wave 6** | **Wave 7** | | |
| **MSM status** | | | | | | | | | |
| Non-MSM males | 385 (67.43%) | 386 (67.60%) | 392 (68.65%) | 397 (69.53%) | 389 (68.13%) | 357 (62.52%) | 389 (68.13%) | Reference | |
| MSM | 73 (37.82%) | 83 (43.01%) | 83 (43.01%) | 84 (43.52%) | 78 (40.41%) | 73 (37.82%) | 76 (39.38%) | .11 (.05, .22) | **<.001** |
| **Age group** | | | | | | | | | |
| 18-24 | 23 (35.94%) | 28 (43.75%) | 27 (42.19%) | 27 (42.19%) | 24 (37.50%) | 23 (35.94%) | 23 (35.94%) | Reference | |
| 25-34 | 128 (53.33%) | 120 (50.00%) | 130 (54.17%) | 137 (57.08%) | 124 (51.67%) | 123 (51.25%) | 126 (52.50%) | 2.39 (.73, 7.79) | .15 |
| 35-44 | 179 (68.32%) | 177 (67.56%) | 177 (67.56%) | 174 (66.41%) | 179 (68.32%) | 151 (57.63%) | 177 (67.56%) | 10.40 (3.20, 33.85) | **<.001** |
| 45+ | 134 (65.69%) | 147 (72.06%) | 144 (70.59%) | 146 (71.57%) | 143 (70.10%) | 136 (66.67%) | 142 (69.61%) | 8.44 (2.51, 28.39) | **<.001** |
| **Ethnicity** | | | | | | | | | |
| Han | 305 (59.69%) | 311 (60.86%) | 313 (61.25%) | 316 (61.84%) | 316 (61.84%) | 284 (55.58%) | 318 (62.23%) | Reference | |
| Minority | 161 (61.69%) | 163 (62.45%) | 167 (63.98%) | 170 (65.13%) | 156 (59.77%) | 150 (57.47%) | 152 (58.24%) | 1.69 (.87, 3.29) | .12 |
| **Marital status** | | | | | | | | | |
| Single | 148 (49.50%) | 153 (51.17%) | 157 (52.51%) | 162 (54.18%) | 142 (47.49%) | 133 (44.48%) | 147 (49.16%) | Reference | |
| Married/life partner | 255 (69.11%) | 257 (69.65%) | 261 (70.73%) | 261 (70.73%) | 266 (72.09%) | 242 (65.58%) | 258 (69.92%) | 3.99 (2.05, 7.77) | **<.001** |
| Divorced/separated/widowed | 54 (58.06%) | 56 (60.22%) | 54 (58.06%) | 55 (59.14%) | 57 (61.29%) | 54 (58.06%) | 59 (63.44%) | 1.25 (.45, 3.47) | .67 |
| **Education** | | | | | | | | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Middle school and below | 278 (67.80%) | 280 (68.29%) | 283 (69.02%) | 286 (69.76%) | 281 (68.54%) | 253 (61.71%) | 278 (67.80%) | 9.57 (4.62, 19.82) | **<.001** |
| High school | 101 (64.74%) | 103 (66.03%) | 101 (64.74%) | 102 (65.38%) | 100 (64.10%) | 94 (60.26%) | 99 (63.46%) | 7.69 (3.07, 19.22) | **<.001** |
| College and above | 86 (41.95%) | 90 (43.90%) | 95 (46.34%) | 97 (47.32%) | 90 (43.90%) | 87 (42.44%) | 92 (44.88%) | Reference | |
| **Employment** | | | | | | | | | |
| Fulltime | 318 (61.39%) | 319 (61.58%) | 322 (62.16%) | 321 (61.97%) | 314 (60.62%) | 287 (55.41%) | 312 (60.23%) | Reference | |
| Parttime | 78 (57.35%) | 82 (60.29%) | 85 (62.50%) | 89 (65.44%) | 85 (62.50%) | 81 (59.56%) | 91 (66.91%) | .46 (.20, 1.04) | .06 |
| Unemployed/retired | 65 (58.56%) | 66 (59.46%) | 67 (60.36%) | 69 (62.16%) | 67 (60.36%) | 61 (54.95%) | 61 (54.95%) | .82 (.33, 2.05) | .68 |
| **Monthly household income (CNY)** | | | | | | | | | |
| <2,000 | 141 (65.58%) | 139 (64.65%) | 143 (66.51%) | 147 (68.37%) | 145 (67.44%) | 131 (60.93%) | 132 (61.40%) | 3.68 (1.53, 8.82) | **.004** |
| 2,000-4,000 | 236 (62.27%) | 243 (64.12%) | 241 (63.59%) | 244 (64.38%) | 239 (63.06%) | 221 (58.31%) | 248 (65.44%) | 2.15 (.99, 4.69) | .05 |
| 4,000 or above | 86 (49.43%) | 89 (51.15%) | 93 (53.45%) | 92 (52.87%) | 85 (48.85%) | 80 (45.98%) | 87 (50.00%) | Reference | |
| **Residence rurality** | | | | | | | | | |
| City | 190 (52.34%) | 200 (55.10%) | 203 (55.92%) | 205 (56.47%) | 200 (55.10%) | 192 (52.89%) | 193 (53.17%) | Reference | |
| County | 82 (63.57%) | 82 (63.57%) | 87 (67.44%) | 90 (69.77%) | 86 (66.67%) | 76 (58.91%) | 89 (68.99%) | 2.19 (.92, 5.25) | .08 |
| Rural | 194 (69.29%) | 192 (68.57%) | 190 (67.86%) | 191 (68.21%) | 186 (66.43%) | 166 (59.29%) | 188 (67.14%) | 4.39 (2.20, 8.76) | **<.001** |

*Note:* Bivariate analyses between socio-demographic characteristics and longitudinal ART adherence were conducted with univariate generalized linear mixed model (GLMM).

Table 5.8 Unconditional and conditional latent growth curve models of CD4 count<500 cells/mm$^3$

| | Unconditional | | | | | Conditional | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-MSM males | | MSM | | *p*-value of Wald test | Non-MSM males | | MSM | | *p*-value of Wald test |
| | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | |
| **Means** | | | | | | | | | | |
| Intercept (*OR*) | 10.88 (5.27, 22.44) | <.001 | .34 (.15, .78) | .01 | **<.001** | .18 (.01, 3.85) | .27 | .15 (.02, .95) | .04 | .87 |
| Slope (*OR*) | .90 (.78, 1.04) | .14 | .69 (.54, .87) | .002 | .85 | .49 (.22, 1.08) | .08 | .66 (.39, 1.13) | .13 | .49 |
| **Variances** | | | | | | | | | | |
| Intercept | 38.99 (22.06, 55.93) | <.001 | 17.07 (6.54, 27.61) | .001 | .39 | 31.98 (18.33, 45.64) | <.001 | 14.52 (5.68, 23.36) | .001 | .34 |
| Slope | .58 (.22, .94) | .002 | .73 (.21, 1.24) | .005 | .64 | .49 (.26, .72) | <.001 | .53 (.12, .94) | .01 | .99 |
| **Correlation** | | | | | | | | | | |
| Intercept with slope | -.04 (-.43, .34) | .83 | .16 (-.28, .60) | .49 | .53 | -.04 (-.43, .35) | .85 | .24 (-.22, .69) | .31 | .84 |

*Note*: Linear trend was assumed. Conditional model adjusted for age, ethnicity, marital status, education attainment, employment, monthly household income, and residence rurality. Odds Ratios are reported for means; coefficients are reported for variances and correlations. Means and variances were unstandardized; correlations were standardized. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 5.9 Unconditional and conditional latent growth curve models of viral load≥50 copies/ml

| | Unconditional | | | | | Conditional | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-MSM males | | MSM | | *p*-value of Wald test | Non-MSM males | | MSM | | *p*-value of Wald test |
| | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | |
| **Means** | | | | | | | | | | |
| Intercept (OR) | 2.3E-05 (9.41E-08, .01) | <.001 | .12 (.04, .33) | <.001 | **<.001** | .07 (.00, 10.34) | .29 | .08 (.01, .54) | .01 | .29 |
| Slope (OR) | 64.65 (3.03, 1380.22) | .008 | 1.19 (.57, 2.45) | .65 | **<.001** | .17 (.00, 21.61) | .48 | .81 (.25, 2.68) | .73 | .30 |
| Quadratic (OR) | .47 (.29, .76) | .002 | .90 (.77, 1.04) | .16 | **<.001** | 1.22 (.53, 2.81) | .64 | 1.05 (.84, 1.30) | .68 | .23 |
| **Variances** | | | | | | | | | | |
| Intercept | 81.59 (-40.39, 203.58) | .19 | 12.44 (.35, 24.52) | .04 | .08 | 56.11 (11.25, 100.97) | .01 | 10.87 (.85, 20.90) | .03 | .20 |
| Slope | 20.56 (-13.86, 54.98) | .24 | 3.74 (-.52, 7.99) | .09 | .15 | 14.01 (.82, 27.19) | .04 | 2.91 (-.38, 6.21) | .08 | .31 |
| Quadratic | .49 (-.24, 1.22) | .19 | .16 (.01, .31) | .04 | .05 | .36 (.03, .69) | .03 | .13 (.00, .25) | .05 | .10 |
| **Correlations** | | | | | | | | | | |
| Intercept with slope | -.98 (-1.00, -.95) | <.001 | -.83 (-1.02, -.65) | <.001 | .14 | -.99 (-1.01, -.98) | <.001 | -.85 (-1.03, -.68) | <.001 | .30 |
| Intercept with quadratic | .90 (.80, 1.00) | <.001 | .60 (.33, .87) | <.001 | .15 | .92 (.84, 1.00) | <.001 | .60 (.30, .89) | <.001 | .31 |
| Slope with quadratic | -.96 (-1.00, -.92) | <.001 | -.94 (-.98, -.89) | <.001 | .10 | -.96 (-.99, -.92) | <.001 | -.93 (-.99, -.87) | <.001 | .20 |

*Note*: Quadratic trend was assumed. Conditional model adjusted for age, ethnicity, marital status, education attainment, employment, monthly household income, and residence rurality. Odds Ratios are reported for means; coefficients are reported for variances and correlations. Means and variances were unstandardized; correlations were standardized. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 5.10 Unconditional and conditional latent growth curve models of depressive symptoms

| | Unconditional | | | | | Conditional | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-MSM males | | MSM | | *p*-value of Wald test | Non-MSM males | | MSM | | *p*-value of Wald test |
| | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | |
| **Means** | | | | | | | | | | |
| Intercept | 7.75 (7.31, 8.19) | <.001 | 7.75 (7.12, 8.39) | <.001 | .99 | 6.03 (4.64, 7.43) | <.001 | 7.28 (5.86, 8.69) | <.001 | .22 |
| Slope | -.33 (-.42, -.24) | <.001 | -.24 (-.35, -.12) | <.001 | .21 | -.25 (-.66, .17) | .24 | -.36 (-.62, -.10) | .008 | .66 |
| **Variances** | | | | | | | | | | |
| Intercept | 9.21 (6.62, 11.79) | <.001 | 8.82 (6.03, 11.62) | <.001 | .84 | 8.09 (5.67, 10.51) | <.001 | 8.03 (5.33, 10.72) | <.001 | .97 |
| Slope | .18 (.08, .27) | .001 | .10 (-.02, .23) | .09 | .38 | .12 (.03, .22) | .01 | .07 (-.05, .18) | .26 | .45 |
| **Correlation** | | | | | | | | | | |
| Intercept with slope | -.65 (-.81, -.50) | <.001 | .25 (-.26, .76) | .33 | **<.001** | -.66 (-.84, -.47) | <.001 | .41 (-.43, 1.25) | .34 | **.001** |

*Note*: Linear trend was assumed. Conditional model adjusted for age, ethnicity, marital status, education attainment, employment, monthly household income, and residence rurality. Means and variances were unstandardized; correlations were standardized. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 5.11 Unconditional and conditional latent growth curve models of anxiety symptoms

| | Unconditional | | | | | Conditional | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-MSM males | | MSM | | *p*-value of Wald test | Non-MSM males | | MSM | | *p*-value of Wald test |
| | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | |
| **Means** | | | | | | | | | | |
| Intercept | 33.94 (33.38, 34.51) | <.001 | 34.21 (33.41, 35.02) | <.001 | .59 | 32.32 (30.21, 34.43) | <.001 | 34.16 (32.56, 35.76) | <.001 | .17 |
| Slope | -.20 (-.32, -.08) | .001 | -.19 (-.33, -.04) | .01 | .91 | .05 (-.60, .70) | .88 | -.34 (-.64, -.04) | .02 | .28 |
| **Variances** | | | | | | | | | | |
| Intercept | 22.35 (13.25, 31.46) | <.001 | 16.26 (11.35, 21.17) | <.001 | .25 | 20.36 (12.08, 28.65) | <.001 | 13.80 (9.39, 18.20) | <.001 | .17 |
| Slope | .65 (.34, .96) | <.001 | .08 (-.18, .35) | .54 | **.007** | .54 (.24, .84) | <.001 | -.02 (-.23, .19) | .83 | **.003** |
| **Correlation** | | | | | | | | | | |
| Intercept with slope | -.66 (-.81, -.50) | <.001 | .34 (-.76, 1.44) | .54 | **.001** | -.68 (-.84, -.52) | <.001 | .64 (-.11, 1.39) | .10 | **.001** |

*Note*: Linear trend was assumed. Conditional model adjusted for age, ethnicity, marital status, education attainment, employment, monthly household income, and residence rurality. Means and variances were unstandardized; correlations were standardized. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 5.12 Unconditional and conditional latent growth curve models of ART adherence

| | Unconditional | | | | | Conditional | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Non-MSM males | | MSM | | *p*-value of Wald test | Non-MSM males | | MSM | | *p*-value of Wald test |
| | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | | Estimate (95% CI) | *p*-value | Estimate (95% CI) | *p*-value | |
| **Means** | | | | | | | | | | |
| Intercept (OR) | 16.23 (8.42, 31.28) | <.001 | .39 (.17, .90) | .03 | **<.001** | .06 (.00, 1.58) | .09 | .11 (.01, .96) | .05 | .38 |
| Slope (OR) | .84 (.74, .94) | .003 | .95 (.84, 1.07) | .38 | .24 | 1.11 (.73, 1.70) | .62 | 1.00 (.76, 1.32) | .99 | .47 |
| **Variance** | | | | | | | | | | |
| Intercept | 28.01 (18.52, 37.50) | <.001 | 25.75 (8.74, 42.76) | .003 | .27 | 26.25 (17.36, 35.15) | <.001 | 24.22 (8.85, 39.60) | .002 | .33 |
| Slope | .23 (.10, .36) | .001 | .12 (-.02, .25) | .10 | .97 | .20 (.07, .33) | .002 | .03 (-.07, .14) | .52 | .78 |
| **Correlation** | | | | | | | | | | |
| Intercept with slope | -.78 (-.99, -.57) | <.001 | .07 (-1.04, 1.17) | .91 | .36 | -.82 (-1.01, -.63) | <.001 | .29 (-1.45, 2.03) | .75 | .23 |

*Note*: Linear trend was assumed. Conditional model adjusted for age, ethnicity, marital status, education attainment, employment, monthly household income, and residence rurality. Odds Ratios are reported for means; coefficients are reported for variances and correlations. Means and variances were unstandardized; correlations were standardized. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

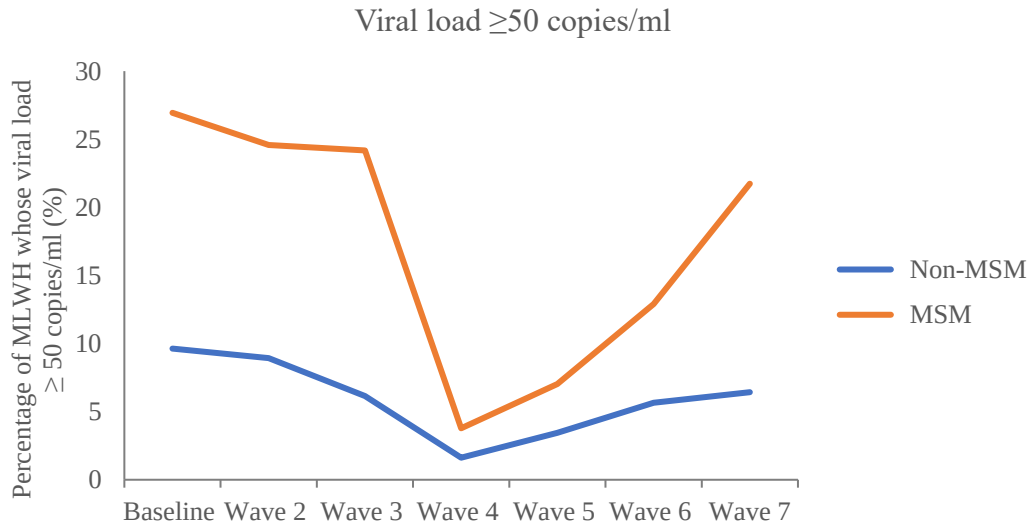


Figure 5.1 The trend in percentage of viral load≥50 copies/ml by study waves

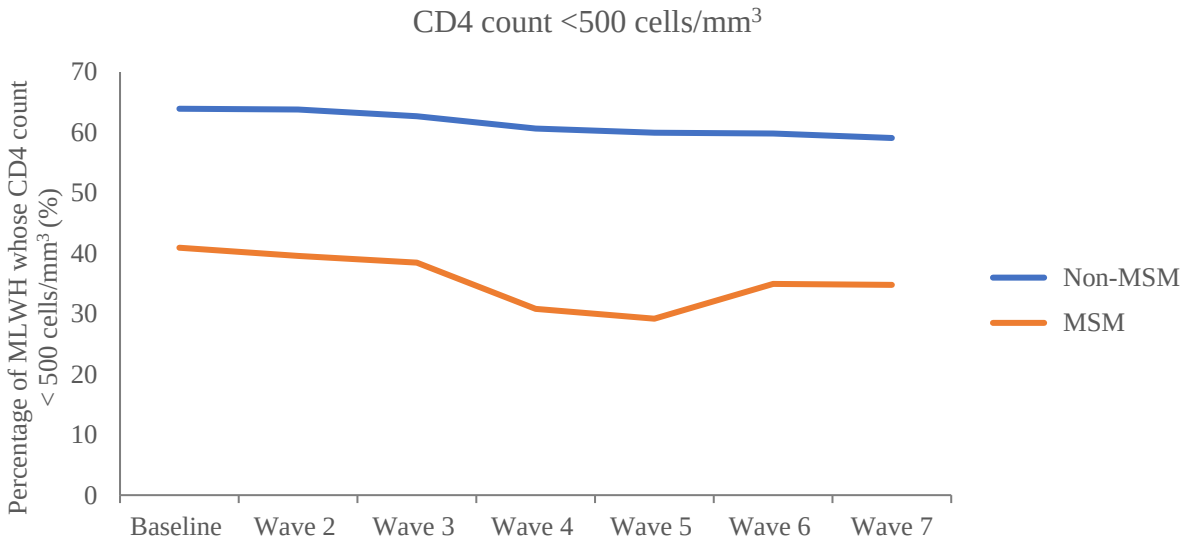


Figure 5.2 The trend in percentage of CD5 count <500 cells/mm$^3$ by study waves

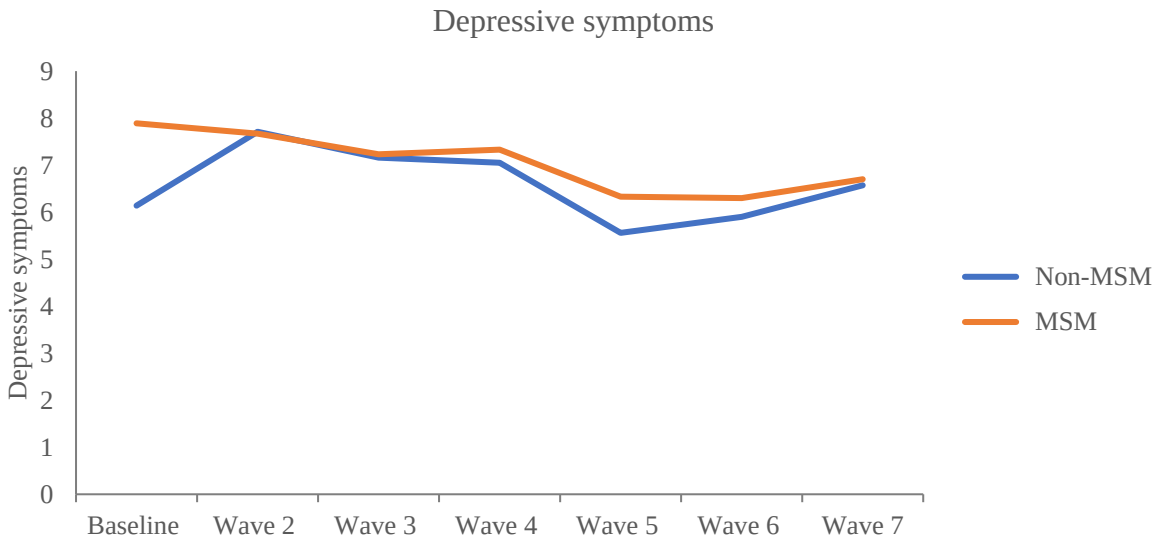


Figure 5.3 The trend in depressive symptoms by study waves

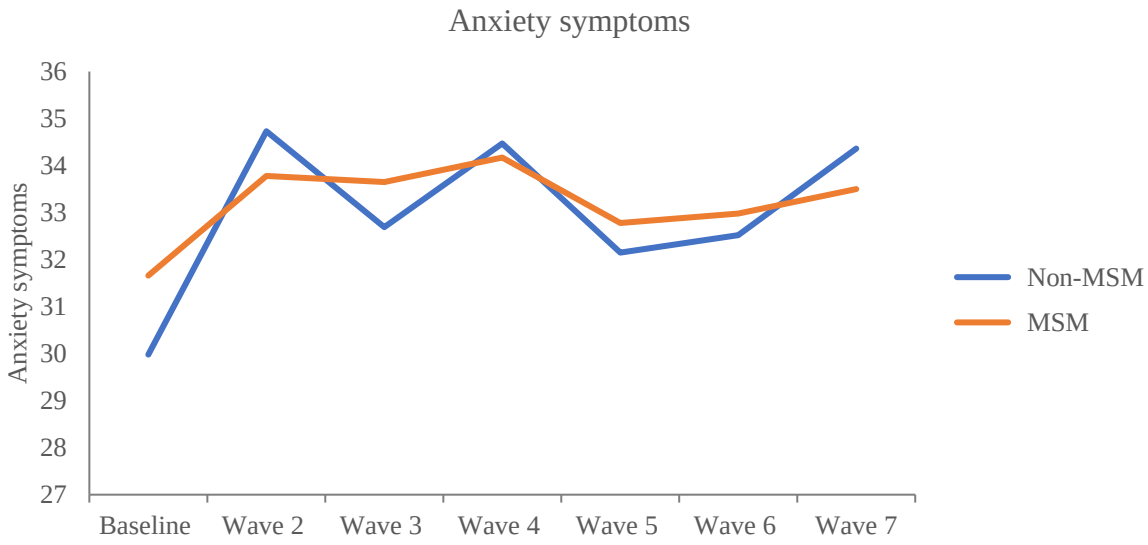


Figure 5.4 The trend in anxiety symptoms by study waves

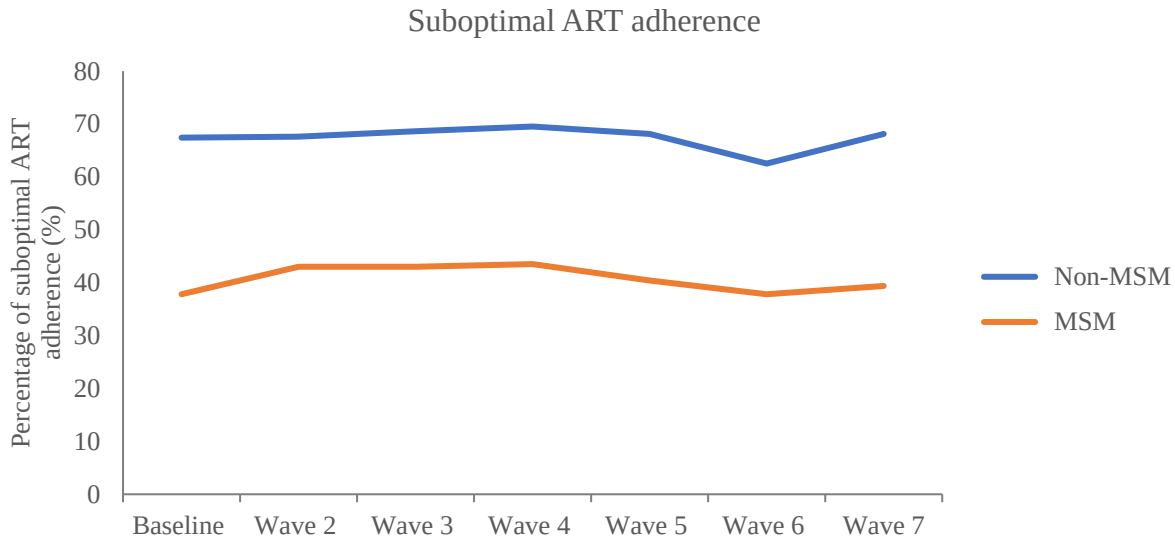


Figure 5.5 The trend in percentage of suboptimal ART adherence by study waves

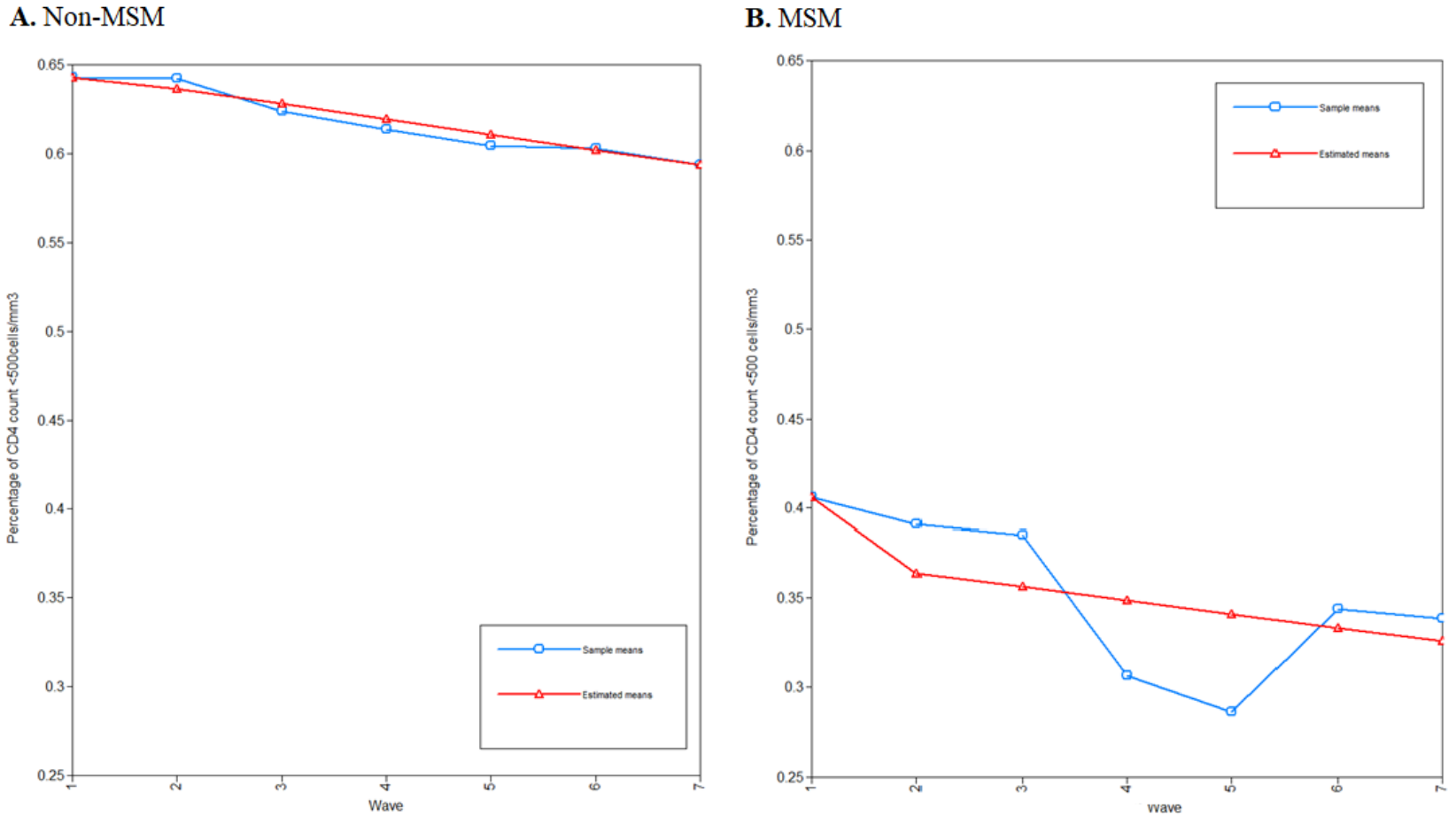


Figure 5.6 Sample proportions and conditional estimated probabilities of CD4 count<500 cells/mm$^3$ among non-MSM males and MSM

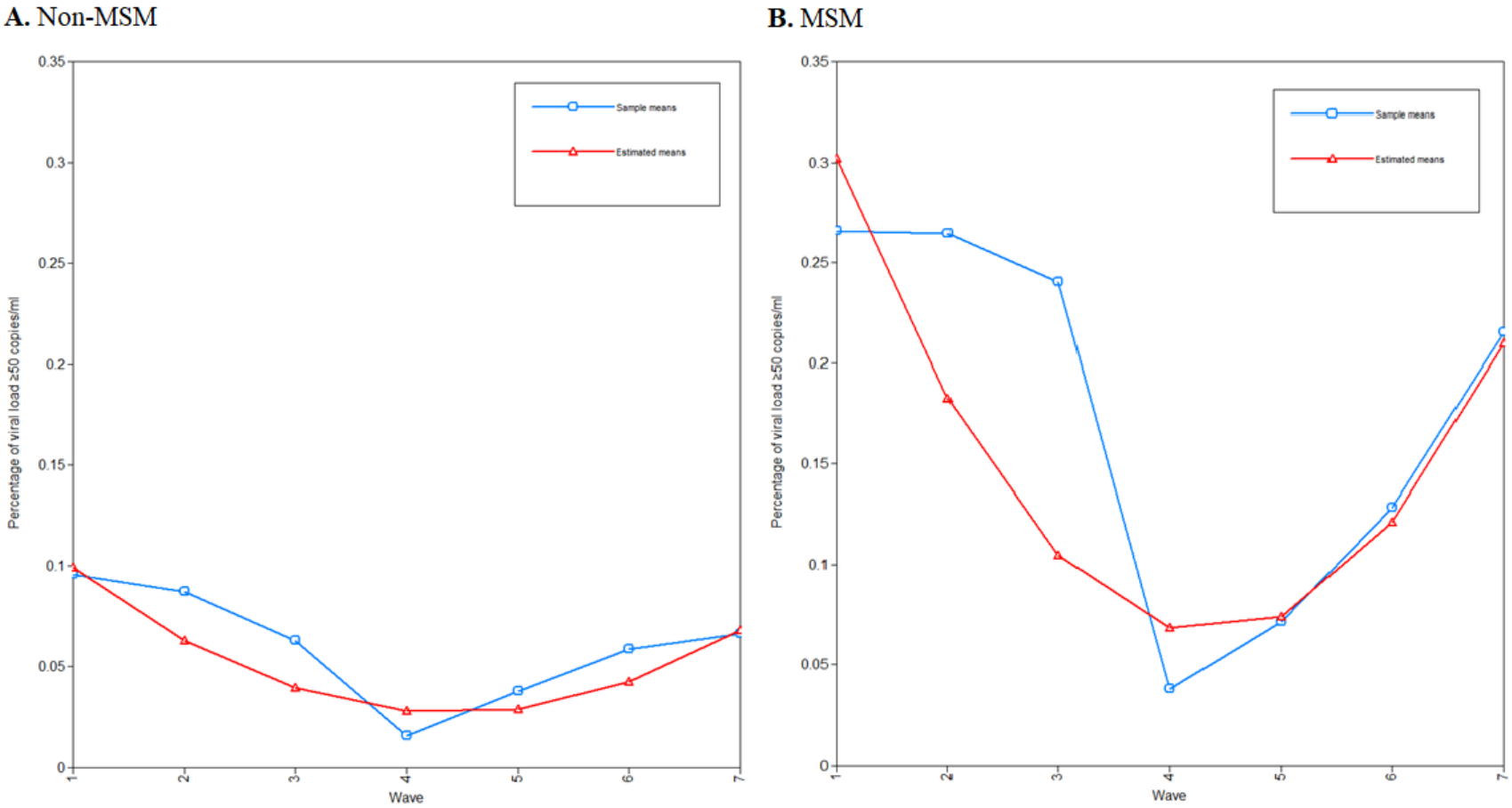


Figure 5.7 Sample proportions and conditional estimated probabilities of viral load≥50 copies/ml among non-MSM males and MSM

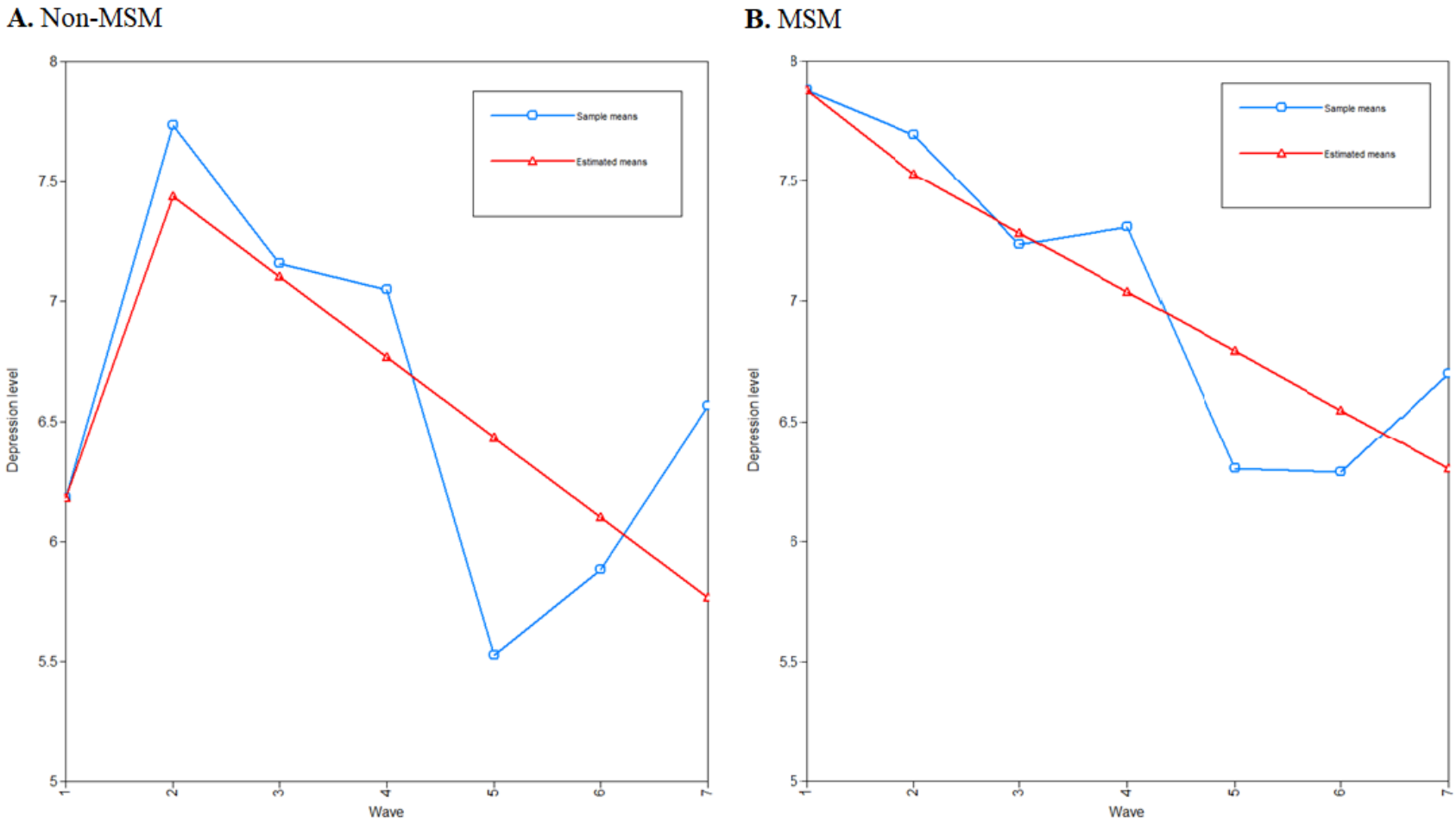


Figure 5.8 Sample and conditional estimated means of depressive symptoms among non-MSM males and MSM

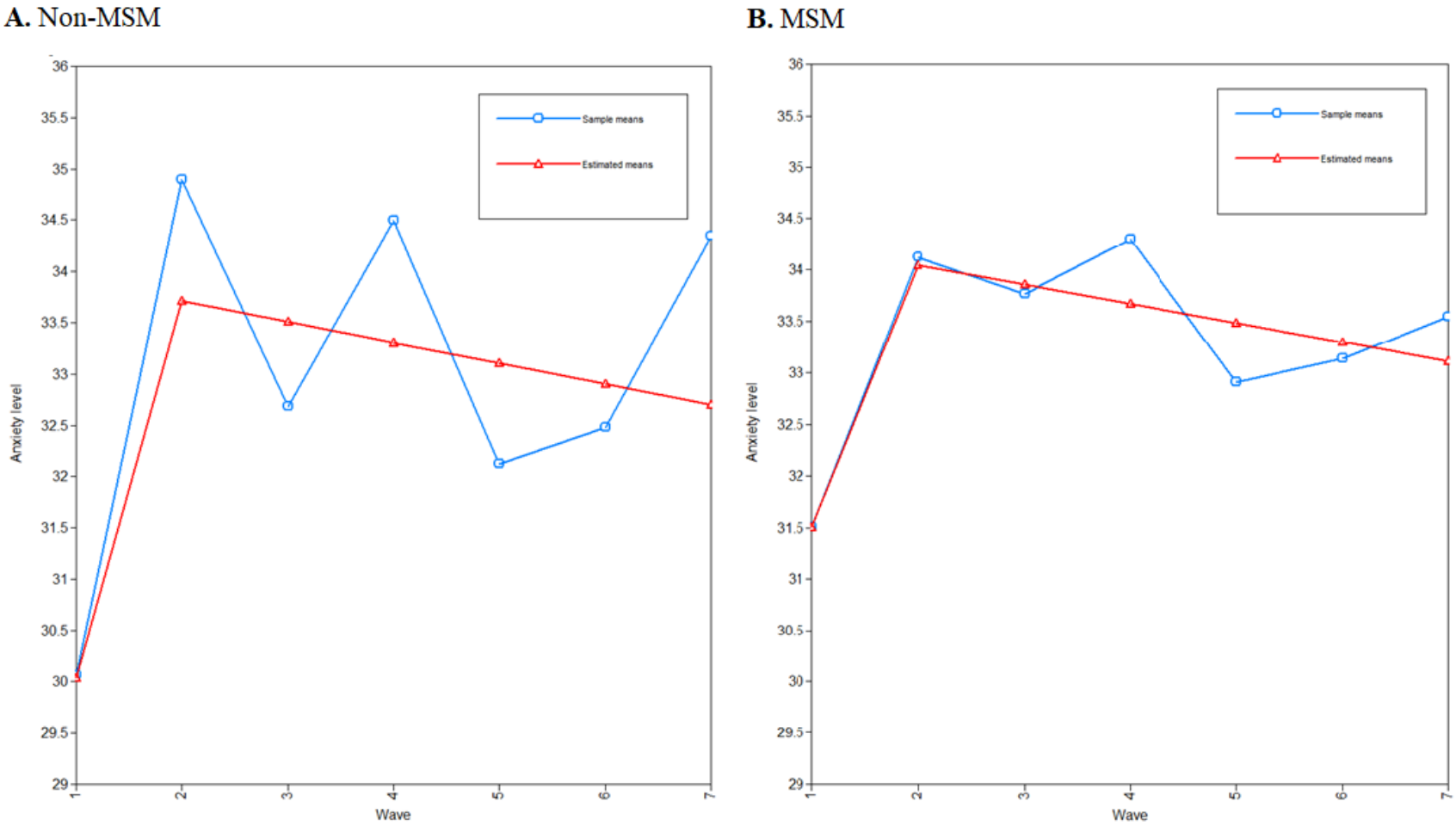


Figure 5.9 Sample and conditional estimated means of anxiety symptoms among non-MSM males and MSM

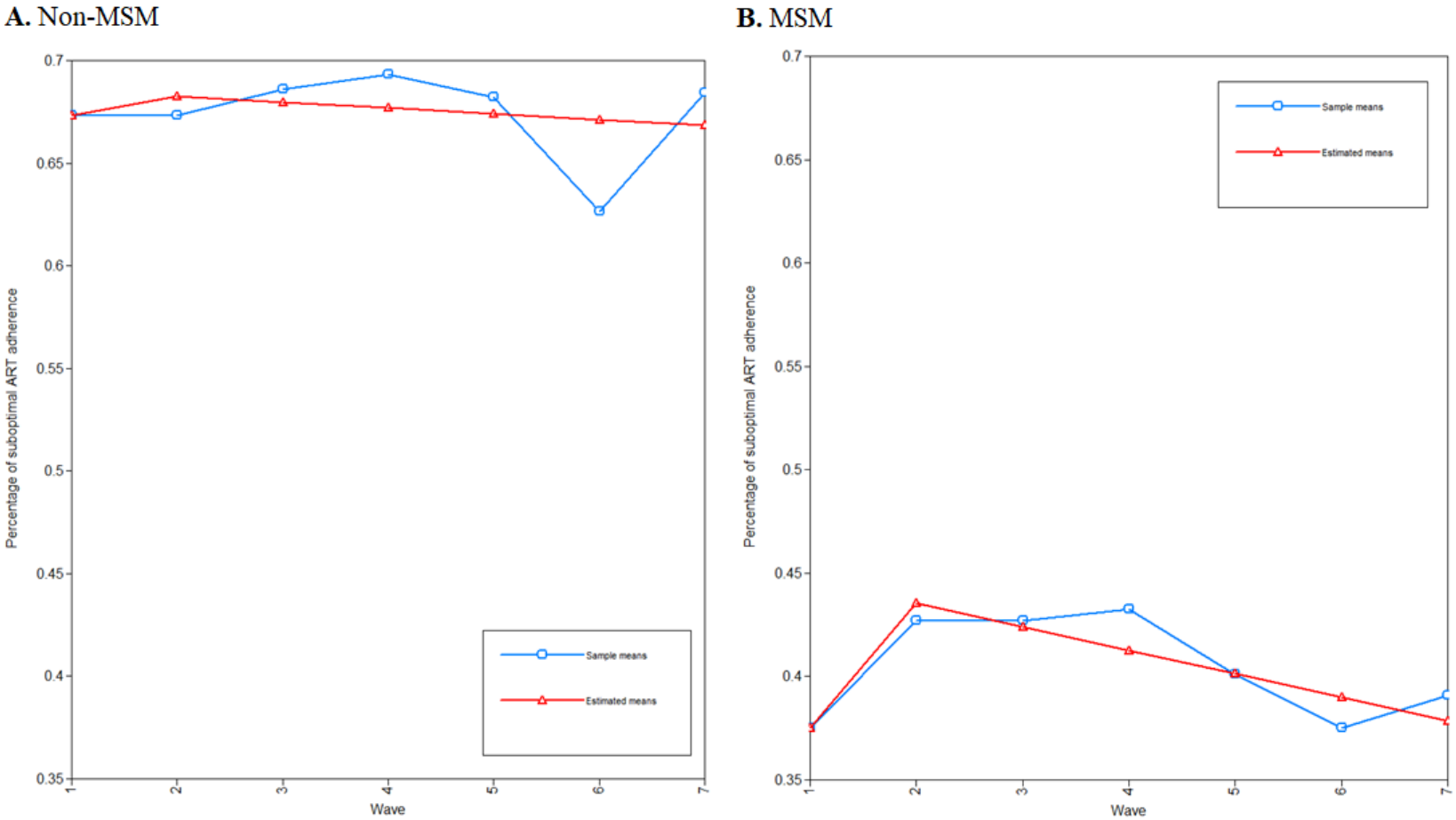


Figure 5.10 Sample proportions and conditional estimated probabilities of suboptimal ART adherence among non-MSM males and MSM

# CHAPTER 6

# IMPACT OF INTERSECTIONAL STIGMA ON HEALTH OUTCOMES AMONG MSM LIVING WITH HIV

## 6.1 Abstract

**Background:** Men who have sex with men (MSM) living with HIV are exposed to multiple layered stigmas, including but not limited to stigmas related to their HIV seropositive status and sexual and gender minority (SGM) identity. The synergistic effect of intersectional stigma may place MSM living with HIV at higher risk of adverse psychological and behavioral conditions, potentially exacerbating disease progress. Instead of considering each stigmatized identity separately and simply summing the impacts, this study examined the main effect and interactive effect of HIV-related stigma and SGM-related stigma on physical, psychological, and behavioral health outcomes among MSM living with HIV.

**Method:** Data were derived from a cross-sectional survey study designed to explore the effects of SGM identity on HIV-related health outcomes among MSM living with HIV in Guangxi, China. Eligible participants were men aged 18-60 years; had a confirmed diagnosis of HIV; and self-reported having sex with men in the last six months. Internalized, anticipated, and enacted HIV-related stigma and SGM-related stigma were assessed. HIV- and SGM-related stigma were treated as latent stigma constructs indicated each by measures of the three types of stigma (Internalized, anticipated, and enacted).

Structural equation model in the Latent Moderated Structural Equations Approach was employed to examine the latent variable interaction.

**Result:** The main effects of HIV-related stigma on depressive symptoms ($\beta$=2.15, 95% CI [.67, 1.40], $p$=.002) and anxiety symptoms ($\beta$=3.28, 95% CI [1.49, 5.06], $p$<.001) were significant. Also, the interactive effects of HIV- and SGM-related stigma on depressive symptoms ($\beta$=1.16, 95% CI [.51, 1.08], $p$=.01) and anxiety symptoms ($\beta$=1.67, 95% CI [.45, 2.89], $p$=.007) were significant. Simple slope tests indicated that the associations between HIV-related stigma and depressive/anxiety symptoms were stronger with a greater level of SGM-related stigma. When SGM-related stigma was one standard deviation below the mean, the associations between HIV-related stigma and depressive symptoms ($\beta$=.99, 95% CI [-.63, 2.61], $p$=.23) or anxiety symptoms ($\beta$=1.61, 95% CI [-.44, 3.65], $p$=.12) were not significant. When SGM-related stigma was one standard deviation above the mean, the association between HIV-related stigma and depressive symptoms ($\beta$=3.32, 95% CI [1.67, 4.96], $p$<.001) or anxiety symptoms ($\beta$=4.95, 95% CI [2.68, 7.22], $p$<.001) were significantly positive. No significant main effect or interactive effect was found in models of CD4 count, viral load, and ART adherence.

**Conclusion:** The study indicated that the relationships between HIV-related stigma and depressive/anxiety symptoms could be aggravated among MSM who reported higher SGM-related stigma. The results provided important contributions to understanding the well-being of stigmatized populations by highlighting intersectional stigma as a mechanism of adverse psychological health outcomes, which will inform effective and

sustainable health strategies, policy, and service provision for preventive measures and well-being improvement

## 6.2 Introduction

Despite tremendous efforts in human immunodeficiency virus (HIV) prevention and control, HIV infection among men who have sex with men (MSM) is still rising globally, including in China. A recent large-scale systematic review suggested that the overall national prevalence in China of HIV among MSM was 5.7%, with meta-regression analysis demonstrating an increased prevalence as time progressed from 2001 to 2018 (Dong et al., 2019). Guangxi Autonomous Region (Guangxi), one of the HIV epicenters in China, reported a similar increasing trend of HIV prevalence among MSM (Chen et al., 2019). In 2008, the annual survey among MSM in Guangxi demonstrated an HIV prevalence of 2.0%; however, such rate grew to 10.0% in 2017 (Lan et al., 2018) due in part to an increase in high-risk behaviors and broader use of the Internet to find sexual partners (He et al., 2012; Qin et al., 2016).

MSM living with HIV perceive and experience various types of stigma (layered stigma) because of their multiple stigmatized identities, including but not limited to sexual and gender minority (SGM) status and HIV diagnosis (Aunon et al., 2020; Fitzgerald-Husek et al., 2017; Herek et al., 2009). Both SGM status and HIV diagnosis are considered undesirable in the Chinese social context and are heavily stigmatized (Shao et al., 2018). HIV-related stigma is often considered a strong driver of increased physical and psychological distress in MSM living with HIV (Goldberg & Smith, 2011; Wohl et al., 2013). A cross-sectional study conducted among 456 MSM living with HIV demonstrated that 61% of participants reported perceived discrimination from the gay

community because of their HIV seropositive status, and such perceived HIV stigma was associated with higher levels of depression, anxiety, loneliness, avoidant coping strategies, and suicidal ideation (Courtenay–Quirk et al., 2006b; Jeffries IV et al., 2015). SGM-related stigma and discrimination have profoundly impeded MSM living with HIV from timely linkage to healthcare and subsequently elicited additional psychological burdens, leading to poorer mental and clinical outcomes (Govindasamy et al., 2012a; Medley et al., 2013b; Sarna et al., 2014b). A study of HIV prevention indicated that MSM tended to avoid or delay HIV-related care due to the fear of others suspecting them of same-sex sexual behavior (Bwambale et al., 2008). Such anticipated SGM-related stigma was further compounded by a fear of discriminatory treatment at healthcare facilities (Kim et al., 2018).

Higher levels of both HIV- and SGM-related stigma could significantly increase the odds of intimate partner violence (Wang et al., 2020) and were related to increased symptoms of depression and anxiety, poorer resilience, and poorer quality of life among MSM living with HIV in China (Yang et al., 2020). Instead of considering each stigmatized identity separately and simply summing the impacts, research on the intersectionality of stigma displayed better external validity and improved understanding of individual experiences of oppression (Bogard et al., 2017; Ingram et al., 2019). There has been a growth of research using the intersectionality framework to understand health inequalities, suggesting the synthesized effects of social status or identities at the micro-level (e.g., HIV status, sexual identity, socioeconomic status) on psychological distress and delayed treatment among PLWH (Arnold et al., 2014b; Bogart et al., 2011; English et al., 2018b; Mill et al., 2009). A recent longitudinal study highlighted the interactive effect

of racial discrimination and SGM-related stigma on the persistence of psychological and behavioral health inequities over time (English et al., 2018a). Results revealed that the positive relationships between racial discrimination and depressive and anxiety symptoms at six months were strengthened by SGM-related stigma (English et al., 2018a). Yet, existing studies are limited by small sample sizes and specific but limited domains of health outcomes. Little is known regarding how multiple stigmas (e.g., SGM-related stigma, HIV-related stigma) elicited by various identities intersect to produce poorer physical, psychological, and behavioral health outcomes among MSM living with HIV in China.

To address the knowledge gaps, the current study focused on identifying how SGM- and HIV-related stigma and their synthesized effect were associated with physical, psychological, and behavioral health outcomes of MSM living with HIV utilizing data from a large sample in Guangxi, China. The results would allow a better understanding of the effect of intersectional stigma, which will inform effective and sustainable health strategies, policy, and service provision for preventive measures and well-being improvement (Ingram et al., 2019).

## 6.3 Methods

*Study setting and participants*

The cross-sectional survey study was designed to explore the effects of SGM status on HIV-related health outcomes among MSM living with HIV. Data collection was initiated in August 2020 and finished in May 2021. In collaboration with Guangxi CDC, four major public hospitals/clinics with the largest cumulative number of MSM living with HIV in three cities in Guangxi (i.e., Nanning, Guilin, and Liuzhou) were selected as

study sites. A purposive sampling method was used to recruit participants. Medical staff or case managers from each study site screened all the HIV patients in their clinical records and invited all eligible participants to join the study. Eligible participants were men who: (1) aged 18-60 years; (2) had a confirmed diagnosis of HIV; and (3) self-reported having sex with men in the last six months. MSM were excluded if they: (1) were physically or mentally incapable of responding to survey questions; (2) were currently incarcerated or institutionalized for drug use or commercial sex; and (3) had already participated in the aforementioned prospective cohort study. After excluding participants that were not eligible, 402 MSM were involved in the final sample.

*Data collection*

With the assistance and collaboration of Guangxi CDC, an interviewer-administered questionnaire was used for quantitative data collection. After obtaining participants' written informed consent, local research team members conducted surveys in private offices in community health centers or HIV clinics where participants received regular medical care. The entire survey took around 60 minutes. Each participant received a small gift equivalent to US$5 upon completion of the questionnaire. The research protocol was approved by Institutional Review Boards at both the University of South Carolina and Guangxi CDC in China.

*Measures*

*Physical health outcomes*

**CD4 count** of each participant was retrieved from the patient's lab results at each hospital. According to the guidelines for ART in adults and adolescents with HIV (U.S. Department of Health and Human Services & Panel on Antiretroviral Guidelines for

Adults and Adolescents, 2017), the cutoff of 500 cells/$mm^3$ has clinical implications in evaluating the normal immunologic functioning. Therefore, instead of using the original continuous measure of CD4 count, CD4 count was categorized into a binary variable: CD4 count<500 cells/$mm^3$ and CD4 count≥500 cells/$mm^3$ for the purpose of data analysis in this dissertation.

**Viral load** of each participant was collected from the EHR system of Guangxi CDC. Viral suppression was defined as HIV RNA less than or equal to 50 copies/ml in PLWH's plasma (CDC & National Center for HIV/AIDS, Viral Hepatitis, and T.B. Prevention 2018). As viral suppression indicates the treatment efficacy, it was used as one of the primary outcomes rather than the original continuous value of viral load. Viral load was categorized into a binary variable: viral load<50 copies/ml and viral load≥50 copies/ml.

*Mental health outcomes*

**Depressive symptoms** were assessed with the 10-item Center for Epidemiologic Studies Depression (CES-D 10) Scale (Kohout et al., 1993). The Chinese version of CES-D 10 has been validated in both the clinical and non-clinical populations in China (Yu et al., 2013). It captured depressed affect (3 items), somatic symptoms (5 items), and positive affect (2 items). The response options ranged from 0 ("rarely or none of the time") to 3 ("all of the time"). The sum scores of CES-D 10 ranged from 0 to 30, with higher scores indicating more severe depressive symptoms. The scale exhibited an acceptable internal consistency in our study (Cronbach's alpha=0.85).

**Anxiety symptoms** were assessed with the 20-item Self-rating Anxiety Scale (Zung, 1971) to quantify the level of anxiety for patients experiencing anxiety-related

symptoms. The Chinese version scale has been validated in the Chinese populations (Zhang et al., 2015). Items tap psychological and physiological symptoms in the past week, and each item is scored on a scale of 1 ("none or a little of the time") to 4 ("most of the time"). Sample items are "I feel easily upset or panicked" and "I experience headache and a sore neck." The sum scores of the scale ranged from 20 to 80, with higher scores indicating more severe anxiety symptoms. The scale exhibited an acceptable internal consistency in our study (Cronbach's alpha=0.80).

*Behavioral health outcomes*

**ART adherence** was assessed with a multiple-item approach to minimize the self-report bias (Mi et al., 2020). Five items derived from the Adult AIDS Clinical Trials Group (AACTG) adherence instrument were adapted to our studies (Chesney et al., 2000). The first two items asked participants if they had missed any dose in the past weekend/ever before. Responses were recorded to reflect ART adherence (1=not missed, 0=missed). The other three items inquired about the total number of prescribed doses and the number of doses that participants reported actually taking within three specific time windows (i.e., past three days, past weekend, and past month). The responses to each of these items were first converted into a percentage of doses taken as scheduled and then dichotomized into 1 (≥ 95% of prescribed doses) or 0 (< 95%). The threshold of 95% is used in the current study as the existing literature suggested 95% as the optimal level of adherence to sustain viral suppression (Paterson et al., 2000) and avoid the evolution of drug-resistant viruses (Raffa et al., 2008). An adherence index score was generated by summing the dichotomous scores of the five items to reflect an optimal adherence (score=5) or suboptimal adherence (score < 5) (Mi et al., 2020). Such measure of ART

adherence has been validated under various cultural contexts (Chesney et al., 2000; Reynolds et al., 2007) and was considered a robust instrument for evaluating ART adherence behaviors among PLWH.

*HIV-related stigma*

**Internalized HIV-related stigma** was assessed with an 8-item scale derived from the subscale of "negative self-image" of the Berger HIV Stigma Scale (Berger et al., 2001). Participants were asked to respond to each statement on a 4-point scale from 1 ("strongly disagree") to 4 ("strongly agree"). Sample statements are "I feel I'm not as good as others because I have HIV" and "I feel guilty because I have HIV." A sum score of the eight items was calculated with a higher score indicating a higher level of internalized HIV stigma. The scale exhibited a Cronbach's α of .94 in our study.

**Anticipated HIV-related stigma** was assessed with a 9-item scale derived from the Health Stigma Framework (Earnshaw et al., 2013). This scale assessed participants' expectations of HIV-related stigma coming from family members, community, and healthcare providers. Sample items are "Family members will avoid touching me," "Community managers will refuse to provide me with social services," and "Healthcare providers will treat me with less respect." Each item was rated on a scale of 1 ("definitely not") to 5 ("definitely"). A sum score of the nine items was calculated, ranging from 9 to 45, with a higher score indicating higher levels of anticipated HIV stigma. The Cronbach's alpha of this scale was 0.92 in our study.

**Enacted HIV-related stigma** was evaluated using the 16-item checklist adapted from a previous study (dos Santos et al., 2014). PLWH were asked whether they had some actual experiences of being stigmatized due to HIV in the past six months,

including "Being excluded from social gatherings or activities," "Being excluded from family activities," and "Being physically assaulted." Participants who answered "yes (1)" were considered to have the experience of being stigmatized, while those who answered "no (0)" were considered to have no such experience. The total score of the 16 items was used as a composite score, with a higher score indicating more experiences of being stigmatized in the last six months. The enacted stigma scale also showed good reliability in our study (Cronbach's alpha=0.89).

*SGM-related stigma*

**Internalized SGM-related stigma** was assessed with 14 items derived from the Chinese version internalized homophobia scale (Ren & Hood, 2018) and the internalized homophobia and perceived stigma scale (Puckett et al., 2017). The scale was conducted on SGM to quantify negative feelings and homophobic attitudes towards themselves. Sample items are “if I were a heterosexual, I would be happier” and “sometimes I feel ashamed of my sexual orientation.” Each statement was rated on a scale of 1 ("strongly disagree") to 4 ("strongly agree"). A sum score of the 14 items was calculated with a higher score indicating higher levels of internalized SGM-related stigma. The reliability of this scale was acceptable (Cronbach's alpha=0.87).

**Anticipated SGM-related stigma** was assessed with 17 items derived from the internalized homophobia and perceived stigma scale (Puckett et al., 2017) and the homosexuality-related stigma scale (Ha et al., 2013) to describe the stigma refers to an MSM’s perception of how others respond if they know about his same-sex behaviors. The researchers introduced an additional item to better fit the Chinese context (“same-sex behavior doesn’t match with the traditional Chinese culture”). Other sample items are

“many employers would underestimate a man due to his homosexuality regardless of his qualifications for the job” and “many people do not see gay men as real men.” Each statement was rated on a scale from 1 ("strongly disagree") to 4 ("strongly agree"). A sum score of the 18 items was calculated with a higher score indicating higher levels of anticipated SGM-related stigma. The Cronbach's alpha of this scale was 0.95 in our study.

**Enacted SGM-related stigma** was assessed with 14 items derived from the China MSM stigma scale (Neilands et al., 2008) and the homosexuality-related stigma scale (Ha et al., 2013) to depict the actual experiences of prejudice and discrimination that occur to a man because of his same-sex behaviors. Participants were asked to rate the frequency of encountering a series of negative life events because of their MSM identity from 1 (“never”) to 4 (“often”). Sample life events are “being hit or beaten up for being homosexual” and “being kicked out of school for being homosexual.” A sum score of the 14 items was calculated with a higher score indicating higher levels of enacted SGM-related stigma. The reliability of this scale was acceptable (Cronbach's alpha=0.85).

*Covariates*

**Sociodemographic characteristics** included age (18-24, 25-34, 35-44, 45 or older), ethnicity (Han, other), marital status (single, married/life partner, divorced/separated/widowed), education (middle school or below, high school, college and above), employment (fulltime employed, parttime employed, unemployed), monthly household income (1,999 CNY or below, 2,000-3,999 CNY, 4,000 CNY or above), and sexual identity (gay/bisexual, straight, unsure).

*Data analysis*

First, descriptive analysis was conducted to describe participants' sociodemographic characteristics using frequency (percentage [%]).
Second, bivariate analyses between sociodemographic characteristics and categorical outcomes (i.e., CD4 count, viral load, ART adherence) were conducted with the Chi-square test or Fisher's exact test as appropriate. Bivariate analyses between sociodemographic characteristics and continuous outcomes (i.e., depressive symptoms, anxiety symptoms) were conducted with ANOVA or t-tests as appropriate. Sociodemographic characteristics significantly associated with health outcomes were controlled as covariates in multivariable analyses.

Lastly, interactive effects between HIV- and SGM-related stigma on physical, psychological, and behavioral health outcomes were tested with a structural equation model (SEM) in the latent moderated structural equations (LMS) approach (Klein & Moosbrugger, 2000). The procedure for estimating LMS using the XWITH command in M*plus* software (Muthén & Muthen, 2017) followed the guideline of Maslowsky et al. (2014). First, as standardized regression coefficients are not provided by M*plus* for LMS models, data were standardized prior to analysis to obtain beta coefficients (Maslowsky et al., 2014). Second, a measurement model was estimated to ensure the goodness of fit prior to estimating structural models, with internalized, anticipated, and enacted HIV-related stigma, and internalized, anticipated, and enacted SGM-related stigma being observed variables, and HIV-related stigma and SGM-related stigma being latent variables. Following Hu and Bentler (1999) recommendations, root mean square error of approximation (RMSEA), standardized root mean square residual (SRMR), comparative

fit index (CFI), and Tucker-Lewis Index (TLI) were also used to evaluate model fit, in addition to the Chi-square statistic, which can be inflated by large sample sizes and moderate discrepancies from normality. RMSEA of .08 or less, SRMR of .08 or less, CFI and TLI of .95 or greater indicate adequate fit (Browne & Cudeck, 1992; Hu & Bentler, 1999; Weiber & Mühlhaus, 2014). Third, structural models are estimated in two steps (Klein & Muthén, 2007; Muthén & Muthen, 2017). In the first step, structural models without the latent interaction term were estimated, henceforth referred to as Model 0. In the second step, structural models with the latent interaction were estimated, henceforth referred to as Model 1. Results of Model 1 provided coefficients and indicated whether the latent interaction was significant.

Model fit indices generally used to interpret the fit of structural equation models, such as $\chi^2$, RMSEA, SRMR, CFI, and TLI have not been developed for LMS models. Instead, log-likelihood ratio tests were used to determine whether Model 0 represents a significant loss in fit relative to the more complex Model 1 (Satorra et al., 2000). The test statistic for a log-likelihood ratio test, D, was calculated using the following equation:

$$D = -2[(log - likelihood\ for\ Model\ 0) - (log - likelihood\ for\ Model\ 1)]$$

D is Chi-square distributed with degrees of freedom calculated by subtracting the number of free parameters in Model 0 from the number of free parameters in Model 1. A significant result of the log-likelihood ratio test indicates the elimination of the interaction would result in a significant decline in the model fit.

In order to interpret the size of the interaction effect, $\Delta R^2$ was yielded by subtracting $R^2$ of Model 0 from $R^2$ of Model 1, which indicated an additional variance explained by the interaction. If the interactive effect was significant, a simple slope test

was conducted and the interaction was plotted (Aiken et al., 1991). The relationships between HIV-related stigma and health outcomes were presented under low vs. high levels of SGM-related stigma (Mean±1SD).

**6.4 Results**

*Descriptive statistics*

As shown in Table 6.1, more than half of the 402 MSM were 25-34 years old (n=213, 53.0%), Han ethnicity (n=255, 63.4%), single (n=337, 83.8%), had a college degree or above (n=230, 57.2%), had a fulltime job (n=268, 66.7%) with monthly household income between 2,000 and 3,999 CNY (n=204, 50.7%), and not sure about their sexual identity (n=223, 55.5%).

*Associations between sociodemographic characteristics, HIV-/SGM-related stigma, and physical, psychological, and behavioral health outcomes*

MSM of Han ethnicity (compared to ethnic minority: 47.06% vs. 36.73%, $p$=.05) and whose monthly household income was between 2,000 and 3,999 CNY (compared to income less than 2,000 CNY: 51.47% vs. 34.15%, $p$=.004) were more likely to have CD4 count<500 cells/mm$^3$ (Table 6.2). MSM who were 18-24 years old were more likely to have viral load≥50 copies/ml compared to MSM who were 45 years old or older (15.46% vs. 3.23%, $p$=.02).

MSM who were 18-24 years old (compared to 35-44 years old: 7.82 vs. 4.26, $p$<.001), single (compared to divorced/separated/widowed: 7.09 vs. 4.34, $p$=.003), had a college degree or above (compared to middle school or below: 7.25 vs. 5.26, $p$=.007), and unemployed (compared to fulltime employed: 7.88 vs. 6.40, $p$=.04) experienced more severe depressive symptoms (Table 6.3). Similarly, MSM who were 18-24 years old

(compared to 35-44 years old: 31.63 vs. 28.09, $p$=.001), single (compared to divorced/separated/widowed: 31.49 vs. 27.00, $p$=.002), and had a college degree or above (compared to middle school or below: 31.51 vs. 28.39, $p$=.004) experienced more severe anxiety symptoms.

MSM who had a college degree or above (compared to middle school or below: 18.70% vs. 2.90%, $p$=.004) were more likely to have suboptimal ART adherence.

As shown in Table 6.5, depressive symptoms was correlated with anxiety symptoms ($r$=.70, $p$<.01) and all types of stigmas including HIV-related internalized stigma ($r$=.20, $p$<.01), HIV-related anticipated stigma ($r$=.32, $p$<.01), HIV-related enacted stigma ($r$=.18, $p$<.01), SGM-related internalized stigma ($r$=.12, $p$<.05), SGM-related anticipated stigma ($r$=.16, $p$<.01), and SGM-related enacted stigma ($r$=.22, $p$<.01). Similarly, anxiety symptoms was also correlated with all types of stigmas including HIV-related internalized stigma ($r$=.31, $p$<.01), HIV-related anticipated stigma ($r$=.31, $p$<.01), HIV-related enacted stigma ($r$=.19, $p$<.01), SGM-related internalized stigma ($r$=.16, $p$<.01), SGM-related anticipated stigma ($r$=.17, $p$<.01), and SGM-related enacted stigma ($r$=.26, $p$<.01).

*Latent moderated structural equations*

First, a CFA analysis was conducted to assess the fit of the measurement model (Figure 6.1). The measurement model elicited satisfied model fit indices: $\chi^2(5)=11.304$, $p$<.05; RMSEA=.056; CFI=.969; TLI=.906; SRMR=.032.

The latent moderated structural equation estimates of CD4 count are displayed in Table 6.6. The main effect model without the latent interaction term (Model 0) and the structural model with a latent interaction term (Model 1) were estimated with the LMS

approach. Ethnicity and monthly household income were controlled in both model 0 and model 1. The interaction effect was not significant (*aOR*=1.17, 95% CI [.87, 1.58], *p*=.34). The relative fit of Model 1 vs. Model 0 was determined by comparing the log-likelihood values of Model 0 and Model 1, yielding a log-likelihood difference value of D=1.46. Based on the Δ*df*=1, using a chi-square distribution, the log-likelihood ratio test proved not significant (*p*=.23), indicating that Model 0 represents a nonsignificant loss in fit relative to Model 1.

The latent moderated structural equation estimates of viral load are displayed in Table 6.7. Age was controlled in both model 0 and model 1. The interaction effect was not significant (*aOR*=.62, 95% CI [.31, 1.26], *p*=.09). The relative fit of Model 1 vs. Model 0 was determined by comparing the log-likelihood values of Model 0 and Model 1, yielding a log-likelihood difference value of D=3.04. Based on the Δ*df*=1, using a chi-square distribution, the log-likelihood ratio test proved not significant (*p*=.08), indicating that Model 0 represents a nonsignificant loss in fit relative to Model 1.

The latent moderated structural equation estimates of depressive symptoms are displayed in Table 6.8. Age, marital status, education, and employment were controlled in both model 0 and model 1. The main effect of HIV-related stigma was significant (Model 0: *β*=2.00, 95% CI [.61, 3.39], *p*=.005; Model 1: *β*=2.15, 95% CI [.67, 1.40], *p*=.002), indicating that the association between HIV-related stigma and depressive symptoms was significantly positive. The interaction effect was significant (*β*=1.16, 95% CI [.51, 1.08], *p*=.01). The relative fit of Model 1 vs. Model 0 was determined by comparing the log-likelihood values of Model 0 and Model 1, yielding a log-likelihood difference value of D=14.70. Based on the Δ*df*=1, using a chi-square distribution, the log-

likelihood ratio test proved significant ($p$<.001), indicating that Model 0 represents a significant loss in fit relative to Model 1. Subtracting $R^2$ of Model 0 from $R^2$ of Model 1 yielded a $\Delta R^2$ value for the interaction of .37, indicating an additional 37% of the variance in depressive symptoms explained by the interaction of HIV-related stigma and SGM-related stigma. A simple slope analysis (Table 6.9) of moderating effect of SGM-related stigma between HIV-related stigma and depressive symptoms was conducted, and the interaction was plotted (Figure 6.2). When SGM-related stigma was 1 SD below the Mean, the association between HIV-related stigma and depressive symptoms was not significant ($\beta$=.99, 95% CI [-.63, 2.61], $p$=.23). When SGM-related stigma was 1 SD above the Mean, the association between HIV-related stigma and depressive symptoms was significantly positive ($\beta$=3.32, 95% CI [1.67, 4.96], $p$<.001).

The latent moderated structural equation estimates of anxiety symptoms are displayed in Table 6.10. Age, marital status, and education were controlled in both model 0 and model 1. The main effect of HIV-related stigma was significant (Model 0: $\beta$=3.06, 95% CI [.97, 5.16], $p$=.004; Model 1: $\beta$=3.28, 95% CI [1.49, 5.06], $p$<.001), indicating that the association between HIV-related stigma and anxiety symptoms was significantly positive. The interaction effect was significant ($\beta$=1.67, 95% CI [.45, 2.89], $p$=.007). The relative fit of Model 1 vs. Model 0 was determined by comparing the log-likelihood values of Model 0 and Model 1, yielding a log-likelihood difference value of D=13.57. Based on the $\Delta df$=1, using a chi-square distribution, the log-likelihood ratio test proved significant ($p$<.001), indicating that Model 0 represents a significant loss in fit relative to Model 1. Subtracting $R^2$ or Model 0 from $R^2$ of Model 1 yielded a $\Delta R^2$ value of .09 for the interaction, indicating an additional 9% of the variance in anxiety symptoms

explained by the interaction of HIV-related stigma and SGM-related stigma. A simple slope analysis (Table 6.11) of moderating effect of SGM-related stigma between HIV-related stigma and anxiety symptoms was conducted, and the interaction was plotted (Figure 6.3). When SGM-related stigma was 1 SD below the Mean, the association between HIV-related stigma and anxiety symptoms was not significant ($\beta$=1.61, 95% CI [-.44, 3.65], $p$=.12). When SGM-related stigma was 1 SD above the Mean, the association between HIV-related stigma and anxiety symptoms was significantly positive ($\beta$=4.95, 95% CI [2.68, 7.22], $p$<.001).

The latent moderated structural equations estimate of ART adherence is displayed in Table 6.12. Education was controlled in both model 0 and model 1. The interaction effect was not significant (*aOR*=.74, 95% CI [.51, 1.08], $p$=.07). The relative fit of Model 1 vs. Model 0 was determined by comparing the log-likelihood values of Model 0 and Model 1, yielding a log-likelihood difference value of D=2.37. Based on the $\Delta df$=1, using a chi-square distribution, the log-likelihood ratio test proved not significant ($p$=.12), indicating that Model 0 represents a nonsignificant loss in fit relative to Model 1.

**6.5 Discussion**

Using data from a cross-sectional survey study among 402 MSM living with HIV, this study assessed how intersectional stigma was associated with physical, psychological, and behavioral health outcomes, including CD4 count, viral load, depressive symptoms, anxiety symptoms, and ART adherence. The main effect of HIV-related stigma as well as the interactive effect between HIV-related stigma and SGM-related stigma were significant on depressive and anxiety symptoms. No significant main

effect or interactive effect was found in models of CD4 count, viral load, and ART adherence.

The main effect of HIV-related stigma on depressive symptoms and anxiety symptoms was significant among MSM living with HIV. HIV-related stigma and stigma-related discrimination are major issues confronted by PLWH (Armoon et al., 2021; Logie & Gadalla, 2009), which were closely related to mental health problems, including depression (Lee et al., 2002), anxiety (Bogart et al., 2010; Gonzalez et al., 2009), emotional distress (Heckman et al., 2004; Kang et al., 2005; Siegel et al., 2005), substance abuse (Tan et al., 2017), and suicidal ideation and attempts (Capron et al., 2012; Carrico, 2010). PLWH diagnosed with depression and PLWH diagnosed with anxiety were 1.6 and 1.9 times more likely to report stigmatized experiences, respectively (Armoon et al., 2022). Depression and anxiety can further negatively impact ART adherence and contribute to the accelerated progress to AIDS (Horberg et al., 2008).

Although the main effect of SGM-related stigma was not significant on health outcomes among MSM living with HIV, findings suggested that the health impacts of SGM-related stigma could be conveyed by enhancing the impacts of HIV-related stigma on health outcomes. The associations between HIV-related stigma and symptoms of depression and anxiety were elevated dramatically by increased SGM-related stigma. These findings provided empirical support for the conceptual model proposed by Turan et al. (2017) by highlighting that intersectional stigma was associated with increased depressive and anxiety symptoms. Previous studies which examined the effect of intersectional stigma of HIV-related stigma, racial discrimination, and gender discrimination on health outcomes suggested that intersectional stigma was associated

with mental disorders by undermining social support, reduced resilience, and compromised coping resources (Logie et al., 2019). MSM with greater SGM-related stigma experienced additional psychological burdens, such as fear of others suspecting their same-sex sexual behaviors (Bwambale et al., 2008) and fear of discriminatory treatment at public organizations (Kim et al., 2018), which further exacerbated the relationship between HIV-related stigma and depression and anxiety.

The associations between HIV-/SGM-related stigma and physical (i.e., CD4 count, viral load) and behavior (i.e., ART adherence) health outcomes were not significant. These findings were in contrast to previous studies which reported that HIV-related stigma could accelerate HIV progression, resulting in a lower level of CD4 count, faster progress to AIDS (Cole et al., 1997), a low level of viral suppression (Lyons et al., 2020), and suboptimal ART adherence (Sweeney & Vanable, 2016). One possible explanation could be the selection bias. Participants in this study were recruited in collaboration with local CDC from hospitals and clinics, thus they likely have better retention in care and more optimal ART adherence than those who are not already affiliated with these sites. Compared to those who did not engage in ART or had limited access to care, participants in the current study might have better physical and behavioral health outcomes, hindering our ability to detect the association between stigma and health outcomes. In addition, the variances of enacted HIV-related stigma and SGM-related stigma were relatively small, as most participating MSM reported that they did not experience anything listed in the enact HIV-related or SGM-related stigma scales in the past six months. The small variance of enacted stigma might impede our ability to differentiate high-level from low-level latent stigma.

Several limitations in the current study should be acknowledged. First, the mechanism underlying the association between intersectional stigma and health outcomes was not investigated, which could be a potential reason for the non-significant associations between intersectional stigma and CD4, viral load, and ART adherence. Suppressed effect can occur when two indirect effects have the opposite sign. Even proximal effects can be substantially diminished if they are suppressed by a competing process (Shrout & Bolger, 2002). In the current case, it was possible that the intersectional stigma led to undermined social support, which further led to reduced HIV care engagement (Logie et al., 2019). It was also possible that the intersectional stigma built resilience to stigmatized characteristics, which protected MSM from deteriorated health outcomes (Turan et al., 2019). The two potential pathways with opposite signs might diminish the direct association between intersectional stigma and physical/behavioral health outcomes in the current study. Future studies are needed to explore the underlying mechanisms between such associations. Second, as participants were recruited from hospitals and clinics and were all enrolled in ART, they were more likely to have well-maintained physical and behavioral health status. The generalizability of the results needs to be confirmed with heterogeneous samples. Despite the limitations, the current study is one of the very few studies assessing the impact of the intersectional stigma of HIV-related stigma and SGM-related stigma on multiple health outcomes among MSM living with HIV in China. HIV-related stigma and SGM-related stigma were latent variables each indicated by three types of assessable stigma, which better captured the construct of HIV-/SGM-related stigma. Although future efforts are still needed to investigate potential mechanisms with longitudinal settings, this study

suggested that interventions targeting depressive and anxiety symptoms among MSM living with HIV should pay attention to the elevated risk of HIV-related stigma in the presence of SGM-related stigma.

## 6.6 Conclusion

HIV-related stigma had main effects on symptoms of depression and anxiety symptoms among MSM living with HIV. The health impacts of SGM-related stigma could be conveyed by enhancing the effect of HIV-related stigma. HIV-related stigma and SGM-related stigma were not associated with physical and behavioral health outcomes, including CD4 count, viral load, and ART adherence. Future efforts are needed to confirm these findings with longitudinal settings. This study suggested that interventions targeting the mental health problems among MSM living with HIV should pay attention to the elevated risk of HIV-related stigma in the presence of SGM-related stigma.

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Table 6.1 Sociodemographic characteristics of MSM living with HIV (n=402)

| Variables | Frequency (percentage) |
|---|---|
| **Age group** | |
| 18-24 | 100 (24.9%) |
| 25-34 | 213 (53.0%) |
| 35-44 | 58 (14.4%) |
| 45+ | 31 (7.7%) |
| **Ethnicity** | |
| Han | 255 (63.4%) |
| Minority | 147 (36.6%) |
| **Marital status** | |
| Single | 337 (83.8%) |
| Married/life partner | 35 (8.7%) |
| Divorced/separated/widowed | 29 (7.2%) |
| **Education** | |
| Middle school and below | 69 (17.2%) |
| High school | 103 (25.6%) |
| College and above | 230 (57.2%) |
| **Employment** | |
| Fulltime | 268 (66.7%) |
| Parttime | 55 (13.7%) |
| Unemployed/retired | 78 (19.4%) |
| **Monthly household income (CNY)** | |
| <2,000 | 82 (20.4%) |
| 2,000-4,000 | 204 (50.7%) |
| 4,000 or above | 113 (28.1%) |
| **Sexual identity** | |
| Gay/bisexual | 129 (32.1%) |
| Straight | 50 (12.4%) |
| Not sure | 223 (55.5%) |

Table 6.2 Bivariate analyses between sociodemographic characteristics and physical health outcomes

| | CD4 count (<500 cells/mm$^3$) | | Viral load (≥50 copies/ml) | |
|---|---|---|---|---|
| | **Frequency (percentage)** | ***p*-value** | **Frequency (percentage)** | ***p*-value** |
| **Overall** | 174 (43.3%) | | 32 (8.0%) | |
| **Age group** | | .55 | | **.02** |
| 18-24 | 42 (42.00%) | | 15 (15.46%) | |
| 25-34 | 88 (41.31%) | | 13 (6.31%) | |
| 35-44 | 30 (51.72%) | | 3 (5.26%) | |
| 45+ | 14 (45.16%) | | 1 (3.23%) | |
| **Ethnicity** | | **.05** | | .34 |
| Han | 120 (47.06%) | | 23 (9.27%) | |
| Minority | 54 (36.73%) | | 9 (6.29%) | |
| **Marital status** | | .86 | | .16 |
| Single | 145 (43.03%) | | 30 (9.20%) | |
| Married/life partner | 15 (42.86%) | | 0 | |
| Divorced/separated/widowed | 14 (48.28%) | | 2 (6.90%) | |
| **Education** | | .26 | | .41 |
| Middle school and below | 31 (44.93%) | | 3 (4.35%) | |
| High school | 51 (49.51%) | | 10 (9.90%) | |
| College and above | 92 (40.00%) | | 19 (8.60%) | |
| **Employment** | | .61 | | .18 |
| Fulltime | 119 (44.40%) | | 19 (7.28%) | |
| Parttime | 25 (45.45%) | | 3 (5.56%) | |
| Unemployed/retired | 30 (38.46%) | | 10 (13.33%) | |
| **Monthly household income (CNY)** | | **.004** | | .27 |
| <2,000 | 28 (34.15%) | | 10 (12.50%) | |
| 2,000-4,000 | 105 (51.47%) | | 15 (7.69%) | |
| 4,000 or above | 40 (35.40%) | | 7 (6.19%) | |
| **Sexual identity** | | .83 | | .59 |
| Gay/bisexual | 53 (41.09%) | | 8 (6.30%) | |
| Straight | 22 (44.00%) | | 5 (10.64%) | |
| Not sure | 99 (44.39%) | | 19 (8.76%) | |

*Note:* Bivariate analyses between socio-demographic characteristics and physical health outcomes (i.e., CD4 count, viral load) were conducted with Chi-square tests or Fisher's exact tests as appropriate.

Table 6.3 Bivariate analyses between sociodemographic characteristics and psychological health outcomes

| | **Depressive symptoms** | | **Anxiety symptoms** | |
|---|---|---|---|---|
| | **Mean (SD)** | ***p*-value** | **Mean (SD)** | ***p*-value** |
| **Overall** | 6.76 (4.60) | | 30.95 (7.13) | |
| **Age group** | | **<.001** | | **.001** |
| 18-24 | 7.82 (5.17) | | 31.63 (7.11) | |
| 25-34 | 7.13 (4.44) | | 31.72 (7.48) | |
| 35-44 | 4.26 (3.53) | | 28.09 (5.34) | |
| 45+ | 5.52 (3.71) | | 28.84 (6.03) | |
| **Ethnicity** | | .79 | | .40 |
| Han | 6.72 (4.85) | | 31.18 (7.46) | |
| Minority | 6.84 (4.16) | | 30.56 (6.52) | |
| **Marital status** | | **.003** | | **.002** |
| Single | 7.09 (4.70) | | 31.49 (7.28) | |
| Married/life partner | 5.80 (4.16) | | 29.34 (5.84) | |
| Divorced/separated/widowed | 4.34 (2.69) | | 27.00 (4.91) | |
| **Education** | | **.007** | | **.004** |
| Middle school and below | 5.26 (3.85) | | 28.39 (6.49) | |
| High school | 6.69 (5.06) | | 31.43 (7.11) | |
| College and above | 7.25 (4.51) | | 31.51 (7.18) | |
| **Employment** | | **.04** | | .53 |
| Fulltime | 6.40 (4.01) | | 30.70 (6.41) | |
| Parttime | 6.96 (6.30) | | 31.16 (9.13) | |
| Unemployed/retired | 7.88 (5.00) | | 31.72 (7.92) | |
| **Monthly household income (CNY)** | | .25 | | .38 |
| <2,000 | 7.50 (5.35) | | 31.88 (8.79) | |
| 2,000-4,000 | 6.55 (4.36) | | 30.57 (6.53) | |
| 4,000 or above | 6.57 (4.32) | | 30.95 (6.90) | |
| **Sexual identity** | | .79 | | .09 |
| Gay/bisexual | 6.53 (4.73) | | 29.91 (7.15) | |
| Straight | 6.82 (4.91) | | 32.28 (8.31) | |
| Not sure | 6.88 (4.47) | | 31.26 (6.78) | |

*Note:* Bivariate analyses between socio-demographic characteristics and psychological health outcomes (i.e., depressive symptoms, anxiety symptoms) were conducted with ANOVA or t tests as appropriate.

Table 6.4 Bivariate analyses between sociodemographic characteristics and behavioral health outcome

| | **Suboptimal ART adherence** | |
|---|---|---|
| | **Frequency (percentage)** | ***p*-value** |
| **Overall** | 58 (14.4%) | |
| **Age group** | | .16 |
| 18-24 | 19 (19.00%) | |
| 25-34 | 31 (14.55%) | |
| 35-44 | 7 (12.07%) | |
| 45+ | 1 (3.23%) | |
| **Ethnicity** | | .77 |
| Han | 38 (14.90%) | |
| Minority | 20 (13.61%) | |
| **Marital status** | | .29 |
| Single | 51 (15.13%) | |
| Married/life partner | 2 (5.71%) | |
| Divorced/separated/widowed | 5 (17.24%) | |
| **Education** | | **.004** |
| Middle school and below | 2 (2.90%) | |
| High school | 13 (12.62%) | |
| College and above | 43 (18.70%) | |
| **Employment** | | .38 |
| Fulltime | 38 (14.18%) | |
| Parttime | 11 (20.00%) | |
| Unemployed/retired | 9 (11.54%) | |
| **Monthly household income (CNY)** | | .08 |
| <2,000 | 8 (9.76%) | |
| 2,000-4,000 | 26 (12.75%) | |
| 4,000 or above | 23 (20.35%) | |
| **Sexual identity** | | .44 |
| Gay/bisexual | 19 (14.73%) | |
| Straight | 10 (20.00%) | |
| Not sure | 29 (13.00%) | |

*Note:* Bivariate analyses between socio-demographic characteristics and behavioral health outcome (i.e., ART adherence) were conducted with Chi-square tests or Fisher's exact tests as appropriate.

Table 6.5 Correlation matrix of psychological health outcomes and stigma levels

| | | Range | Mean (SD) | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Depressive symptoms | 0-30 | 6.76 (4.60) | | | | | | | |
| 2 | Anxiety symptoms | 20-80 | 30.95 (7.13) | .70** | | | | | | |
| 3 | HIV-related internalized stigma | 8-32 | 17.92 (6.07) | .30** | .31** | | | | | |
| 4 | HIV-related anticipated stigma | 9-45 | 23.54 (8.03) | .32** | .31** | .42** | | | | |
| 5 | HIV-related enacted stigma | 0-16 | .69 (1.85) | .18** | .19** | .06 | .10 | | | |
| 6 | SGM-related internalized stigma | 14-56 | 35.86 (7.02) | .12* | .16** | .43** | .19** | .06 | | |
| 7 | SGM-related anticipated stigma | 18-72 | 36.47 (10.36) | .16** | .17** | .31** | .24** | .13* | .43** | |
| 8 | SGM-related enacted stigma | 14-56 | 15.38 (3.42) | .22** | .26** | .19** | .17** | .29** | .15** | .18** |

*$p$<.05; **$p$<.01

Table 6.6 Latent moderated structural equations estimate of CD4 count

| | **Model 0** | | **Model 1** | | **$\Delta R^2$** | **D** | ***p*-value of log-likelihood ratio test** |
|---|---|---|---|---|---|---|---|
| | ***aOR* (95% CI)** | ***p*-value** | ***aOR* (95% CI)** | ***p*-value** | | | |
| HIV-related stigma | .98 (.75, 1.29) | .91 | 1.00 (.75, 1.33) | 1.00 | .01 | 1.46 | 0.23 |
| SGM-related stigma | .83 (.62, 1.11) | .16 | .81 (.59, 1.10) | .13 | | | |
| Interaction | | | 1.17 (.87, 1.58) | .34 | | | |

*Note:* Ethnicity and monthly household income were controlled in both model 0 and model 1. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 6.7 Latent moderated structural equations estimate of viral load

| | **Model 0** | | **Model 1** | | **$\Delta R^2$** | **D** | ***p*-value of log-likelihood ratio test** |
|---|---|---|---|---|---|---|---|
| | ***aOR* (95% CI)** | ***p*-value** | ***aOR* (95% CI)** | ***p*-value** | | | |
| HIV-related stigma | .84 (.49, 1.43) | .47 | .76 (.45, 1.30) | .25 | .09 | 3.04 | .08 |
| SGM-related stigma | 1.14 (.65, 1.97) | .67 | 1.21 (.67, 2.19) | .56 | | | |
| Interaction | | | .62 (.31, 1.26) | .09 | | | |

*Note:* Age was controlled in both model 0 and model 1. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 6.8 Latent moderated structural equations estimate of depressive symptoms

| | **Model 0** | | **Model 1** | | **$\Delta R^2$** | **D** | ***p*-value of log-likelihood ratio test** |
|---|---|---|---|---|---|---|---|
| | ***coefficient* (95% CI)** | ***p*-value** | ***coefficient* (95% CI)** | ***p*-value** | | | |
| HIV-related stigma | 2.00 (.61, 3.39) | **.005** | 2.15 (.67, 1.40) | **.002** | .37 | 14.70 | **<.001** |
| SGM-related stigma | -.03 (-1.11, 1.05) | .96 | .02 (.90, 2.36) | .98 | | | |
| Interaction | | | 1.16 (.51, 1.08) | **.01** | | | |

*Note:* Age, marital status, education, and employment were controlled in both model 0 and model 1. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 6.9 Simple slope analysis of moderating effect of SGM-related stigma between HIV-related stigma and depressive symptoms

| **SGM-related stigma** | **Simple slope (95% CI)** | **SE** | ***p*-value** |
|---|---|---|---|
| Mean-SD | .99 (-.63, 2.61) | .82 | .23 |
| Mean+SD | 3.32 (1.67, 4.96) | .84 | <.001 |

Table 6.10 Latent moderated structural equations estimate of anxiety symptoms

| | **Model 0** | | **Model 1** | | **$\Delta R^2$** | **D** | ***p*-value of log-likelihood ratio test** |
|---|---|---|---|---|---|---|---|
| | ***coefficient* (95% CI)** | ***p*-value** | ***coefficient* (95% CI)** | ***p*-value** | | | |
| HIV-related stigma | 3.06 (.97, 5.16) | **.004** | 3.28 (1.49, 5.06) | **<.001** | .09 | 13.57 | **<.001** |
| SGM-related stigma | .22 (-1.47, 1.91) | .80 | .66 (-1.46, 1.92) | .79 | | | |
| Interaction | | | 1.67 (.45, 2.89) | **.007** | | | |

*Note:* Age, marital status and education were controlled in both model 0 and model 1. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

Table 6.11 Simple slope analysis of moderating effect of SGM-related stigma between HIV-related stigma and anxiety symptoms

| **SGM-related stigma** | **Simple slope (95% CI)** | **SE** | ***p*-value** |
|---|---|---|---|
| Mean-SD | 1.61 (-.44, 3.65) | 1.05 | .12 |
| Mean+SD | 4.95 (2.68, 7.22) | 1.15 | <.001 |

Table 6.12 Latent moderated structural equations estimate of ART adherence

| | **Model 0** | | **Model 1** | | **$\Delta R^2$** | **D** | ***p*-value of log-likelihood ratio test** |
|---|---|---|---|---|---|---|---|
| | ***aOR* (95% CI)** | ***p*-value** | ***aOR* (95% CI)** | ***p*-value** | | | |
| HIV-related stigma | .94 (.63, 1.40) | .74 | .97 (.67, 1.40) | .86 | .04 | 2.37 | .12 |
| SGM-related stigma | 1.41 (.86, 2.31) | .25 | 1.45 (.90, 2.36) | .21 | | | |
| Interaction | | | .74 (.51, 1.08) | .07 | | | |

*Note:* Education was controlled in both model 0 and model 1. After Bonferroni adjustment, a *p*-value less than .01 is statistically significant.

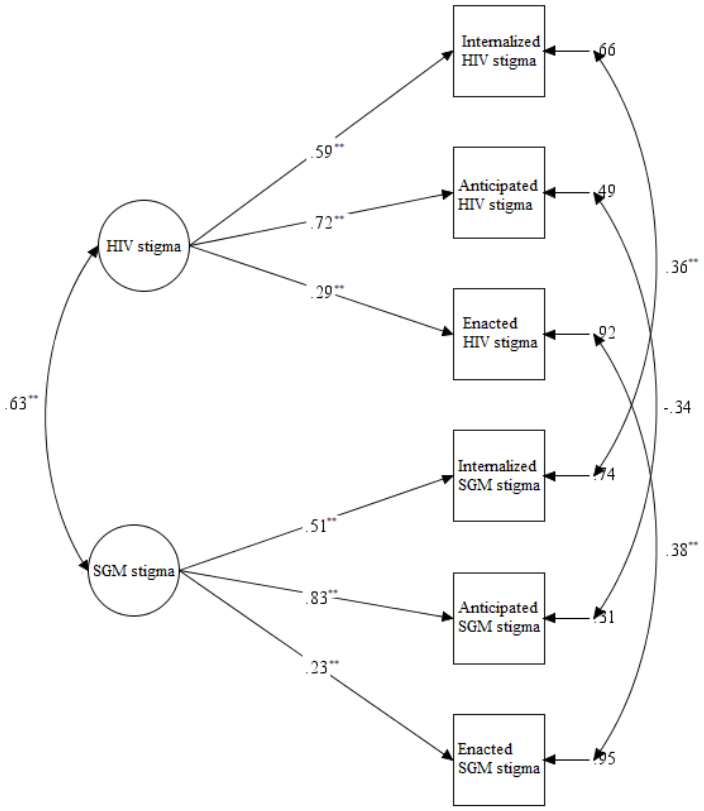


Figure 6.1 Measurement model of HIV- and SGM-related stigma
*Note:* $\chi^2(5)=11.304$, $p<.05$; RMSEA=.056; CFI=.969; TLI=.906; SRMR=.032. All estimates are standardized.

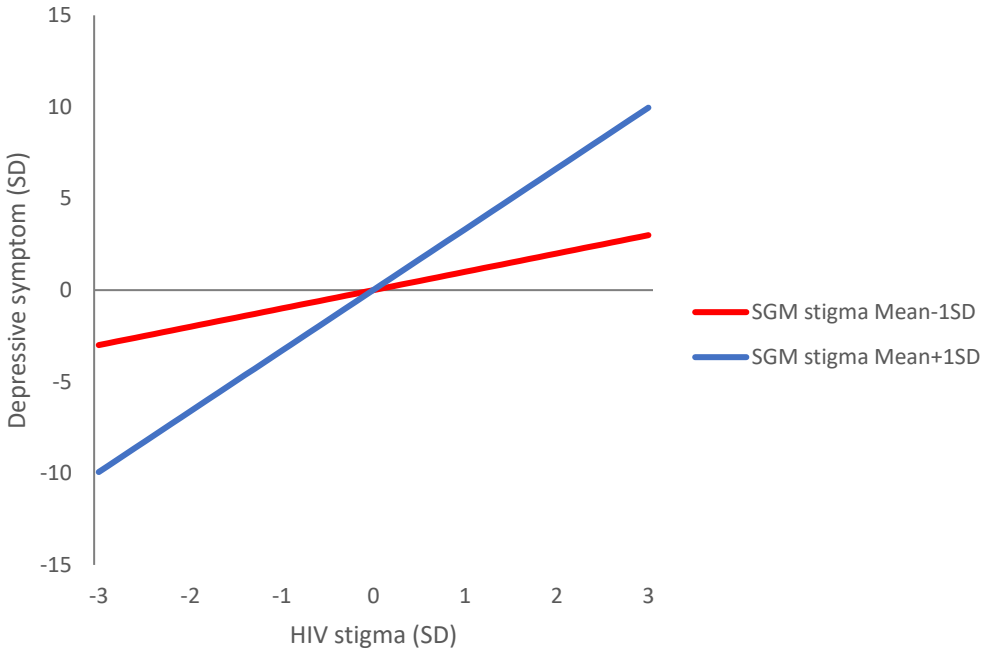


Figure 6.2 Simple slope analysis of moderating effect of SGM-related stigma between HIV-related stigma and depressive symptoms

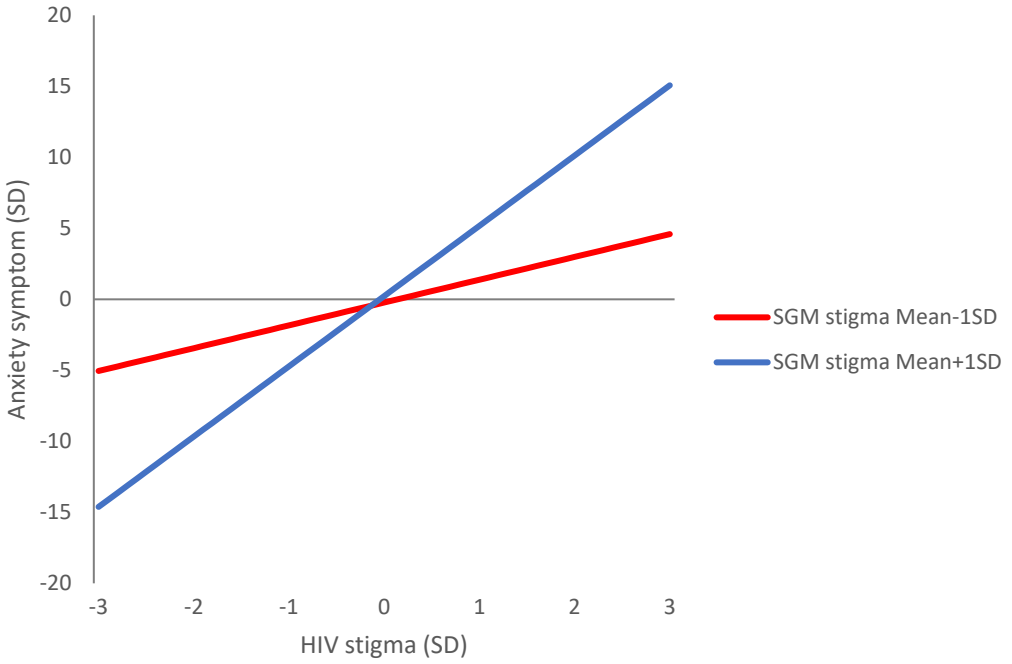


Figure 6.3 Simple slope analysis of moderating effect of SGM-related stigma between HIV-related stigma and anxiety symptoms

# CHAPTER 7

# DISCUSSION

## 7.1 Summary of the dissertation

The purpose of this dissertation research is to investigate how MSM status is related to long-term physical, psychological, and behavioral health outcomes. Furthermore, the research specifically examines the association between intersectional stigma and health outcomes among MSM living with HIV in China. Leveraging data derived from a cross-sectional study and a prospective cohort study, this dissertation addresses the knowledge gaps based on three specific aims and in the form of three studies: 1) examining the measurement invariance for internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males; 2) examining health disparities in 3-year continual trajectories of physical, psychological, and behavioral health outcomes between MSM and non-MSM males; and 3) examining the main effect and interactive effect of HIV-related stigma and SGM-related stigma on physical, psychological, and behavioral health outcomes among MSM living with HIV. Overall, the hypotheses of this dissertation were partially confirmed, and these findings provided important implications for policy, research, healthcare system, and practices.

With a cross-sectional study design in study 1, all four levels of measurement invariance, including configural, metric, scalar, and residual invariance, of the internalized, anticipated, and enacted HIV-related stigma scales were examined between

595 MSM and 579 non-MSM males living with HIV. Internalized HIV-related stigma was assessed with an 8-item scale derived from the "negative self-image" subscale of the Berger HIV Stigma Scale (Berger et al., 2001). Anticipated HIV-related stigma was assessed with a 9-item scale derived from the Health Stigma Framework (Earnshaw et al., 2013). Enacted HIV-related stigma was evaluated using a 16-item checklist adapted from a previous study (dos Santos et al., 2014). This study is a prerequisite for using these scales to assess internalized, anticipated, and enacted HIV-related stigma in between-group comparisons. In study 1, the anticipated HIV-related stigma scale had the same factor loadings and intercepts, and similar item residual variances between the two groups and achieved partial residual invariance. The internalized and enacted HIV-related stigma scales had the same factor loadings and similar intercepts in the two groups and achieved partial scalar invariance. Scalar invariance is considered the minimum requirement for meaningfully comparing latent factor means across groups (Muthén & Muthen, 2017). Overall, this study presented acceptable measurement invariance for internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males. The invariance across groups should be interpreted with caution since the parameters of some items were varied across groups.

Using a longitudinal analysis, study 2 quantified the health disparities in 3-year continual trajectories of physical, psychological, and behavioral health outcomes between MSM and non-MSM males. At baseline, a higher risk of having CD4 count<500 cells/$mm^3$ was observed among non-MSM males compared to MSM. Multiple studies across different geographical regions reported similar results where CD4 count in early infection were lower in non-MSM males than in MSM (Cascade Collaboration, 2003;

Frentz et al., 2014; Gupta et al., 2000; James & Dixit, 2022; Robertson et al., 2020; Tang et al., 2014). A potential explanation could be the tolerance to transmitted/founder (T/F) strains (James & Dixit, 2022). In addition, MSM had a higher risk of viral load≥50 copies/ml at baseline and a more rapid change at follow-ups than non-MSM males. However, after adjusting for the baseline sociodemographic covariates, both CD4 count and viral load at baseline and the viral load change over time were no longer different between MSM and non-MSM males, indicating that sociodemographic covariates could explain these differences. In terms of trajectories of depressive and anxiety symptoms, although the baseline level and the change over time were not different between groups after adjusting for sociodemographic characteristics, the correlations between baseline level and change over time were different between MSM and non-MSM males even after adjusting for covariates. Inverse relationships between baseline level and change over time of depressive and anxiety symptoms were significant among non-MSM males but not significant among MSM. This finding suggested that the higher baseline levels of depressive and anxiety symptoms were, the faster they reduced overtime among non-MSM males but not among MSM. Such group difference was not due to the differences in sociodemographic characteristics between groups, but could be distributed to less social support and multi-layered stigma associated with MSM (Arends et al., 2020; Parsons et al., 2017; Rzeszutek, 2018; Shao et al., 2018).

Study 3 examined the health impact of intersectional stigma on physical, psychological, and behavioral health outcomes among MSM living with HIV. Data was derived from a cross-sectional survey study designed to explore the effects of SGM identities on HIV-related health outcomes, including CD4 count, viral load, depressive

symptoms, anxiety symptoms, and ART adherence among MSM living with HIV in Guangxi, China. In this study, the main effect of HIV-related stigma on depressive symptoms and anxiety symptoms was significant among MSM living with HIV. Although the main effect of SGM-related stigma was not significant on health outcomes among MSM living with HIV, the health impacts of SGM-related stigma could be conveyed by enhancing the impacts of HIV-related stigma on psychological health outcomes. The associations between HIV-/SGM-related stigma and physical (i.e., CD4 count, viral load) and behavioral (i.e., ART adherence) health outcomes were not significant. This was in contrast to previous studies which reported that HIV-related stigma could accelerate HIV progression, resulting in a lower level of CD4 count, faster progress to AIDS (Cole et al., 1997), a low level of viral suppression (Lyons et al., 2020), and suboptimal ART adherence (Sweeney & Vanable, 2016). One possible explanation could be the ceiling effect of CD4 count, viral load, and ART adherence. Participants in this study were recruited in collaboration with local CDC from hospitals and clinics, who tended to have better retention in care and more optimal ART adherence.

### 7.2 Strengths and limitations

*Strengths*

There are several strengths in this dissertation. First, this dissertation developed a new conceptual framework describing the health disparities between MSM and non-MSM males, and the impact of intersectional stigma on health outcomes among MSM living with HIV. In the framework, sociodemographic and HIV-related characteristics are taken into consideration as they were well documented to be associated with health outcomes as well as the stigma faced by PLWH. Second, this study is one of the very few

studies comprehensively examining the measurement invariance of HIV-related stigma scales between MSM and non-MSM males. All four levels of measurement invariance (i.e., configural, metric, scalar, residual) were tested compared to a previous study that only tested the first three levels of measurement invariance (Miller & Sheu, 2008). Third, data used in study 2 were obtained from a prospective cohort study in Guangxi, China, with seven waves of longitudinal assessment of HIV-related health outcomes. With longitudinal data, this study demonstrated the overtime pattern of health outcomes dynamically and proposed potential causal inference. Furthermore, compared to previous studies that mainly focused on the overall HIV-related stigma (Fuster-Ruizdeapodaca et al., 2014; Logie et al., 2019; Parcesepe et al., 2020), this dissertation simultaneously included three subtypes of HIV-related stigma (i.e., internalized, anticipated, and enacted stigma). In addition, the impacts of intersectional stigma regarding HIV-related stigma and SGM-related stigma on multiple health outcomes among MSM living with HIV were assessed for the first time in this dissertation.

*Limitations*

Several limitations in this dissertation research should be acknowledged. First, as the sample was limited to MSM and non-MSM males in China, findings may not be generalized to MLWH in other areas. Second, as self-reported questionnaires were used in this study, the recall bias and social desirability could not be ignored. To mitigate this bias, objective indicators such as biomarkers and device-based measurement are needed. Third, participants were recruited from hospitals and clinics and their health status could be well-maintained and better than the general PLWH population. Selection bias resulting from sampling only in healthcare facilities might render the surveillance data hard to

interpret, especially when tracking populations that are “hard to reach” (Magnani et al., 2005). The generalizability of the results needs to be confirmed with heterogeneous samples. Fourth, the mechanism underlying the association between intersectional stigma and health outcomes was not investigated, which could be a potential reason for the non-significant associations between intersectional stigma and CD4, viral load, and ART adherence.

### 7.3 Implications

This study has several implications for future research, clinical interventions, and public health policymaking. First, the conceptual framework regarding the impact of intersectional stigma on health outcomes among MSM living with HIV unraveled the relationship among sociodemographic and HIV-related characteristics, social-cultural context, health outcomes, and MSM status. This framework could help explain the impacts of intersectional stigma and provide a solid research basis for future studies. Second, this dissertation presented acceptable measurement invariance for internalized, anticipated, and enacted HIV-related stigma scales between MSM and non-MSM males. These findings provided evidence and support for future studies using these scales to assess HIV-related stigma between MSM and non-MSM males, which could be a basis for future intervention in stigma reduction. Third, this study supported the opinion that sociodemographic factors played an important and complex role in health outcome of PLWH. For instance, after adjusting the baseline sociodemographic covariates, viral load at baseline and overtime were no longer different between MSM and non-MSM males, indicating that sociodemographic covariates could explain these differences. Hence, the impacts of sociodemographic covariates still need further investigations (Frentz et al.,

2014), which informs researchers and healthcare providers to develop more targeted approaches for different groups and improve our patient-centered care. In addition, the inverse correlations between intercept and slope of depressive and anxiety symptoms were only found in non-MSM males but not MSM. Typically, MSM are exposed to more risk factors of psychological distress than non-MSM males, such as a lack of social support and multiple stigmas associated with HIV diagnosis and SGM identities. Clinical interventions and social care about long-term mental health could pay more attention to MSM. Fourth, study 3 indicated that the relationships between HIV-related stigma and depressive/anxiety symptoms could be aggravated among MSM who reported higher SGM-related stigma, suggesting that interventions targeting mental health problems among MSM living with HIV should pay attention to the elevated risk of HIV-related stigma when combined with SGM-related stigma. These findings provided important contributions to understanding the well-being of stigmatized populations by highlighting intersectional stigma as a mechanism of adverse psychological health outcomes, which will inform effective and sustainable health strategies, policy, and service provision for preventive measures and wellbeing improvement.

**7.4 Future direction**

Future efforts such as research, implementation, and practices are needed to further dig into this topic, improve the quality of data, methods, and study design, and confirm the findings of this dissertation. Future studies are needed to explore the underlying mechanisms between intersectional stigma and health outcomes. Because the current study did not explore the mediation pathways between intersectional stigma and physical/behavioral health outcomes, we could not tell if the nonsignificant relationships

between intersectional stigma and physical/behavioral health outcomes were credible. The nonsignificance might also be simply due to the diminished direct association caused by two indirect effects that have opposite signs. Moreover, the inconsistency between CD4 count and viral suppression among MSM was observed in this dissertation. At baseline, MSM had a higher risk of viral load≥50 copies/ml and a lower risk of having CD4 count<500 cells/$mm^3$ compared to non-MSM males. Future efforts are still needed to explain this contradiction between CD4 count and viral load

## 7.5 Conclusion

By establishing a conceptual framework, this dissertation investigated the disparities in long-term health outcomes between MSM and non-MSM males living with HIV, and how SGM-related stigma and HIV-related stigma intersect to be associated with health outcomes among MSM in resource-limited settings in China. The differences between MSM and non-MSM males in physical, psychological, and behavioral health trajectories were identified in this dissertation. These findings could contribute to understanding the well-being of stigmatized and marginalized populations and informing future stigma reduction interventions of the unique vulnerability of MSM living with HIV.

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# APPENDIX A

## MEASUREMENT SCALES OF INTERNALIZED, ANTICIPATED, AND ENACTED HIV-RELATED STIGMA

Table A.1 Internalized HIV-related stigma scale

| | Rate each of the statements below using the following scale | Strongly disagree | Disagree | Agree | Strongly agree |
|---|---|---|---|---|---|
| 1 | I feel guilty because I have HIV | | | | |
| 2 | I feel ashamed of having HIV | | | | |
| 3 | Having HIV makes me feel unclean | | | | |
| 4 | I feel I am not as good a person as others because I have HIV | | | | |
| 5 | I think less of myself because I have HIV | | | | |
| 6 | I feel guilty because I have HIV | | | | |
| 7 | Having HIV in my body is disgusting to me | | | | |
| 8 | People's attitudes about HIV make me feel worse about myself | | | | |

Table A.2 Anticipated HIV-related stigma scale

| | How likely is it that people will treat you in the following ways in the future because of your HIV status? | Very unlikely | Unlikely | Neither unlikely nor likely | Likely | Very Likely |
|---|---|---|---|---|---|---|
| 1 | Family members will avoid me | | | | | |
| 2 | Family members will look down on me | | | | | |
| 3 | Family members will treat me differently | | | | | |
| 4 | Community/social workers won't take my needs seriously | | | | | |
| 5 | Community/social workers will discriminate against me | | | | | |
| 6 | Community/social workers will deny me services | | | | | |
| 7 | Healthcare workers will not listen to my concerns | | | | | |
| 8 | Healthcare workers will avoid touching me | | | | | |
| 9 | Healthcare workers will treat me with less respect | | | | | |

Table A.3 Enacted HIV-related stigma scale

| | Have people treated you this way in the past 6 months because of your HIV status? | Yes | No |
|---|---|---|---|
| 1 | Excluded from social gatherings | | |
| 2 | Excluded from family activities | | |
| 3 | Being gossiped about | | |
| 4 | Verbally insulted/harassed, threatened | | |
| 5 | Physically harassed or threatened | | |
| 6 | Physically assaulted | | |
| 7 | Husband/spouse/other household member have been discriminated against | | |
| 8 | Sexual rejection | | |
| 9 | Discriminated against by other PLWH | | |
| 10 | Other household members being discriminated because I have HIV | | |
| 11 | Forced to move or rejected for house leasing | | |
| 12 | Lose job or source of income | | |
| 13 | Rejected by employer or being fired | | |
| 14 | Forced to change job or denied promotion | | |
| 15 | Children being rejected by educational institutions because I have HIV | | |
| 16 | Denied by healthcare facilities | | |