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Disparities in healthcare expenditures among people living with HIV in the United States

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Disparities in healthcare expenditures among people living with HIV in the United States

A Thesis submitted in partial satisfaction of the requirements for the Master's degree

of

Public Health

by

Jennifer Huynh Pham

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Professor Todd Gilmer, Chair
Professor Mark Bounthavong, Co-Chair
Professor Cinnamon Bloss

2023

The Thesis of Jennifer Huynh Pham is approved, and it is acceptable in quality and form for publication on microfilm and electronically.

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ABSTRACT OF THE THESIS

Disparities in healthcare expenditures among people living with HIV in the United States

by

Jennifer Huynh Pham

Master of Public Health

University of California San Diego, 2023

Professor Todd Gilmer, Chair

Professor Mark Bounthavong, Co-Chair

Importance: In the United States (U.S.), HIV-related health disparities have been reported, particularly among communities of color where the incidence of new HIV cases has been higher. However, it is unclear if disparities exist across different socioeconomic demographics, and whether they are associated with healthcare expenditures.

Objectives: To evaluate the association between HIV status and healthcare expenditures, and assess the effect modification of socioeconomic factors on healthcare expenditures among people living with HIV (PLHIV) in the U.S.

Methods: Using the Medical Expenditure Panel Survey (MEPS) database from 2011 to 2020, our study employed a serial cross-sectional design to compare total healthcare expenditures of adult household respondents aged ≥ 18 years with and without an HIV diagnosis. We used generalized linear models to estimate the marginal effects of socioeconomic factors on healthcare expenditures adjusting for potential confounders.

Results: PLHIV had significantly higher total health care expenditures ($35,363, $p<0.001$) compared to those living without HIV after adjusting for age, sex, race, ethnicity, education, poverty status, and insurance status. However, there were no statistically significant differences in the marginal effects between males and females for each poverty, race, and education category.

Conclusion: Consistent with the existing literature, there was a significant association between HIV status and total healthcare expenditures among PLHIV in the US from 2011 to 2020. Future research should explore other factors such as the added burden of comorbidities and income inequality that could drive higher direct medical costs among PLHIV in our country.

CHAPTER 1: INTRODUCTION

1.1 Background: Epidemiology and social burden

Since 1987 when the first antiretroviral therapy (ART) gained the FDA approval for HIV (human immunodeficiency virus), HIV has no longer been recognized as an inevitably fatal infection, but rather, a chronic disease that 38.4 million people globally live with.[1] In the United States (U.S.), there were 1.2 million people living with HIV (PLHIV) at the end of 2019.[2] Despite being an incurable disease, having normal lives with improved life expectancy and reduced mortality rates is now virtually attainable for PLHIV, owing to the advanced therapeutics and HIV management strategies. However, those improvements do not come without trade-offs.

As HIV/AIDS is a complex medical condition that necessitates lifelong treatment, and the unemployment rates among PLHIV being three times higher than national unemployment rates, many PLHIV are dependent on public assistance for health insurance.[3] As a result, the cost of managing and controlling HIV infection poses numerous challenges to public health resources. For instance, Tran and colleagues in their 2020 systematic review stated that the lifetime cost for managing HIV could be as high as $377,820 for high-income countries.[4] In contrast, Schackman and his colleagues reported that avoiding one HIV infection could save the US $229,800, and potentially up to $338,400 when HIV-positive individuals engaged and remained in care early.[5] These findings not only signify the economic consequences of HIV, but also emphasize that successful HIV prevention strategies, as well as early identification of cases and compliance with treatment to eradicate the infection are crucial social imperatives.

1.2 Disparities exist

Ending the HIV epidemic requires more than just a biomedical solution. Of particular importance, HIV susceptibility is a function of multiple factors, including but not limited to the local prevalence, risky behaviors, inequality in access to treatment, poverty, and other social conditions.[6,7] Furthermore, HIV-related health disparities have been reported, particularly among communities of color where the incidence of new HIV cases has been higher.[8] For example, CDC reported that linkage to HIV care, while being the most critical step after confirmed diagnosis, is often delayed and lower among the African American population.[2,9] Ramos and colleagues also highlighted socioeconomic challenges such as lacking healthcare access are obstacles to effective HIV prevention methods in Black and Hispanic/Latinx populations.[10] Results from the HIV Cost and Services Utilization Study (HCSUS), the U.S. first national survey among HIV-positive individuals and their healthcare usages, also showed multiple barriers, such as lower income and educational attainment, could affect early access to HIV treatment and mortality rates.[11] Similarly, difficulties in enhancing HIV treatment outcomes were associated with social factors underlying disparities in access to HIV therapy, viral suppression and HIV prognosis, all of which can impact HIV progression and infectiousness.[12]

From a public health perspective, knowledge of factors that could promote or inhibit HIV transmission is invaluable, such as viral suppression, medication adherence, and early HIV testing. Viral suppression refers to the undetectable viral load needed for HIV-infected individuals to live longer and healthier lives while not sexually transmitting the disease to their HIV-negative partners. However, according to Kalichman and colleagues, income inequality and being female were positively associated with viral load.[13] Over the years, other studies also demonstrated that women have been less likely than men to maintain viral suppression.[14] Likewise, poorer adherence, an important reason for suboptimal response to HIV treatment, was observed among women of color with lower socioeconomic status, who were less well resourced and often disproportionately suffered from poverty and HIV infection.[7] Similarly, CDC reported that African Americans were more likely to get tested later in course of the infection, leading to delayed linkage to care or initiation of treatment while simultaneously amplifying HIV transmission risk (CDC 2003).[7] These studies offer strong support that HIV containment strategies, when focusing on high risk populations with apparent disparities, will generate benefits beyond personal health, and extend to public health benefits overall.

1.3 Ineffective responses and economic burden

Recognizing HIV disparities present in HIV incidence, linkage to treatment, retention in care, and adherence to positive health behaviors, multiple national initiatives have been enacted to lessen their impacts on PLHIV. For instance, the U.S. Department of Health and Human Services (HHS), Health Resources and Services Administration (HRSA), HIV/AIDS Bureau (HAB) administers the Ryan White HIV/AIDS Program (RWHAP), the largest federal program focused on HIV that was enacted in 1990. This program has been providing grants to cities, states, counties, and community-based groups to provide HIV medical care, treatment, and support services for PLHIV.[15] In addition, to improve the global AIDS response to end the HIV epidemic, the Joint United Nations Programme on HIV/AIDS (UNAIDS) set a target in 2014 for 90% of PLHIV to know their HIV status, 90% of those PLHIV diagnosed to be on treatment, and 90% of those on treatment to have adequate viral suppression ("90-90-90" target) by 2020.[1] Currently, none of these targets have been met. At the end of 2019, of 1.2 million PLHIV in the U.S., there were about 66% on HIV therapy, 50% retained in care, and 56.8% achieved viral suppression.[2] The discrepancies between the most recent percentages and the national goals raise questions about whether these programs have been implemented at full scale, and if there are existing disparities that were left unaddressed.

In 2010, the National HIV/AIDS Strategy (NHAS) was introduced with three primary goals: reducing HIV incidence rate, increasing access to care for PLHIV, and reducing HIV-related health disparities.[16] Although Ritchwood and colleagues reported that healthcare expenditures in the United States (US) among people with HIV was 800-900% higher compared to those without HIV), results from the national study by the W.K. Kellogg Foundation (WKKF) and Altarum demonstrated that potentially, the U.S. could have a total economic gain of $135 billion per year, including $93 billion in excess medical care costs and $42 billion in untapped productivity, if health disparities are addressed and eliminated.[17,18] This re-emphasizes the importance of goal 3 of the NHAS with particular focus on the impacts of HIV-related disparities across all segments of the U.S. population.

1.4 Importance of our research study

Effective HIV therapeutics have positively enhanced health outcomes and lifespan of many PLHIV. Nevertheless, the benefits have not been successfully and equally delivered to all PLHIV in the U.S. Previous research has identified that sociodemographic characteristics were associated with barriers to HIV care, which could lead to economic burden. Economic disparities can impact the quality of healthcare HIV patients receive prompting decision makers to be more attentive to healthcare expenditure disparities. However, there is little information on the impact these have had on the healthcare expenditures among patients with HIV. This gap in the literature has prompted our investigation to evaluate the presence of disparities in healthcare expenditures across sociodemographic groups among patients with HIV. Moreover, I also evaluated the effect modification of HIV on healthcare expenditures compared to the population without HIV.

To meet the CDC goal of decreasing new HIV infections to 3,000 by 2023, it is crucial to address differences in social and economic circumstances, as it will help guide a more holistic preventative approach to focus on high-risk populations and align resources with the highest need. Having a reasonably accurate estimation of lifetime cost for managing HIV is crucial not only for public health planning and allocating resource purposes, but also for policy and decision-making processes to ensure cost-effectiveness and affordability of HIV treatment for all.

1.5 Research aims

In Aim 1, we compared healthcare expenditures between HIV and non-HIV subjects based on a representative sample of the US population from the MEPS database between 2011 and 2020.[7,8] We used generalized linear models to evaluate the association between HIV status (HIV versus non-HIV) and healthcare expenditures adjusting for potential confounders (e.g., age, sex, race, ethnicity, poverty status, and educational level). MEPS is publicly available data from surveys conducted by the Agency for Healthcare Research and Quality (AHRQ).[19]

We hypothesized that HIV subjects would have higher healthcare expenditures compared to non-HIV subjects living in the United States from 2011 to 2020.

In Aim 2, we evaluated the effect modification of socioeconomic factors (e.g., sex, ethnicity, poverty status) on healthcare expenditures among a representative sample of subjects with an HIV diagnosis in the US using the MEPS database from 2011 to 2020. We used generalized linear models and estimated the marginal effects of interactions between socioeconomic factors on healthcare expenditures adjusting for potential confounders (e.g., age, sex, race, ethnicity, poverty status, and educational level). Results are presented as marginal effects on healthcare expenditures for each variable with their corresponding 95% confidence interval (CI).

We hypothesized that sociodemographic characteristics of the HIV respondents living in the United States from 2011 to 2020 would have significant interactions on total healthcare expenditures.

CHAPTER 2: METHODS

2.1 Study Design

Using data from the Medical Expenditure Panel Survey (MEPS), our study employed a serial cross-sectional design to compare total healthcare expenditures of unique adult household respondents (aged ≥ 18 years) with and without an HIV diagnosis from 2011 to 2020. MEPS is a nationally representative survey of the U.S. noninstitutionalized population managed by the federal Agency for Healthcare Research and Quality (AHRQ) of the Department of Health and Human Services.[19] MEPS is the only national large-scale survey that collects information from individuals and their families, medical providers and employers to capture how the US non-institutionalized civilian population utilize and pay for healthcare services.[19]

2.2 Sample

Data were pooled from the MEPS-Household Component (HC) full year consolidated files and Medical Condition files from 2011 to 2020.[20] The full-year consolidated data files provided information about the unique person identifier of each respondent (DUPERSID) and other variables relating to demographic characteristics, geographic location, income and tax filing status, employment, health insurance, access to care, health status, utilization and expenditure, weight and variance estimation.[21] The Medical Condition files contained self-reported information on medical conditions at the person level, with each record representing one current medical condition that was linked to an event and reported for a household survey member during the calendar year.[20,21] HIV diagnoses were recorded by the interviewers using the codes from International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) for the years 2011-2015 and the International Classification of Disease, Tenth Revision, Clinical Modification (ICD-10-CM) for 2016-2020.[20] To group similar ICD-9-CM condition codes, Clinical Classification Software was used to aggregate these ICD-9-CM codes into clinically relevant categories (CCCODEX) for 2011-2015.[22,23] Similarly, Clinical Classification Software Refined was used to group similar ICD-10-CM condition codes into clinically relevant categories (CCSR).[24,25] All fully specified ICD codes were collapsed to three digits to protect respondents' confidentiality making the use of the Clinical Classification Software and CCSR categories necessary.[20]

2.3 Primary independent variable: HIV status

The primary independent variable was unique respondents with HIV diagnosis. To identify unique respondents with HIV infection in the MEPS data, we used the CCCODEX code of 005 for the years 2011-2015, and CCSR code of INF006 for the years 2016-2020.[22-25]

2.4 Primary outcome (dependent) variable: total healthcare expenditure

The outcome of interest was the total healthcare expenditures which reflect the sum of all direct payments related to healthcare services provided during the survey year, including out-of-pocket and insurance payments (e.g., private, Medicare, Medicaid, and other sources).[26] Costs were adjusted to 2022 $USD using the Consumer Price Index.

2.5 Other variables

Self-reported variables of interest included age, sex, ethnicity, poverty status and education level. The continuous age variable selected for our study represented the exact age, calculated from the survey respondent's date of birth to the end of the survey year.[26] Data on gender of each sample person was coded as male or female determined by the first name (if obvious), or family relationships, or random assignment for gender when necessary (MEPS documentation confirmed no cases were resolved this way).[26] The binary Hispanic ethnicity variable was based on the sample person's national origin or ancestry. All sample persons whose main national origin or ancestry was reported in one of the Hispanic groups (Puerto Rican; Cuban; Mexican, Mexicano, Mexican American, or Chicano; other Latin American; or other Spanish) were classified as Hispanic, regardless of racial background.[27] Poverty status of each sample person was determined by the ratio of his or her family's total annual income to the corresponding federal poverty thresholds, which control for the head of family's age and family size.[27] This ratio classified poverty status into five categories: Negative/Poor (less than 100%), Near poor (100% to less than 125%), Low income (125% to less than 200%), Middle income (200% to less than 400%), and High income (greater than or equal to 400%). Education was based on the highest education level the participant completed when entering the survey and categorically coded as: No school/Kindergarten only, Elementary grades 1-8, High school grades 9-12, 1-3 years of college, 4+ years of college, Don't know, Refused, Cannot be computed, Inapplicable.[27]

2.6 Statistical analysis

For each survey year, data from the MEPS-HC full-year consolidated files and the MEPS-HC medical condition files were merged using the unique person identifier (DUPERSID) on a one-to-many match. We used the used `tbl_svysummary` function in R to account for individual sampling weight and to properly estimate corresponding values for the U.S. noninstitutionalized civilian population. Demographic characteristics were compared between respondents with and without HIV diagnosis. Mean and standard deviations are presented for continuous data, and frequency and proportions are presented for categorical data.

For the first aim, we compared healthcare expenditures between individuals with and without an HIV diagnosis based on a representative sample of the US population from the MEPS database between 2011 and 2020.[19, 20] We constructed a generalized linear model to evaluate the association between HIV status (HIV versus non-HIV) and healthcare expenditures adjusting for potential confounders (e.g., age, sex, race, ethnicity, poverty status, and educational level). In the second aim, we evaluated the effect modification of socioeconomic factors (e.g., sex, ethnicity, poverty status) on healthcare expenditures among a representative sample of respondents with an HIV diagnosis in the US using the MEPS database from 2011 to 2020. Previous literature reported significant differences between males and females in terms of healthcare expenditures among the HIV population.[17] Hence, we were interested in the interaction between sex and other sociodemographic characteristics. We constructed generalized linear models to evaluate the interaction effects between socioeconomic factors on healthcare expenditures adjusting for potential confounders (e.g., age, sex, race, ethnicity, poverty status, and educational level). Interaction terms included sex with poverty, sex with education, and sex with race. Marginal effects of sociodemographic characteristics on total healthcare expenditures were estimated using the `margins` command, which estimates the partial derivative of the regression equation generating the average effect of the changes in a variable on the outcome.[28] Results are presented as the marginal effects on healthcare expenditure for each variable with their corresponding 95% confidence interval (CI). A two-tailed alpha < 0.05 was considered statistically significant. All analyses were performed using R software version 4.2.1 (The R Foundation for Statistical Computing; http://wwwa.r-project.org).[29]

CHAPTER 3: RESULTS

3.1 Population characteristics

Among the 244,753 unique respondents who were pooled between 2011 and 2020, a total of 548 (0.22%) had at least one HIV diagnosis (Table 1). Those respondents represented a survey weighted estimate of 244.8 million total respondents with 445,323 people having an HIV diagnosis. The majority of these subjects with an HIV diagnosis were 45 to 64 years of age (266,743 [59.9%]), male (344,868 [77.4%]) , white (245,675 [55.2%]), non-Hispanic (367,225 [82.5%]), had high school education level grades 9-12 (147,318 [33.1%]), and publicly insured (227,429 [51.1%])

3.2 Expenditures differences between respondents with and without an HIV diagnosis

Between 2011 and 2020, respondents with an HIV diagnosis had significantly higher unadjusted average annual total healthcare ($43,544 versus $7178; P < 0.001), out-of-pocket healthcare ($2031 versus $957; P < 0.001), prescription ($31,957 versus $1698; P < 0.001), and out-of-pocket prescription ($1166 versus $235; P < 0.001) expenditures compared to respondents without an HIV diagnosis (Table 2). Table 3 summarizes the results from our adjusted GLM on differences in expenditures associated with HIV status controlling for age, sex, race, ethnicity, education, poverty status, and insurance status. After adjusting for sociodemographic factors, respondents living with HIV have significantly higher total healthcare expenditures compared to respondents living without HIV ($35,363; 95% CI: $31,196, $39,531), as well as higher out-of-pocket healthcare ($1364; 95% CI $907, $1820), prescription ($29,725; 95% CI: $26,125, $33,325), and out-of-pocket prescription ($959; 95% CI: $662, $1,255) expenditures.

3.3 Marginal effects of gender interaction with poverty status, race and education on healthcare expenditures

Table 4 and Figures1-3 illustrate the estimated marginal effects of the interactions between socioeconomic factors on healthcare expenditures adjusting for potential confounders (e.g., age, sex, race, ethnicity, poverty status, insurance status and educational level).

3.3.1 Marginal effects of gender interacting with poverty status on healthcare expenditures

Among female respondents living with HIV, the differences in total healthcare expenditures between poverty status of "Near poor", "Low income", Middle income", and "High income" versus "Poor" were $8703 (95% CI: -$34,893, $52,298), $26,547 (95% CI: -$23,628, $76,723), -$7051 (95% CI: -$32,508, $18,405), and -$22,636 (95% CI: -$54,416, $9144), respectively (Table 4). For male respondents, the corresponding differences were $3848 (95% CI: -$15,771, $ 23,466), -$4242 (95% CI: -$12,765, $4281), -$9558 (95% CI: -$21,291, $2174), and -$19,772 (95% CI: -$31,212, -$8332), respectively (Table 4 & Figure 1). A statistically significant difference was observed between "High income" versus "Poor" male respondents (P=0.001). Overall, there were no statistically significant differences in the marginal effects for each poverty category between males and females.

3.3.2 Marginal effects of gender interacting with race on healthcare expenditures

The differences in total healthcare expenditures among female respondents who lived with HIV and identified as "Black" and "Others" versus "White" were $2246 (95% CI: -$20,388, $24,880) and -$25,836 (95% CI: -$56,588, $4916), respectively. Among male respondents, the corresponding differences were which were $1665 (95% CI: -$10134, $13463) and -$5966 (95%

CI: -$15189, $3256), respectively (Table 4 & Figure 2). There were no statistically significant differences in the marginal effects for each race category between males and females.

3.3.3 Marginal effects of gender interacting with education level on healthcare expenditures

Compared to the reference group "No school/Kindergarten only," the differences in total healthcare expenditures among female respondents who had an HIV diagnosis and an education level of "Grades 1-12" or "College ≥ 1 year(s)" were $21,002 (95% CI: $4458, $37,547) and $32,597 (95% CI: $2391, $62,802), respectively (Table 4). Among male respondents, those estimates were -$4289 (95% CI: -$12054, $3476) and $7975 (95% CI: -$1365, $17315). There was a statistically significant difference between females in "Grades 1-12" versus "No school/Kindergarten only" (P=0.013). Overall, there were no statistically significant differences in the marginal effects for each education level between males and females.

Table 1: Demographic characteristics of adult (≥ 18 years) respondents from the MEPS, 2011 to 2020

Characteristics	Respondents without an HIV diagnosis	Respondents with an HIV diagnosis	Standardized difference
Unweighted sample	244,205	548	
Weighted sample	244,373,441	445,323	
Age (years), mean (SD)	47.39 (18.21)	50.19 (12.09)	0.181
Age category, n (%)			0.631
18 to 24 years	29,465,463 (12.1)	9,586 (2.2)	
25 to 44 years	83,507,782 (34.2)	123,708 (27.8)	
45 to 64 years	82,441,506 (33.7)	266,743 (59.9)	
65+ years	48,958,689 (20.0)	45,285 (10.2)	
Gender, n (%)			
Male	117,807,547 (48.2)	344,868 (77.4)	-0.635
Female	126,565,893 (51.8)	100,455 (22.6)	0.635
Race, n (%)			0.611
White	182,541,804 (74.7)	245,675 (55.2)	
Black	28,140,049 (11.5)	145,482 (32.7)	
American Indian/ Alaska Native	1,702,090 (0.7)	2,765 (0.6)	
Asian/ Native Hawaiian/ Pacific Islander	14,271,602 (5.8)	4,520 (1.0)	
Multiple races reported/ Inapplicable	17,717,895 (7.3)	46,881 (10.5)	
Ethnicity, n (%)			
Hispanic	38,657,573 (15.8)	78,098 (17.5)	-0.046
Not Hispanic	205,715,867 (84.2)	367,225 (82.5)	0.046
Education, n (%)			0.123
Kindergarten/ No school	47,908,308 (19.6)	86,358 (19.4)	
Elementary grades 1-8	7,711,539 (3.2)	16,336 (3.7)	
High school grades 9-12	73,595,221 (30.1)	147,318 (33.1)	
College (1-3 years)	51,050,833 (20.9)	98,566 (22.1)	
College (4+ years)	62,864,412 (25.7)	96,022 (21.6)	
Cannot be obtained	1,243,129 (0.5)	724 (0.2)	
Insurance coverage, n (%)			0.666
Any Private	167,948,094 (68.7)	192,676 (43.3)	
Public	50,861,108 (20.8)	227,429 (51.1)	
Uninsured	25,564,238 (10.5)	25,218 (5.7)	

Table 2: Unadjusted total expenditures between non- HIV and HIV groups*

Expenditures ($)	Non-HIV	HIV	P-value
Total healthcare expenditures, mean (SD)	$7,178 (20,298)	$43,544 (40,948)	< 0.001
Out-of-pocket healthcare expenditures, mean (SD)	$957 (2,995)	$2031 (4,162)	< 0.001
Prescription expenditures, mean (SD)	$1,698 (9,174)	$31,957 (30,232)	< 0.001
Out-of-pocket prescription expenditures, mean (SD)	$235 (949)	$1166 (3160)	< 0.001

*Costs were adjusted for inflation to 2022 US dollars.

Table 3: Regression model results on healthcare expenditures and HIV groups*

Expenditures ($)	Difference in expenditures (HIV v. non-HIV)	95% CI	P-value
Total healthcare expenditures	$35,363	$31,196, 39,531	< 0.001
Out-of-pocket healthcare expenditures	$1364	$907, 1820	< 0.001
Prescription expenditures	$29,725	$26,125, 33,325	< 0.001
Out-of-pocket prescription expenditures	$959	$662, 1255	< 0.001

*Results of the GLM model adjusting for age, sex, race, ethnicity, education, poverty status, and insurance status. Costs were adjusted for inflation to 2022 US dollars.

Table 4: Marginal effects of sex interacting with poverty status, race, and education on total healthcare expenditures

Socioeconomic factors	Gender			
	Male ($N_{weighted}$ = 344,868)	**P-value**	**Female ($N_{weighted}$ = 100,455)**	**P-value**
Poverty status				
Near poor	$3848 (-15,771, 23,466)	0.701	$8703 (-34,893, 52,298)	0.696
Low income	-$4242 (-12,765, 4281)	0.329	$26,547 (-23,628, 76,723)	0.300
Middle income	-$9558 (-21,291, 2174)	0.110	-$7051 (-32,508, 18,405)	0.587
High income	-$19,772 (-31,212, -8332)	**0.001**	-$22,636 (-54,416, 9144)	0.163
Race				
Black	$1665 (-10,134, 13,463)	0.782	$2246 (-20,388, 24,880)	0.846
Others	-$5966 (-15,189, 3256)	0.205	-$25,836 (-56,588, 4916)	0.100
Education				
Grades 1-12	-$4289 (-12,054, 3476)	0.279	$21,002 (4458, 37,547)	**0.013**
College ≥ 1 year(s)	$7975 (-1365, 17,315)	0.094	$32,597 (2391, 62,802)	0.034

Within each gender group, the comparison is between each socioeconomic category with a reference group. The reference groups for poverty status, race, and education are “Poor”, “White”, and “No school/ Kindergarten only”, respectively. Estimates were adjusted for inflation to 2022 US dollars.

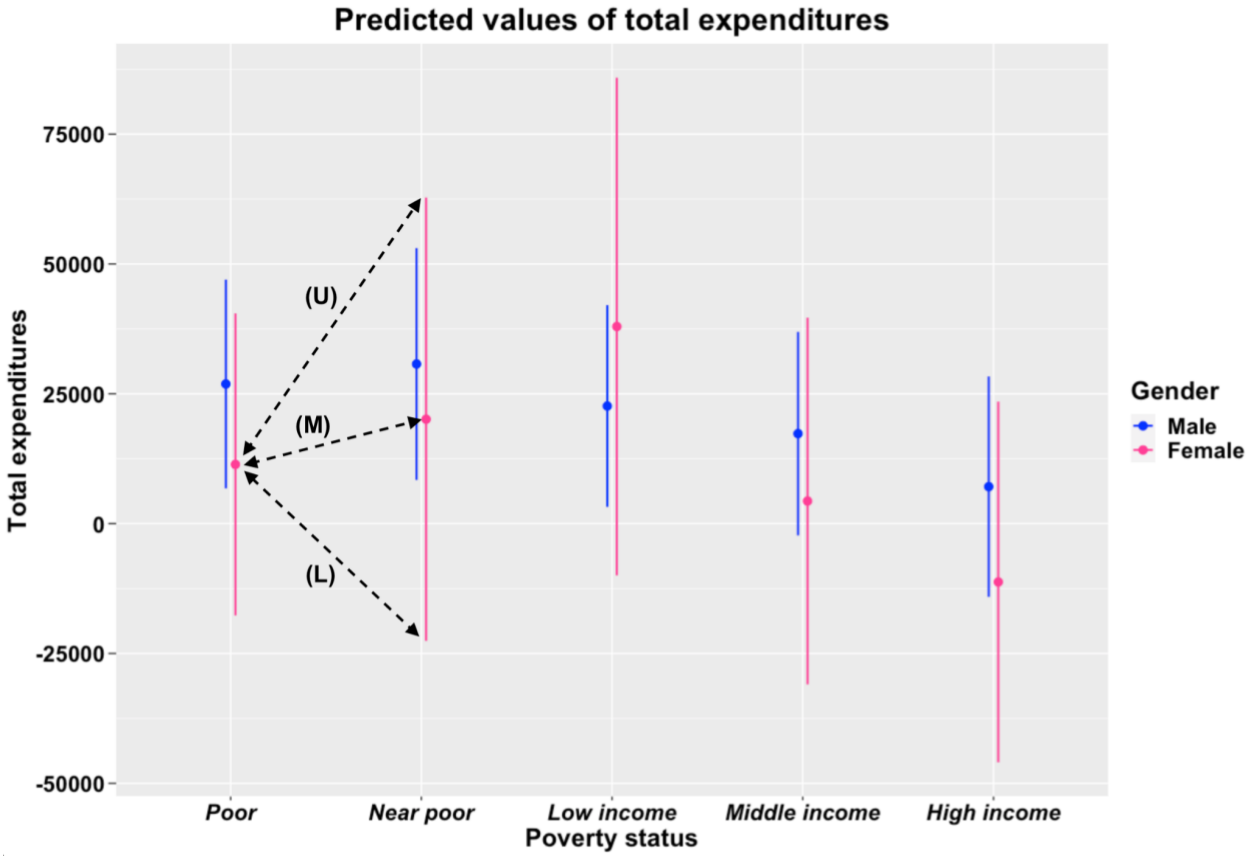

Figure 1: Marginal effects of gender interacting with poverty status from 2011 to 2020
This plot illustrates the difference in the total expenditures between males and females at each poverty category compared to the reference group "Poor". For instance, among female respondents living with HIV from 2011 to 2020, the difference in total healthcare expenditures between "Near poor" versus "Poor" groups was $8703, annotated by the distance (M). The lower and upper 95% CIs of this estimate were -$34,893 and $52,298, respectively (annotated by (L) and (U)). Among a weighted sample of 445,323 unique respondents with an HIV diagnosis, the majority of them were male (344,868 [77.4%]). The weighted estimates for "Poor", "Near poor", "Low income", "Middle income" and "High income" among these male respondents were 110,559 [32.1%], 41,101 [11.9%], 51,797 [15.0%], 54,503 [15.8%], 86,908 [25.2%], respectively. For female respondents, these estimates were 48,041 [47.8%], 8,135 [8.1%], 14,355 [14.3%], 13,207 [13.1%], and 16,718 [16.6%], respectively. All estimates were adjusted for inflation to 2022 US dollars.

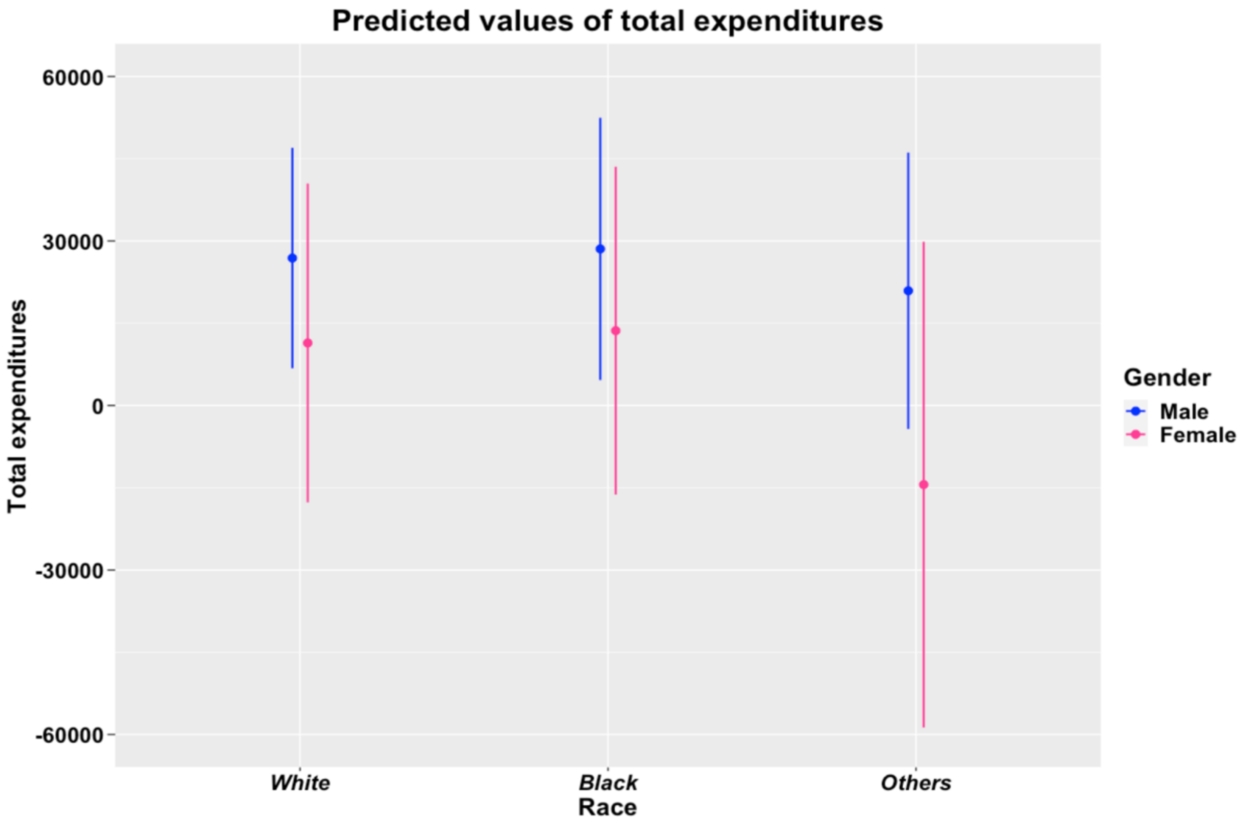

Figure 2: Marginal effects of gender interacting with race from 2011 to 2020.
“Others” category includes American Indian/ Alaska Native, Asian/ Native Hawaiian/ Pacific Islander, and Multiple races reported. The weighted estimates for “White”, “Black”, and “Others” among male respondents were 206,756 [60.0%], 90,289 [26.2%], and 47,823 [13.9%], respectively. For female respondents, these estimates were 38,919 [38.7%], 55,193 [54.9%], 6,343 [6.3%], respectively. All estimates were adjusted for inflation to 2022 US dollars.

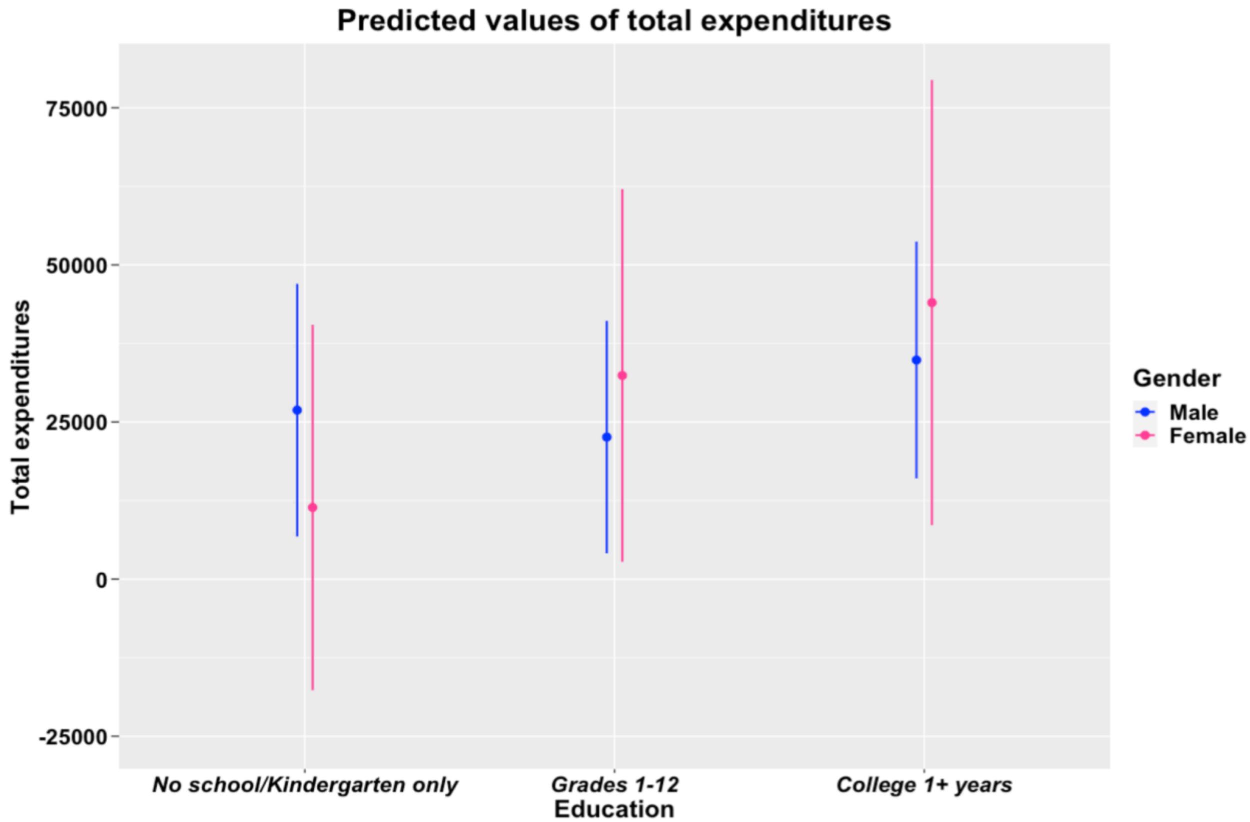

Figure 3: Marginal effects of gender interacting with education level from 2011 to 2020.
Among male respondents, the weighted estimates for “No school/Kindergarten only”, “Grades 1-12”, and “College 1+ years” were 70,549 [20.5%], 103,742 [30.1%], and 170,577 [49.5%], respectively. Among female respondents, these estimates were 16,533 [16.5%], 59,911 [59.6%], 24,011 [23.9%], respectively. All estimates were adjusted for inflation to 2022 US dollars.

CHAPTER 4: DISCUSSION

The results of this study highlight significant differences in expenditures between MEPS respondents with and without an HIV diagnosis. Similar to the findings reported by Ritchwood and colleagues in 2017, we found that from 2011 to 2020, individuals living with HIV had significantly higher total health care expenditures ($35,363, $p<0.001$) compared to those living without HIV after adjusting for age, sex, race, ethnicity, education, poverty status, and insurance status. In addition to the total healthcare expenditures, HIV respondents had significantly higher out-of-pocket healthcare, prescription, and out-of-pocket prescription expenditures compared to non-HIV respondents (+$1364, +$29,725, and +$959, respectively; $p < 0.001$ for all comparisons). When looking at the interaction between gender and poverty status, our generalized linear models revealed no statistically significant differences in the marginal effects for each poverty category between male and female respondents living with HIV from 2011 to 2020. Similarly, there were no statistically significant differences in the marginal effects between males and females for each race and education category.

Based on the current literature, our study is among the first in the United States to investigate the effect modification of socioeconomic status on healthcare expenditures among a representative sample of individuals with an HIV diagnosis. Although there are currently no HIV-focused studies assessing interaction of different socioeconomic factors on medical expenditures, disparity studies in other diseases have reported similar findings where health spending was not significantly different between subgroups. For instance, Egede and colleagues reported no significant differences in incremental effects of healthcare expenditures by depression and diabetes status. Moreover they report no significant difference in expenditures between individuals identifying as Non-Hispanic Black versus Non-Hispanic White.[30] Similarly, Spector and colleagues reported no significant differences in office-based visit expenditures among males and females for Hispanic, Non-Hispanic Asian, and Non-Hispanic Other compared to Non-Hispanic White, as well as for those in “Near poor” and “Low income” compared to “Poor” using MEPS data from 2011 to 2019.[31] These findings suggest that differences in common healthcare expenditures cannot be solely explained by variations in socioeconomic status and their interactions. However, individuals concomitantly living with HIV other comorbidities tend to result in more costly medical care, which suggests the need for a more focused framework on the added burden of comorbidities.[32] Therefore, when looking at costs, underlying chronic conditions should also be taken into account, which did not occur in our analysis.

Our present study has several strengths as well as limitations. Pooling data from a longitudinal panel survey allows us to not only observe cost trends, but also track how HIV prevalence and its economic burden to the U.S. have progressed over the past 10 years. Additionally, the large collection of demographic characteristics in MEPS enables us to analyze a variety of expenditures while adjusting for multiple confounding variables. However, being a secondary analysis, our study could not assess indirect costs associated with HIV status such as cost due to reduction in productivity or due to illness-related disability. Additionally, potential recall bias cannot be excluded in the survey where data are collected by means of self-report. Furthermore, because diagnostic codes in MEPS only contain the first three digits of the ICD-10 codes to provide patient confidentiality, we are not able to differentiate patients who were newly diagnosed with HIV versus patients who were at the most advanced stage of HIV with AIDS, which often requires more comprehensive and expensive care and therefore, might have confounded our results. Finally, as our study only included U.S. respondents who were at least

18 years of age, our findings cannot be generalizable to individuals in other populations such as in pediatrics or in other countries.

Although our findings did not indicate a presence of an effect modification of socioeconomic status on healthcare expenditures, there is a need to identify and address factors driving higher direct medical costs among PLHIV in the U.S, and whether those factors are associated with socioeconomic characteristics. We acknowledge our study has several limitations, and we only examined three interaction terms in our GLM model for the analysis. Therefore, the absence of significant marginal effects of the sociodemographic characteristics being assessed on total healthcare expenditures among HIV respondents does not imply an absence of health disparities among these individuals. In fact, the National Institutes of Health has emphasized we must address health disparities to end the HIV epidemic.[33] Of particular concern is the income-based health disparities in the U.S, which was not investigated in the current study. The existing literature shows that income inequality is not only associated with negative health outcomes such as increased likelihood of comorbidities, higher COVID-19-related mortality risk, higher rate of mental illnesses, but can also influence longevity, with low-income earners decreasing their life expectancy while the high-income counterparts increasing theirs.[34] As a result, future studies should consider adding other factors such as the added burden of comorbidities, types of service utilized, and behavioral measures such as medication adherence. Additionally, evaluating how income interacts with those components should be a priority, as it may reveal the income-health relationship that health disparities researchers have to adjust for.[35] In the context of the HIV epidemic, understanding how these socioeconomic factors and disparities interact with HIV-related expenditures could help result in policies that optimally allocate resources to those in greatest need through social programs focusing on the economically disadvantaged populations. Having the knowledge of what could lead to an increase in the cost of managing HIV is important not only for public health planning and allocating resource purposes, but also for policy and decision-making processes to ensure cost-effectiveness and affordability of HIV treatment for all PLHIV.

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