

## Trends in HIV/AIDS incidence rate in Mississippi, 2008-2019

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### Abstract

**Background and objectives:** Despite the decline in new HIV infection across the United States, Mississippi is still experiencing high rates of new HIV infections. Reports highlighted significant variations by geographical locations and socio-demographic factors. This study examined trends of HIV/AIDS incidence rates in Mississippi from 2008 to 2019.

**Materials and methods:** Data on HIV/AIDS diagnosis were extracted from Mississippi Enhanced HIV/AIDS Reporting System database. Data were cleaned and de-identified using Microsoft Excel and SAS 9.4. Overall and annual age-adjusted HIV and AIDS incidence rates were calculated by sex, race, and age using 2000 US population. Annual Percentage Change (APC) and Average Annual Percentage Change (AAPC) were analyzed using *Joinpoint* regression models.

**Results:** Overall, HIV incidence rate declined from 25.0 in 2008 to 18.79 per 100,000 population in 2019 (24.8% decrease) while AIDS incidence increased from 6.4 in 2008 to 8.2 per 100,000 population in 2019 (28.1% increase). Comparison between sexes of all age groups showed a downward trend of new HIV infection (AAPC: Male:-1.50, Female:-5.17) and an upward trend of AIDS incidence (AAPC: Male: 1.90, Female: 3.70). Age adjusted HIV incidence declined by 26.8% and 12.4% among blacks and whites respectively (AAPC: Blacks: -2.8, Whites:-1.0) but there was no significant change in age-adjusted AIDS incidence among both races from 2008-2019.

**Conclusion:** This study indicated that age-adjusted HIV incidence rate is declining in Mississippi but trends differ by race, gender, and age. More interventions aimed at ensuring early diagnosis, proper linkage to care and preventing the progression of HIV to AIDS particularly among at-risk population are needed in Mississippi.

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### Introduction

Human immunodeficiency virus (HIV) still poses a significant threat to public health globally despite improved antiretroviral therapies (ART) [1]. About 50,000 new HIV infections have been reported annually over the past decade in the United States. In 2015, Mississippi ranked seventh highest in the rate of new HIV infections (19.2) and the city of Jackson ranked fourth highest HIV infection rate in the nation. Also, Mississippi has one of the highest

numbers of AIDS-related deaths in the nation [2,3]. New HIV infection patterns and distribution highlight that high-risk groups, some geographical locations, and racial and ethnic minorities are disproportionately affected by HIV/AIDS [4,5]. The Centers for Disease Control and Prevention CDC, (2018) reported 37,968 new HIV diagnoses; gay and bisexual men accounted for 69%, while heterosexuals and injection drug users (IDUs) accounted for 24% and 7% respectively; these

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groups represent the largest proportion of new HIV diagnoses. In addition, the incidence of new HIV infections is commonest among adolescents and adults between ages 13-34 [6].

Various epidemiological studies reported that new HIV infection in the United States has declined by 9% in recent years; this decline varies by gender, ethnicity/race, and geographical location [7,8]. Mississippi still has high rates of new HIV infection [9]. Annual incidence rates of HIV infection in Mississippi vary significantly and range from 5 to 19.1 per 100,000 persons depending on the region and location. The city of Jackson and Mississippi Delta region has the highest rates of HIV infection in the state [10,11]. Examining trends of HIV/AIDS incidence rates by age, gender, ethnicity/race is important and would be informative for statewide policymakers to design and implement effective interventions to protect vulnerable populations and prevent new infections. Despite its public health importance, limited studies have been conducted to examine trends and annual changes in HIV/AIDS incidence rates in Mississippi. To address this gap, an in-depth study was undertaken to explore the annual percentage change, and average annual percentage change in age-adjusted HIV/AIDS infection among Mississippians from 2008 to 2019.

## Materials and Methods

### Data collection and analyses

Data was extracted from Mississippi Enhanced HIV/AIDS Reporting System (eHARS). eHARS is a secure relational database with web-based data system and a SQL-server back-end which is designed and provided by CDC to all jurisdictions in United States to collect HIV surveillance data. Like other jurisdictions, Mississippi maintains HIV surveillance data in eHARS and submits de-identified data to CDC's national database monthly through a secure data network. SAS versions 9.3 and 9.4 were used to preprocess data from eHARS into a standardized format [12]. Data of newly diagnosed HIV/AIDS infection between 2008 and 2019 in Mississippi were collected. Age adjustment was done using direct method and the 2000 US standard projected population [13]. The US census

estimates for Mississippi population for each year from 2008 to 2019 were used to calculate crude and age-adjusted incidence rates, as well as standard errors for the overall population. Stratified analyses were done by age groups (0-14, 15-44, 45-64, ≥65 years), race (white or black), and gender (male or female) for each year. Analyses for racial groups were restricted to non-Hispanic black and non-Hispanic white groups because these groups accounted for 96.9% of the entire Mississippi population in 2019 [14].

### Formulae used:

Yearly crude HIV and AIDS incidence rate was calculated using the formula below:

$$\text{Yearly crude incidence rate (R)} = \frac{[\text{Total number of new cases each Year (2008 - 2019)} / \text{Total number of Mississippi population in each Year (2008 - 2019)}] \times 100,000$$

Age adjusted rates for each year were computed by gender and race/ethnicity using the formula below:

$$\text{Age adjusted incidence rate} = \text{Weights (W)} \times \text{Calculated crude rates (R)}$$

The standard error represents a measure of precision of the estimates calculated. Age-adjusted standard error for incidence, prevalence, and deaths for each year from 2008-2019 was computed by gender and race/ethnicity using the formula below:

$$\text{Age adjusted standard error} = \frac{\text{Total number of cases each Year by specified age groups}}{(\text{Total population of the specified age groups each Year})^2} \times (\text{Weight of specified age group})^2$$

### Statistical Analysis

The data were analyzed using SAS 9.4 (SAS Institute Inc). PROC FREQ procedure was used for frequency analysis to count the proportions of new HIV and AIDS cases for each year from 2008 to 2019. Crude and age-adjusted HIV/AIDS incidence rates were calculated using excel spreadsheet for new cases, total number of cases as numerators and the corresponding overall and strata-specific population estimates as the denominator. All stratified age-adjusted rates and standard errors

were calculated to estimate respective yearly rates. Age at diagnosis were categorized into age groups (0-14, 15-44, 45-64, and 65 and above) of the 2000 US standard population and weights for these age groups were calculated [13]. Then, we exported the computed age-adjusted rates and standard errors to the US Surveillance, Epidemiology, and End Results (SEER) *Joinpoint regression program* version 4.9.0.1.0 [15] to calculate Annual Percentage Change (APC) and Average Annual Percentage Change (AAPC) of HIV/AIDS incidence rates in Mississippi by age, sex, and race. *Joinpoint regression analysis* is one of the widely applied methods for examining trends of disease incidence rates, death rates or survival rates. *Joinpoint regression* fits linear regression and describes trend in each time segment and these trends could significantly change between segments thus identifying change points of trend over time. *Joinpoint regression analysis* identifies points where there were significant changes in a trend and pinpoints periods with distinct log-linear trends in HIV/AIDS incidence rates.

The *Bayesian information criterion* was used to select parsimonious model with the best fit and a maximum of 3 *Joinpoints* were specified; using *Monte Carlo Permutation method*, the test for significance finds the best fit line for each segment [16]. Slopes of the model were used to calculate APC for each trend segment as well as AAPC, 95% confidence intervals were calculated for each AAPC with significant *P*-values set at <0.05.

## Results

From 2008 to 2019, Mississippi recorded a total of 7,322 new cases of HIV and 3,044 new cases of AIDS. The source population for which incidence rates were estimated from 2008 to 2019 was obtained from Mississippi vital statistics. Most cases were reported among males (77.4% HIV, 76.91% AIDS), blacks, (77.4% HIV, 78% AIDS), age group 15-44 (78.2% HIV, 71.9% AIDS), and MSMs (50.1% HIV, 46.04 % AIDS) (Table-1).

**Table-1:** Number of new HIV/AIDS cases reported, 2008-2019

Variables	(N=7322) <sup>a</sup>	%	(N=3044) <sup>b</sup>	%
<b>Gender</b>				
Male	5666	77.38	2341	76.91
Female	1656	22.62	703	23.09
<b>Race</b>				
Black	5451	77.35	2275	77.96
White	1596	22.65	643	22.04
<b>Age group (yrs)</b>				
0-14	10	0.14	2	0.07
15-44	5729	78.24	2190	71.94
45-64	1465	20.01	792	26.02
65+	118	1.61	60	1.97
<b>Risk Factors</b>				
MSM	3671	50.14	1401	46.02
IDU	124	1.69	63	2.07
MSM and IDU	144	1.97	66	2.17
Heterosexual contact with PLWHA	1248	17.04	552	18.13
Heterosexual contact with person NOT HIV+	1202	16.42	541	17.77
Perinatal exposure	16	0.22	3	0.10
Others <sup>c</sup>	917	12.52	418	13.73

Note: <sup>a</sup>Total number of HIV cases reported; <sup>b</sup>Total number of AIDS cases reported; <sup>c</sup>others including those who contracted HIV through blood transfusion and hemophilia; MSM=Men who have sex with men; IDU= Injection drug users; PLWHA= Persons living with HIV/AIDS

The overall age-adjusted HIV incidence rate declined from 25 cases per 100,000 population in 2008 to 18.8 cases in 2019 (-24.8% decrease) whereas age-adjusted AIDS incidence rate increased from 6.4 cases per 100,000 population in 2008 to 8.2 cases in 2019 (28.1% increase) (Figure-1).

**HIV Incidence Rates by Gender**

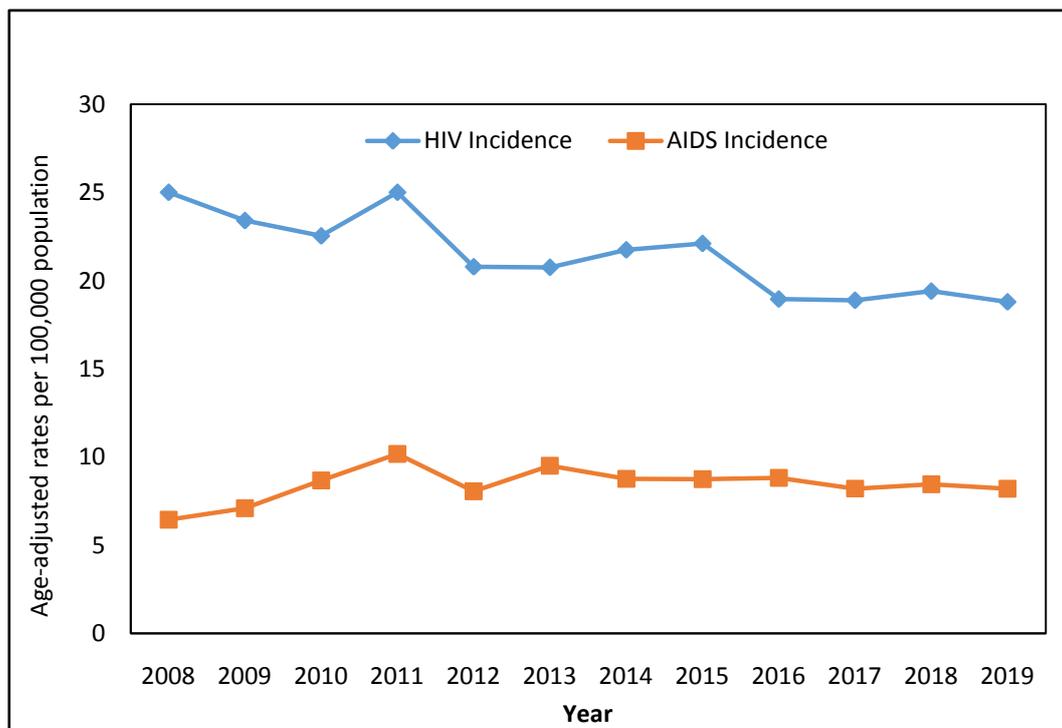
From 2008 - 2019, among females age-adjusted HIV incidence rate declined by 50% (14.2 cases per 100,000 to 7.1 cases per 100,000), with an average annual decline of -5.2% (AAPC, -5.2%, 95% CI, -7.9% to -2.5%). However, there was no significant decline among males during this period (50% decline; 36.1 cases per 100,000 to 30.7 cases per 100,000; AAPC, -1.5%, 95% CI, -3.8% to 0.9%).

The trends in males consisted of 2 segments; a nonsignificant APC of 1.4% (95% CI, -7.2% to 10.9%) during the first segment (2008-2011) and a significant APC of -2.6% (95% CI, -4.6% to -0.6%) in the second segment (2011-2019). In addition,

trends in females consisted of 2 segments; a significant APC of -10.8% (95% CI, -16.8% to -4.3%) during the first segment (2008-2012) and a nonsignificant APC of -1.9% (95% CI, -5.5% to 1.7%) in the second segment (2012-2019). In addition, trends in females consisted of 2 segments; a significant APC of -10.8% (95% CI, -16.8% to -4.3%) during the first segment (2008-2012) and a nonsignificant APC of -1.9% (95% CI, -5.5% to 1.7%) in the second segment (2012-2019). See Table-2 and Figure-2.

**Incidence Rates by Race**

From 2008- 2019, among blacks age-adjusted HIV incidence rate declined by 26.8% (47.8 per 100,000 population to 35.0 per 100,000) with an average annual decline of -2.8% (AAPC, -2.8% 95% CI, -5.1% to -0.4%). However, there was no significant decline among whites during this period (a relative decline of 12.4%; 8.9 per 100,000 population to 7.8 per 100,000) with an average annual decline of -1.0% (AAPC, -1.0%, 95% CI, -3.4% to 1.5%).



**Figure-1:** Overall age-adjusted HIV/AIDS Incidence rate per 100,000 population in Mississippi, 2008-2019

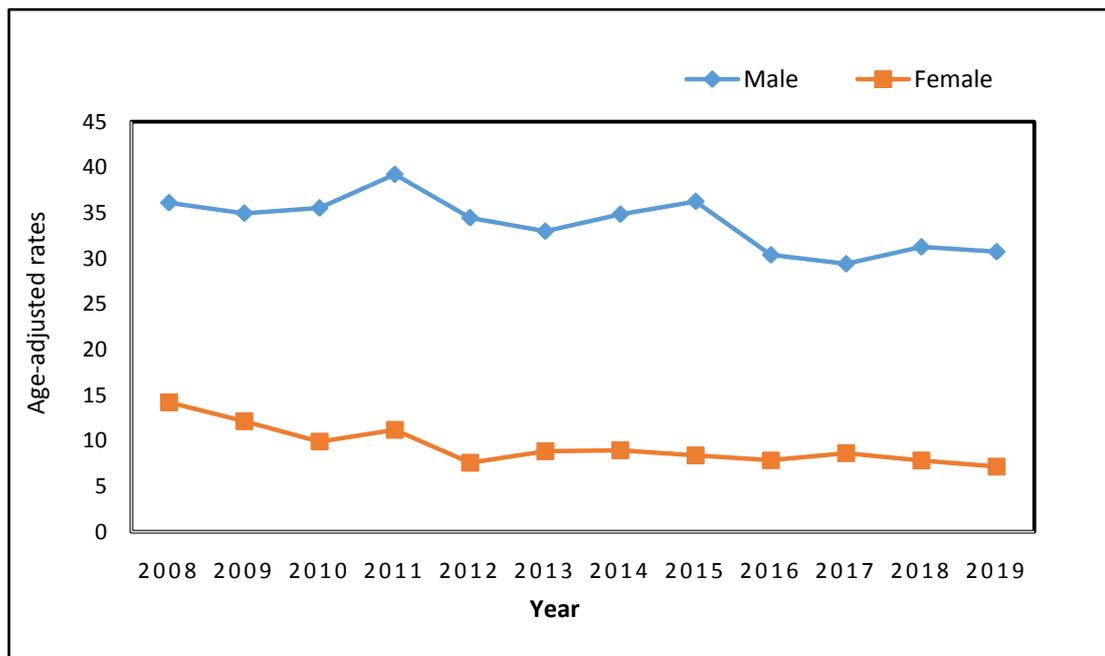
The trend among whites consisted of 2 segments; a significant APC of -2.9% (95% CI, -4.8% to -1.0%) during the first segment between 2008 and 2016 and a nonsignificant APC 4.5% (95% CI, -5.0% to 15.0%) in the second segment (2016-2019)

whereas trend among blacks consisted of 2 nonsignificant segments; an APC of -2.4% (95% CI, -4.9% to 0.2%) during the first segment (2008-2015) and -3.5% (95% CI, -9.7% to 3.1%) in the second segment (2015-2019). See Table- 2 and Figure-3.

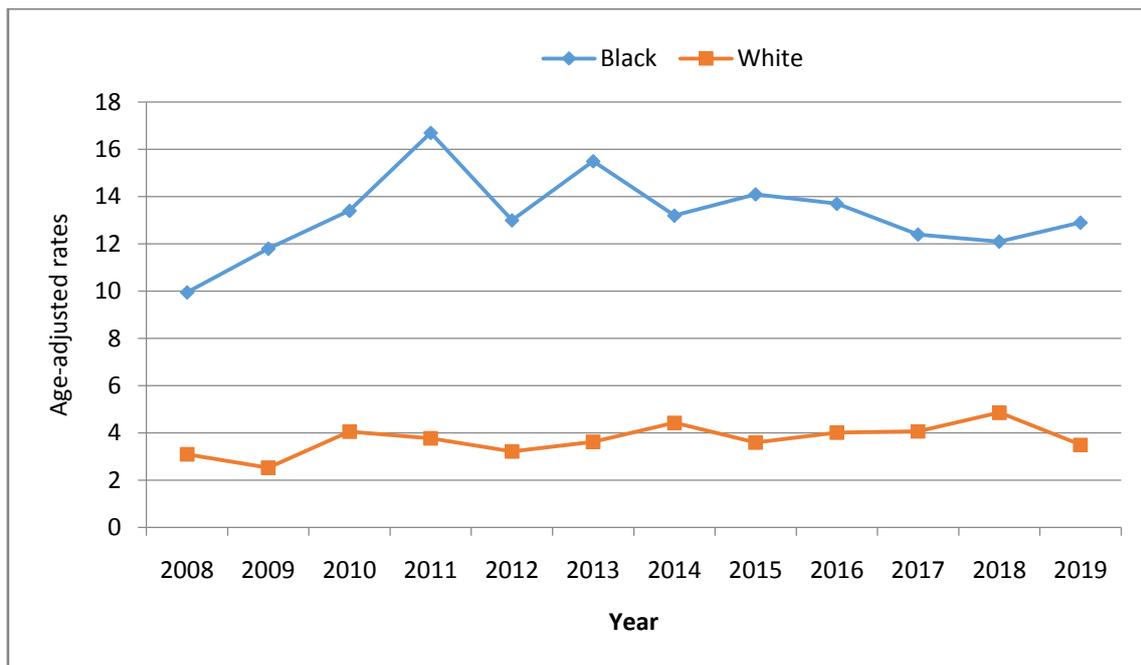
**Table-2:** Trends in HIV Incidence in Mississippi, 2008-2019

Characteristics	No. of HIV cases (age-adjusted rate)		AAPC (95% CI) 2008-2019	Trend segment1		P-value	Trend segment 2		P-value
	2008	2019		Years	APC (95% CI)		Years	APC (95% CI)	
<b>Gender</b>									
Male	508 (36.12)	420 (30.73)	-1.5(-3.8 to 0.9)	2008-2011	1.4(-7.2 to 10.9)	0.72	2011-2019	-2.6*(-4.6 to -0.6)	0.02
Female	206 (14.21)	107 (7.14)	-5.2*(-7.9 to -2.5)	2008-2012	-10.8*(-16.6 to -4.3)	<0.01	2012-2019	-1.9(-5.5 to 1.7)	0.25
<b>Race</b>									
Black	526 (47.8)	391 (35.0)	-2.8*(-5.1 to -0.4)	2008-2015	-2.4(-4.9 to 0.2)	0.06	2015-2019	-3.5(-9.7 to 3.1)	0.25
White	152 (8.9)	124 (7.8)	-1.0(-3.4 to 1.5)	2008-2016	-2.9*(-4.8 to -1.0)	<0.01	2016-2019	4.5(-5.0 to 15.0)	0.31
<b>Age group ( yrs)</b>									
0-14	2	0							
15-44	550	407	-2.2*(-4.4 to -0.1)	2008-2015	-1.6(-3.8 to 0.7)	0.15	2015-2019	-3.4(-9.1 to 2.6)	0.22
45-64	156	108	-3.6(-7.1 to 0.1)	2008 -2016	-6.6*(-9.2 to -3.9)	<0.01	2016-2019	4.9(-9.3 to 21.3)	0.47
≥65	6	11	12.3(-22.7 to 63.0)	2008-2011	81.4(-64.0 to 814.4)	0.41	2011-2019	-6.2(-16.8 to 5.7)	0.25

Note: \* Significant AAPC or APC, Average Annual Percentage Change (AAPC)



**Figure-2:** Age-adjusted HIV incidence rates per 100,000 population in Mississippi. By gender, 2008-2019



**Figure-3:** Age-adjusted HIV incidence rates per 100,000 population in Mississippi. By race, 2008-2019

**HIV Incidence Rates by Age**

Among children aged 0 to 14 years, new HIV infection declined from 2 per 100,000 population in 2008 to 0 per 100,000 population in 2019. Among people aged 15 to 44 years, new HIV infection declined from 550 per 100,000 population in 2008 to 407 per 100,000 population in 2019, a relative decline of -26% and a significant AAPC decline of -2.2% (95% CI, -4.4% to -0.2%).

The trend among this age group consisted of 2 segments; an APC of -1.6% (95% CI, -3.8% to 0.7%) during the first segment (2008-2015) and -3.4% (95% CI, -9.1% to 2.6%) in the second segment (2015-2019).

Among adults aged 44 to 65 years, new HIV infection declined from 156 per 100,000 population in 2008 to 108 per 100,000 population in 2019, a relative decline of -30.8% and an AAPC decline of -3.6% (95% CI, -7.1% to 0.1%).

In this age group, the trend consisted of 2 segments; a significant APC of -6.6% (95% CI, -9.2% to -3.9%) during the first segment (2008-2016) and a nonsignificant APC 4.9% (95% CI, -9.3% to 21.3%) in the second segment (2016-2019).

Among adults aged 65 years and above, new HIV infection increased from 6 per 100,000 population in 2008 to 11 per 100,000 population in 2019, a relative increase of 83.3% and an AAPC of 12.3% (95% CI, -22.7% to 63.0%).

The trend among this age group consisted of 2 segments; an APC of 81.4% (95% CI, -64.0% to 814.4%) during the first segment (2008-2011) and -6.2% (95% CI, -16.8% to 5.7%) in the second segment (2011-2019). See Table-2.

**AIDS Incidence Rates by Gender**

From 2008- 2019, among males age-adjusted AIDS incidence rate increased by 30% (10 cases per 100,000 to 13 cases per 100,000), with an average annual increase of 1.9% (AAPC, 1.9%, 95% CI, -0.6% to 4.4%). Also, there was an increase among females during this period (12.9% increase; 3.1 cases per 100,000 to 3.5 cases per 100,000; AAPC, 3.7%, 95% CI, -4.3% to 12.4%).

The trends in males consisted of 2 significant segments; an APC of 15.8% (95% CI, -5.9% to 26.6%) during the first segment (2008-2011) and -

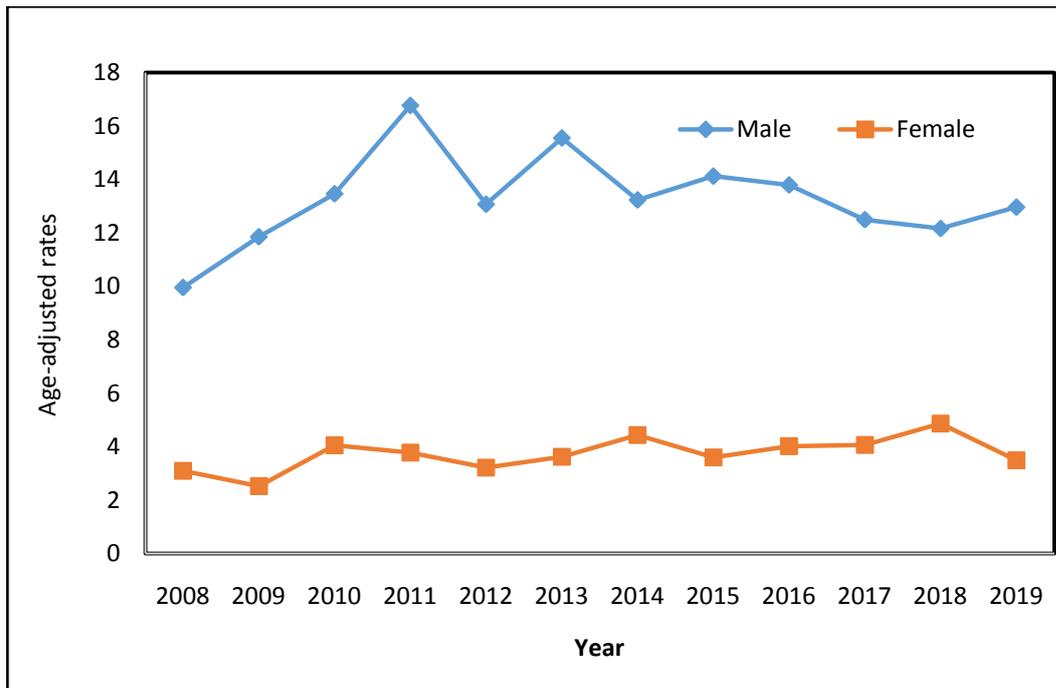


Figure 4: Age-adjusted AIDS incidence rates per 100,000 population in Mississippi. By gender, 2008-2019

Table-3: Trends in AIDS Incidence in Mississippi, 2008-2019

Parameter	No. of AIDS cases (age-adjusted rate)		AAPC (95% CI) 2008-2019	Trend segment1		P-value	Trend segment 2		P-value
	2008	2019		Years	APC (95% CI)		Years	APC (95% CI)	
<b>Gender</b>									
Male	143 (10)	180 (13)	1.9 (-0.6 to 4.4)	2008-2011	15.8*(5.9 to 26.6)	<0.01	2011-2019	-2.9*(-0.5 to -2.9)	0.02
Female	46 (3.1)	53 (3.5)	3.7 (-4.3 to 12.4)	2008-2010	13.7(-31.2 to 87.9)	0.57	2010-2019	1.6(-2.3 to 5.7)	0.37
<b>Race</b>									
Black	121 (11.1)	180 (16.1)	3.7 (-6.2 to 4.8)	2008- 2010	28.5(-31.7 to 141.9)	0.38	2010-2019	-1.1(-5.9 to 3.9)	0.61
White	51 (2.9)	47 (2.8)	-0.3 (-5.8 to 5.5)	2008-2011	8.6(-13.0 to 35.6)	0.41	2011-2019	-3.5(-7.6 to 0.9)	0.10
<b>Age group (yrs)</b>									
0-14	1	0	-						
15-44	115	164	3.9 (-0.4 to 8.5)	2008-2011	23.8*(3.8 to 47.7)	0.02	2011-2019	-2.7*(-5.1 to -0.2)	0.04
45-64	71	65	-2.1 (-4.9 to 0.8)	2008-2012	-7.1(-14.1 to 0.4)	0.06	2012-2019	0.9(-2.3 to 4.2)	0.53
≥65	2	4	6.0 (-8.5 to 22.8)	2008-2015	21.8*(4.3 to 42.2)	0.02	2015-2019	-16.9(-44.7 to 24.7)	0.32

Note: \* Significant AAPC or APC

2.9% (95% CI, -0.5% to 2.9%) during the second segment (2011-2019). However, trends in females consisted of 2 segments which were not significant; an APC of 13.7% (95% CI, - 31.2% to 87.9%) during

the first segment (2008-2010) and 1.6% (95% CI, - 2.3% to 5.7%) in the second segment (2010-2019). See Table-3 and Figure-4.

**AIDS Incidence Rates by Race**

From 2008- 2019, there was no significant change in age-adjusted AIDS incidence rate among whites and blacks. The age-adjusted AIDS incidence rate among blacks increased by 45% (11.1 per 100,000 population to 16.1 per 100,000) with an average annual increase of 3.7% (AAPC, 3.7% 95% CI, -6.2% to 14.8%). Among whites, the age-adjusted AIDS incidence rate declined slightly by 3.4% (2.9 per 100,000 population to 2.8 per 100,000) with an average annual decline of 0.3% (AAPC, -0.3%, 95% CI, -5.5% to 5.8%).

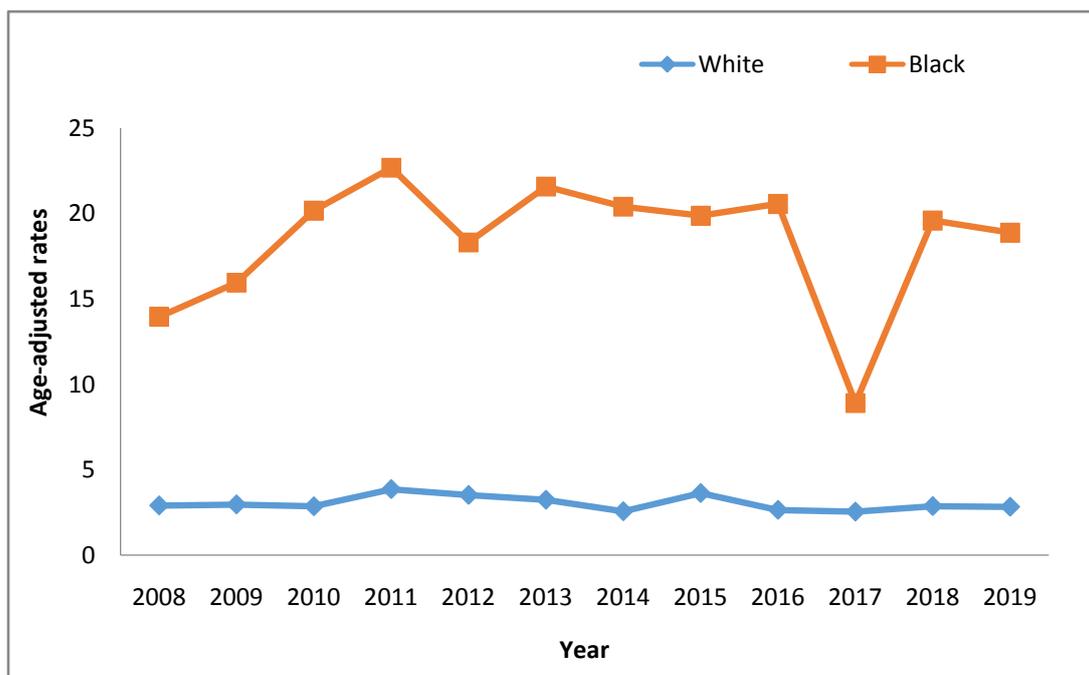
The trend among blacks consisted of 2 non-significant segments; an APC of 28.5% (95% CI, -31.7% to 141.9%) during the first segment (2008-2010) and -1.1% (95% CI, -5.9% to 3.9%) in the second segment (2010-2019). Also, trend among whites consisted of 2 non-significant segments; an APC of 8.6% (95% CI, -13.0% to 35.6%) during the first segment (2008-2011) and -3.5% (95% CI, -7.6% to 0.9%) in the second segment (2011-2019). See Table-3 and Figure-5.

**AIDS Incidence Rates by Age**

Among children aged 0 to 14 years, AIDS diagnosis decreased from 1 case per 100,000 population in 2008 to 0 per 100,000 population in 2019. Among people aged 15 to 44 years, AIDS diagnosis increased from 115 per 100,000 population in 2008 to 164 per 100,000 population in 2019, a relative increase of 42.6% and an AAPC of 3.9% (95% CI, -0.4% to 8.5%).

The trend among this age group consisted of 2 significant segments; an APC of 23.8% (95% CI, 3.8% to 47.7%) during the first segment (2008-2011) and -2.7% (95% CI, -5.1% to -0.2%) in the second segment (2011-2019).

Among adults aged 44 to 65 years, AIDS diagnosis declined from 71 per 100,000 population in 2008 to 65 per 100,000 population in 2019, a relative decline of -8.5% and an AAPC decline of -2.1% (95% CI, -4.9% to 0.8%). In this age group, the trend consisted of 2 segments; an APC of -7.1% (95% CI, -14.1% to 0.4%) during the first segment (2008-2012) and 0.9% (95% CI, -2.3% to 4.2%) in the second segment (2012-2019).



**Figure-5:** Age-adjusted AIDS incidence rates per 100,000 population in Mississippi. By race, 2008-2019

Among adults aged 65 years and above, AIDS diagnosis increased from 2 per 100,000 population in 2008 to 4 per 100,000 population in 2019, a relative increase of 100% and a significant AAPC of 6.0% (95% CI, -8.5% to 22.8%). The trend among this age group consisted of 2 segments; a significant APC of 21.8% (95% CI, 4.3% to 42.2) during the first segment (2008-2015) and a nonsignificant APC of -16.9% (95% CI, -44.7% to 24.7%) in the second segment (2015-2019; Table 3).

### Discussion

In Mississippi across all age groups, age-adjusted HIV incidence rate declined by 24.8% between 2008 and 2019; however, the timing and magnitude of decline differed by gender, race, and age group. Our finding of declining age-adjusted HIV incidence rates is consistent with findings on national trends of new HIV infection reported in 2017 (17) where an annual decline of 4.0% was reported. Various reasons have been documented for the decline in HIV incidence, which includes improved care and prevention services, increased HIV counseling and testing, advanced ART, estimated recency of infection, and reducing HIV incidence among MSMs and other high-risk groups [17,18]. Furthermore, data from CDC highlighted a significant decline of 8% in HIV incidence rate between 2016-2019, however, decline was highest among women, whites, and adults 55 years and above [19, 20, 21]. Reports showed that Mississippi has made considerable progress in reducing new HIV infection and improving diagnosis/testing, as well as quick linkage to care. Knowledge of HIV status is important for an individual to gain access to quality medical care which in turn can improve quality of life, modify health behaviors that could prevent HIV transmission to others, improve quality of life, and extend life expectancy [22]. Unfortunately, about 15% of HIV-positive individuals are not aware of their HIV status [23].

In addition, HIV incidence among Mississippians changed between 2008-2019, age-adjusted HIV incidence rate decreased across all age groups, races, and gender categories. Many studies have reported that the number of new HIV infections in the US has leveled off which could be due to increased awareness about HIV counseling and

testing as well as achievement of viral load suppression thus resulting in undetectable and untransmissible viral load [22,24,25,26,27,28]. Also, the new HIV infection was higher among males and blacks when compared to their respective counterparts of the same age group. Adolescents and adults between age 15- 44 years had the highest age-adjusted HIV incidence rates. The lowest rate was observed among females and adults aged 65 years and above. Of the mode of transmission or risk factors category, the highest number of new cases reported between 2008-2019 were among MSM (3,971), followed by heterosexual contact with PWA (1,248), and heterosexual contact with person not HIV positive (1,202). These findings are in line with a national report from 2009- 2018 which indicated considerable progress, an overall decline in new HIV incidence [29].

Similarly, despite overall decline some reports also highlighted disparities in new HIV incidence with blacks, MSMs, adult females who have heterosexual contacts, and age group 25-34 years bearing the highest burdens which are even more prominent in the southern states and the District of Columbia [29,30,31]. The decline in HIV incidence rate reported nationally can be attributed to proven effective HIV prevention interventions some of which include increased HIV testing, quick linkage to care, ART, viral load suppression, increased access to condoms and sterile syringes, increased access to PREP and PEP, education of PWA targeted at reducing risk behaviors and transmission from person to person, education and prevention program to high risk groups, proper screening of blood and body fluids before transfusion, substance abuse treatment, as well as testing and treatment for other sexually transmitted infections. The strategies have averted over 350,000 new HIV infection in the US [2,32]. This decline in HIV incidence rate in Mississippi can also be attributed to increased funding of CDC through Ending HIV Epidemic (EHE). This highlights an improvement in Mississippi's efforts to reducing new HIV infection which not only targets increasing HIV screenings and testing sites but also includes increase access of Mississippians to pre-exposure prophylaxis (PREPs), condoms, providers/healthcare workers training, HIV information,

education, and communication (IEC) materials, community outreaches.

Contrastingly, this study findings also indicated that overall age-adjusted AIDS incidence and death rate increased significantly by 28.1% and 190% respectively. Age adjusted AIDS incidence was highest among males and people between age 15 to 44 years. The upward trend of AIDS incidence highlighted that Mississippi needs to more efforts to create awareness and educate Mississippians about the management of HIV infection to slow disease progression. Males, African Americans, gays, MSMs, adolescents and adults between age 14-44 years were mostly affected by HIV/AIDS in Mississippi. Researchers and medical practitioners have attributed systemic poverty, homophobia and transphobia, late diagnosis and late linkage to care, lost in care or loss to follow up, nonadherence to ART medications, lack of insurance, stigmatization, and unavailability of support group as factors which increase AIDS incidence and death rates [33,34]. In 2013, President Obama signed an executive order giving directives to all federal agencies to prioritize and support HIV Care Continuum Initiative. The initiative which all states including Mississippi benefitted from aimed at accelerating efforts to improve the number of people living with HIV (PLWHIV) to move from testing to treatment and ultimately to achieve viral (The White House [35].

Also, efforts to collectively combat HIV/AIDS in the U.S. recorded progress. For example, in 2013, CDC launched a national bilingual campaign tagged "Reasons/Razones" to encourage bisexual and Latino gay men to get tested for HIV and consider their reasons for getting tested. In addition, in 2017, communities and religious bodies garnered more support, the first national Faith HIV & AIDS Awareness Day which involved collaborations from Christians, Muslims, Jewish, Hindu, Sikh, Buddhist, and Baha'i was launched. The main goal of the organization was to publicly take a stand against stigma within their respective congregations and to create HIV/AIDS awareness in their communities [36]. These collective efforts have significantly contributed to reducing HIV nationally and regionally. Mississippi's integrated HIV prevention and care plan implemented similar intervention

strategies to curb new HIV infection and notable improvement has been reported so far in Mississippi especially with prevention of mother-to-child transmission recording the most successful based on this study findings. Furthermore, findings from this study indicated a 100% decline in pediatric HIV/AIDS incidence between 2008-2019 and no HIV/AIDS related deaths were recorded during this period [37,38]. In 2020, Mississippi received a federal grant to aid the state's effort of fighting HIV epidemic. One of the goals of the Office of National AIDS policy was to reduce disparities in new HIV diagnoses by at least 15% by year 2020, however, this goal was not met, the disparity ratio increased rather than decrease [39]. It is worthy to note that more interventions targeting AIDS is urgently needed. Mississippi needs comprehensive collective efforts to improve HIV prognosis and reduce AIDS incidence, frequency of testing and counseling in at-risk communities is very paramount.

This study has some limitations. First, only people with confirmed HIV diagnosis in the state of Mississippi were included which may have left out individuals who are positive but unaware of their current HIV status. Second, given the nature of the study, there is limited capacity to measure association. Information for some variables collected from eHARS were self-reported, therefore it may be subjected to recall bias as well as under-reporting and over-reporting. Third, some variables in the dataset like education and marital status, had too much missing information which may affect the final interpretation of the results.

The major strength of this study was its use of statewide HIV/AIDS surveillance data. Also, the study analyzed trends and observed changes over time. Reliability is the ability of an instrument to consistently measure the variable of interest. All variables measured and reported including lab reports in the eHARS database are reliable and consistent not only in the U.S. but globally. The algorithm for HIV/AIDS case definition is consistent with national and global standards. Generalizability, the result of this analysis can be generalized to all PLWHA in Mississippi and the southern states.

## Conclusions

From 2008-2019, the overall age-adjusted HIV incidence rate declined significantly but the magnitude and timing of the recorded decline varied by age, race, and sex. HIV incidence rates increased significantly among males, MSMs, and blacks; AIDS incidence rates increased significantly among males and people between age 15 to 44 years; HIV/AIDS death rates increased significantly among men from year 2008 to 2014 and among women from 2008 to 2017. Also, overall age-adjusted death rate was highest among people ages 15 to 44 years.

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