

Introduction

Since 2005, Michigan has participated in a Centers for Disease Control and Prevention (CDC) funded initiative called STARHS (Serologic Testing Algorithm for Recent HIV Seroconversion). The goal of STARHS is to estimate HIV incidence, or number of new infections occurring each year, nationally and at the state level. HIV incidence data differ from traditionally reported prevalence data. Incidence data estimate new infections in a particular year. Prevalence data measures everyone living with HIV, including newly diagnosed cases that may have been infected recently or years earlier.

HIV incidence data have important public health implications for evaluating HIV intervention and prevention programs for effectiveness; for targeting prevention efforts associated with ongoing transmission; and for allocating resources to populations in greatest need of prevention efforts.

In 2008, HIV incidence rates were estimated nationally and in the state of Michigan for the year 2006. Since that time, more data have been collected and the estimation procedure used nationwide has undergone significant refinements. Using these improved methods, CDC released an updated estimate for 2006 on August 3, 2011, along with estimates for 2007 through 2009. The national data come from an incidence surveillance group comprised of 16 states, including Michigan, and two cities. Together, these sites account for 61% of AIDS cases in the U.S.¹

Presented in this document are Michigan's estimated incidence rates for 2006 through 2009, based on the revised estimation procedure. The revised estimate for 2006 should not be compared to the first estimate for 2006, which was generated in 2008, as the methods used to create the estimates have changed significantly.

Methods

STARHS uses results of the BED Assay (a laboratory test for incidence), and data collected on newly diagnosed cases' testing history and antiretroviral use to estimate incidence for the whole population, including those not yet diagnosed. The BED incidence test is performed on available leftover serum from diagnostic, confirmed-positive specimens. The remnant serum is sent without name to the New York State STARHS Lab for testing after HIV infection has been confirmed. If the original diagnostic specimen is not available, a subsequent blood specimen obtained within three months of HIV diagnosis is obtained for testing.

The BED Assay is an enzyme immunoassay that classifies each HIV infection as recent or long-standing based on the amount of HIV-specific antibody present in each sample. Test results are not reliable enough to report on an individual basis, but across a large population they do provide the foundation to estimate the number and rate of new HIV infections occurring each year in the population.

We used a set of statistical programs provided by CDC to estimate HIV incidence at the state level^{1,2,3}. These programs use a stratified extrapolation approach (inference of incidence rates by subgroups) with multiple imputation (statistical technique for analysis of incomplete data). For 2006 to 2009 estimates, reporting delay weights were calculated to account for cases diagnosed but not yet reported to the surveillance program by December 2010.

Rates were calculated for all cases greater than 12 years of age at infection using the estimated population for each year found in the July 2009 State Characteristics Population Estimates

KEY FINDINGS

- Michigan's HIV incidence rates are lower than national rates and stable overall
- Michigan had an average of 754 new infections per year for an average estimated infection rate of 9.0 cases per 100,000 population, ages 13 and older between 2006 and 2009
- Consistent with national rates, Michigan males, blacks, 30 to 39 year olds, and MSM have higher incidence rates/counts

from the U.S. Census Bureau⁴. Data are reported for subgroups (such as sex, race, age and risk) where there are a minimum of 200 reported HIV cases, 40 incidence tests (or 20% completeness), and 10 recent incidence results. Age groups are based on *age at infection*, which is derived from age at diagnosis, BED result, and whether the person was a new tester or repeat tester. Risk groups include men who have sex with men (MSM), injection drug users (IDU, including MSM/IDU), and heterosexuals. Since reliable denominator data is not available for risk groups, rates cannot be calculated for these groups. A z-test was used to test for significant differences in incidence rates between years for sex, race, and age, and for significant differences in number of infections between years for risk, with a significance level of $p < 0.05$.

Results

Incidence Estimates Overall

Michigan's HIV incidence rates are lower than those seen nationally and were stable through the four year period of 2006 to 2009 Table [1]. Michigan's overall incidence rates ranged from 8.1 to 11.1 infections per 100,000 population, while the overall national rate ranged from 19 to 22.5 infections per 100,000 population. There were no significant changes overall in Michigan or in any of the reported subgroups. Consistent with national rates, Michigan males, blacks, 30 to 39 year olds, and MSM have the highest incidence rates/counts. We are unable to report estimated counts or rates for Hispanics and other race/ethnic groups due to insufficient data to produce reliable estimates. For the same reason, we are unable to report an estimated number and percent of new infections for IDU in 2006.

Table 1: Estimated Number and Rate of New HIV Infections in Michigan and the U.S., 2006-2009

Category	2006				2007				2008				2009			
	N [¥]	%	Rate [^]	U.S. Rate ^Σ	N [¥]	%	Rate [^]	U.S. Rate ^Σ	N [¥]	%	Rate [^]	U.S. Rate ^Σ	N [¥]	%	Rate [^]	U.S. Rate ^Σ
Sex																
Male	548	79	13.4	30.1	770	83	18.9	34.9	517	77	12.7	29	531	74	13.1	29.8
Female	150	21	3.5	9.8	154	17	3.6	10.7	157	23	3.7	9.5	188	26	4.4	8.6
Race/ethnicity																
White	221	32	3.3	9.8	327	35	5.0	11.2	174	26	2.6	8.7	287	40	4.4	9.1
Black	373	54	33.0	72.7	522	57	46.2	79.2	440	65	39.0	73.2	389	54	34.6	69.9
Age																
13-29	239	34	10.1	21.8	379	41	16.0	27.2	298	44	12.7	26.5	298	41	12.8	25.8
30-39	184	26	14.0	37	276	30	21.6	27.9	178	26	14.2	34.2	161	22	13.1	32.2
40+	274	39	5.9	N/A [§]	269	29	5.7	N/A [§]	198	29	4.2	N/A [§]	261	36	5.5	N/A [§]
Risk																
MSM	466	67	N/A	N/A	630	68	N/A	N/A	447	66	N/A	N/A	456	63	N/A	N/A
IDU	N/A	N/A	N/A	N/A	104	11	N/A	N/A	108	16	N/A	N/A	144	20	N/A	N/A
Hetero-sexual	154	22	N/A	N/A	189	20	N/A	N/A	117	17	N/A	N/A	121	17	N/A	N/A
TOTAL	697		8.3	19.8	924		11.1	22.5	674		8.1	19	720		8.6	19

¥ Numbers have been adjusted for reporting delay.

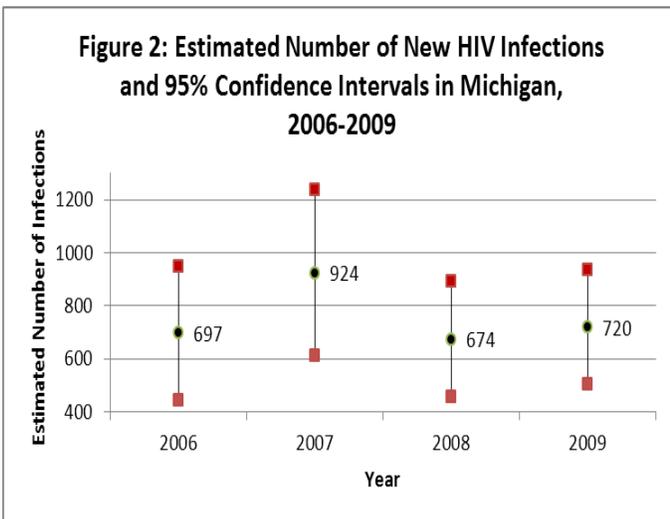
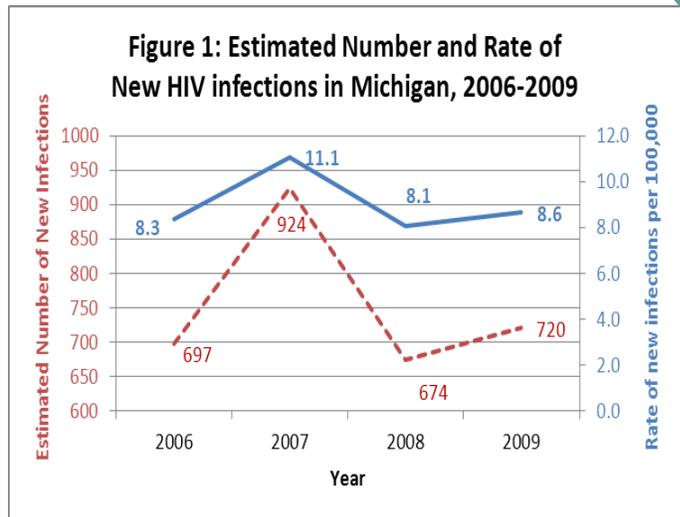
^ Rate per 100,000 population for ages 13 and older, 2009 intercensal estimates⁴.

Σ U.S. Rates are from "Estimated HIV Incidence in the United States, 2006-2009" in the online journal, PLoS One, August 2011, Volume 6, Issue 8, e17502. (www.plosone.org)

§ National data did not include a 40+ age group. Rates were reported for 40-49 and 50-99 age groups.

Both nationally and in Michigan, 2007 stands out as an unusual year where estimated count and rate of new infections are higher than in other years Figure [1]. Counts and rates return to more typical levels in 2008. No statistically significant changes in estimates of recent infection were detected for 2006-2009 in Michigan, but in the national data a significant increase in 2007 was followed by a significant decrease in 2008.

An explanation has not yet been found for the 2007 increase, either in Michigan or nationally. Michigan’s HIV/AIDS Prevention and Intervention Section (HAPIS) did not have additional outreach efforts for increased testing in 2007, and there have been no changes in state reporting policies in Michigan to explain the 2007 increase. In 2006, however, CDC recommended screening all patients ages 13 to 64 in health care settings that have a prevalence of undiagnosed infection greater than 0.1%. In October 2007, CDC initiated the Expanded Testing Initiative (a three-year plan to conduct 1.5 million HIV tests and identify 20,000 new HIV infections annually, targeting disproportionately impacted populations, particularly African Americans). Despite this, CDC has concluded that changes in testing patterns and reporting practices do not account for the increases seen nationally in 2007. There may have been an actual increase in incidence between 2007 and 2008; however, overall rates were stable from 2006 to 2009.

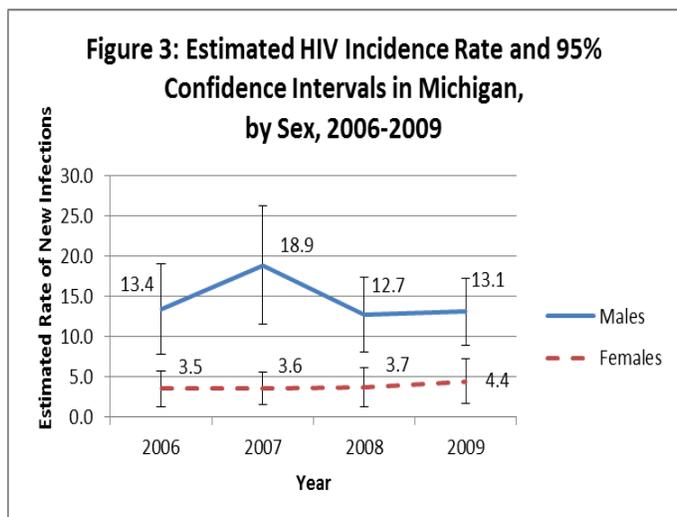


Another method to demonstrate that number of new infections in Michigan did not change significantly over time is to show confidence intervals. The 95% confidence intervals (95% certainty that the true number falls between the upper and lower values) for the number of new HIV infections from 2006 to 2009 are shown in Figure [2]. Note that the confidence intervals range of values overlap each year and are large due to the estimation process.

Incidence Estimates by Demographic Groups

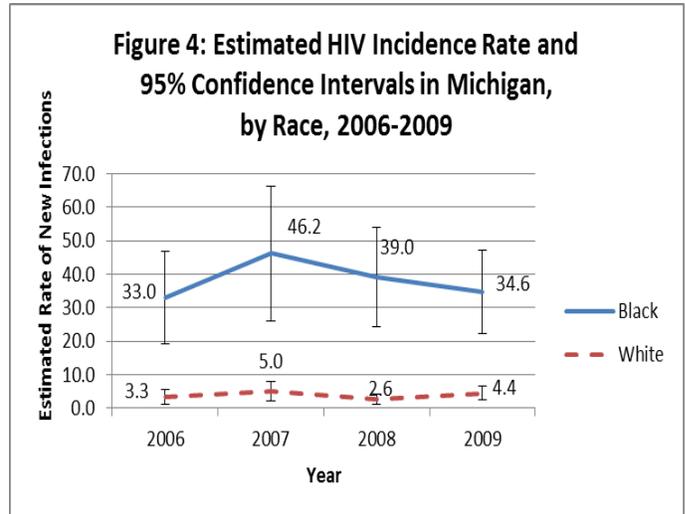
Incidence Estimates by Sex

There were no statistically significant changes in estimated rates of new infections for males or females between 2006 and 2009 Figure [3]. Note how 95% confidence intervals shown by brackets for each data point overlap across each subgroup, demonstrating no significant change from year to year. Estimated rates of recent infection for males in Michigan ranged from 3.0 to 5.25 times the rates for women. This is comparable to differences between the sexes seen nationally, where rates for men are 3.1 to 3.5 times the rates for women.



Incidence Estimates by Race

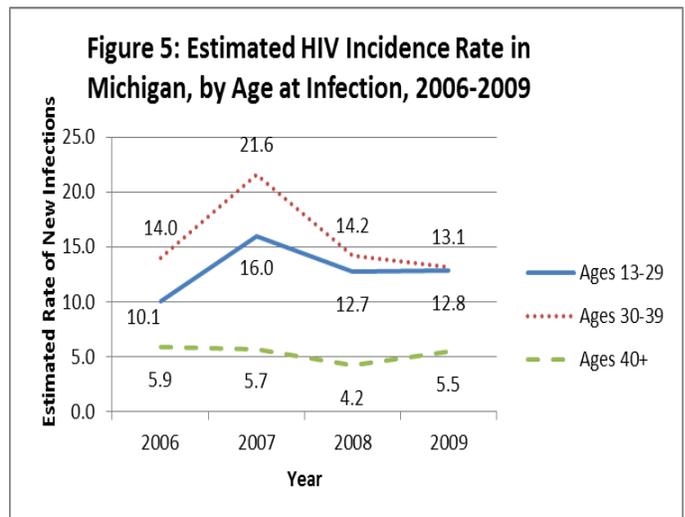
There were no statistically significant changes in estimated rates of new infections for any race group between 2006 and 2009 Figure [4]. Note how 95% confidence intervals shown by brackets for each data point overlap across each subgroup, demonstrating no significant change from year to year. Estimated rates of new infection for blacks in Michigan ranged from 7.9 to 15 times the rates among whites. This disproportionate impact on blacks is seen across the four-year period and is more variable in Michigan than national data. Nationally, rates among blacks were 7.1 to 8.4 times the rate among whites.



Incidence Estimates by Age Group

There were no statistically significant changes in estimated rates of new infections for any age group between 2006 and 2009 Figure [5]. 95% confidence intervals, Table [2], overlap across each subgroup, demonstrating no significant change from year to year. In Michigan, as at the national level, the highest rates are among 30-39 year olds.

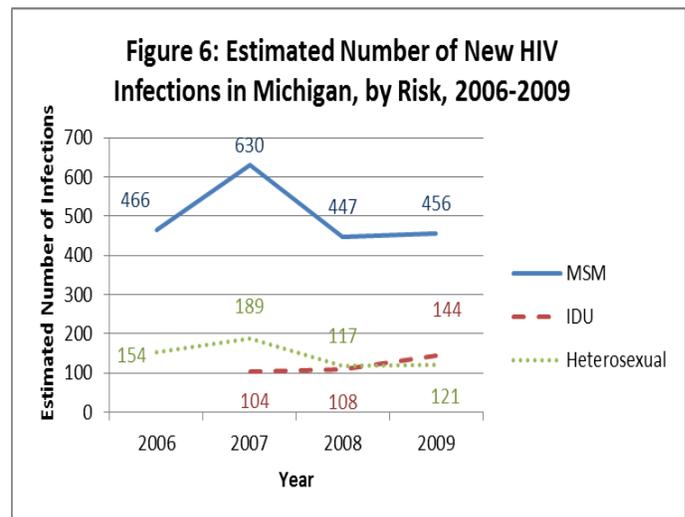
	13-29	30-39	40+
2006	5.2 - 14.9	5.3 - 22.6	2.3 - 9.4
2007	9.2 - 22.8	8.1 - 35.0	1.5 - 9.9
2008	6.7 - 18.7	3.7 - 24.7	2.0 - 6.3
2009	6.1 - 19.6	2.4 - 23.8	4.0 - 6.9



Incidence Estimates by Risk Group

There were no statistically significant changes in the estimated number of new infections per year for any risk group between 2006 and 2009 Figure [6]. 95% confidence intervals Table [3] overlap across each subgroup, demonstrating no significant change from year to year. As in the national data, MSM represent the largest number of new infections. There were an insufficient number of new infections among IDUs in

	MSM	IDU	HETERO
2006	262 - 669	N/A	44 - 263
2007	377 - 883	0 - 208	81 - 297
2008	259 - 636	14 - 202	35 - 199
2009	299 - 613	13 - 275	50 - 191



2006 to produce reliable estimates for the IDU risk group in that year. The gradual increase in number of IDU cases seen between 2007 and 2009, though not statistically significant, warrants close scrutiny in the future.

Comparing Incidence Estimates to Trends in New Diagnoses in Michigan

Estimates of HIV Incidence Rates in Michigan, 2006-2009 (“Incidence”) estimates new infections per year while the *Annual Review of HIV Trends in Michigan 2006-2010*⁵ (“Trends”) evaluates new diagnoses each year. When comparing these two reports, similarities are seen. Both documents demonstrate that infection rates in Michigan remain stable overall. The Trends analysis found an average of 803 new diagnoses per year and an average rate of 8.1 cases per 100,000 population, while incidence estimates show an average of 754 new infections per year and an average estimated infection rate of 9.0 cases per 100,000 population, ages 13 and older.

Several differences are also seen between the two reports. The Trends report demonstrated significant changes over a five-year period for several groups: increases among males and 20-29 year olds and decreases in females overall, black females, females of “other” races (all races excluding white or black), 35-44 year olds, IDU, MSM/IDU, and heterosexuals. In contrast, incidence data does not show any significant changes in any subgroup over the four year period. This may be due to the incidence estimation process, which results in large confidence intervals that may mask any significant changes that may be present.

Differences in the methodologies between the Trends report and this Incidence document include:

- Incidence data reflects cases diagnosed between 2006 and 2009; the Trends report spans 2006 to 2010.
- Incidence data measures *age at infection*, excluding those under the age of 13; Trends includes all age groups but uses *age at diagnosis*.
- The documents, created at different points in time, use different census data. Incidence uses the 2009 Intercensal Estimates⁴ while Trends uses the CDC 2010 Bridged-Race Population Estimates.⁶ Thus, denominators for rates vary slightly.
- The reports have different age groupings. Incidence age groups are 13-29, 30-39 and 40 years and over at infection. Trends age groups are 0-12, 13-19, with subsequent 5 year age groups through 55-59 years, and 60 years and over at diagnosis.
- Incidence data group MSM-IDU cases with IDU; MSM/IDU are a separate risk group in the Trends report.
- Incidence estimates are calculated based on programming developed by CDC, which is not applicable when analyzing trends in new diagnoses.
- Incidence estimates utilize a z-test to test for significance; Trends uses negative binomial regression.

Similarities in Incidence and Trends methodology include:

- Both analyses use the same race groupings (white, black, other).
- Both employ reporting delay weights to account for cases diagnosed but not reported to surveillance by a certain date.

In summary, incidence data define where the epidemic is heading by identifying who is recently infected. Trends in new diagnoses describe the path of the epidemic in recent years as another way to study its trajectory. Both sets of data should be considered when determining how best to interrupt ongoing transmission of HIV. However, until incidence data mature, trends in new diagnoses should continue to be used to describe changes over time.

¹ “Estimated HIV Incidence in the United States, 2006-2009” in the online journal, PLoS One, August 2011, Volume 6, Issue 8, e17502. (www.plosone.org)

² Hall HI, Song R, Rhodes P, et al; HIV Incidence Surveillance Group. Estimation of HIV incidence in the United States. *JAMA* 2008;300:520-9. (<http://jama.ama-assn.org/content/300/5/520.full>)

³ Karon JM, Song R, Brookmeyer R, Kaplan EH, Hall HI; Estimating HIV incidence in the United States from HIV/AIDS surveillance data and biomarker HIV test results. [Journal Article, Research Support, N.I.H., Extramural] *Stat Med* 2008 Oct 15; 27(23):4617-33.

⁴ U.S. Census Bureau, FactFinder-1 2009 Intercensal Estimates³: http://factfinder.census.gov/servlet/DTTable?_bm=y&-context=dt&-ds_name=PEP_2009_EST&-mt_name=PEP_2009_EST_G2009_T001&-CONTEXT=dt&-

⁵ Annual Review of HIV Trends in Michigan, 2006-2010: http://www.michigan.gov/mdch/0,4612,7-132-2940_2955_2982_46000_46003-36304--,00.html

⁶ CDC 2010 Bridged-Race Population Estimates http://www.cdc.gov/nchs/nvss/bridged_race/data_documentation.htm