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Trends in human immunodeficiency virus diagnoses among men who have sex with men in North America, Western Europe, and Australia, 2000–2014

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Abstract

Purpose: The aim of the article was to investigate recent trends in human immunodeficiency virus (HIV) diagnosis rates among men who have sex with men (MSM) in high-income countries in North America, Western Europe, and Australia.

Methods: Data on annual rates of HIV diagnoses among MSM aged 15 to 65 years from 2000 to 2014 were collected from 13 high-income countries. Joinpoint regression software was used to empirically determine country-specific trend periods. Trends in HIV diagnosis rates and in the proportion of diagnoses occurring in young MSM aged 15 to 24 years were analyzed using Poisson regression and log-binomial regression, respectively.

Results: Six countries experienced an increasing trend from 2000 to 2007–08 followed by either a stable or declining trend through 2014. Five countries had recently increasing trends, and two countries had one stable trend from 2000 to 2014. All 13 countries experienced increases in the proportion of diagnoses occurring in young MSM.

Conclusions: Since 2008, half of the 13 high-income countries examined experienced stable or decreasing trends. Still, some countries continue to experience increasing HIV trends, and young MSM are increasingly represented among new diagnoses. Efforts to support early sexual health promotion, reduce barriers to pre-exposure prophylaxis, and improve care engagement for young MSM are critical to addressing current HIV trends.

Keywords

HIV; HIV diagnoses; HIV trends; International; High-income countries

Introduction

In high-income countries, the human immunodeficiency virus (HIV) has predominantly affected gay, bisexual, and other men who have sex with men (MSM). In 2014, MSM accounted for 52% to 70% of HIV diagnoses in North America, 44% in Western Europe, and 75% in Australia [1–4]. HIV prevalence in MSM is estimated at 15% in North America, 6% in Western Europe, and 17% in Australia [5,6]. During the 1990s, increases in HIV diagnoses earlier in the decade were followed by decreases in diagnoses for some subgroups of MSM in later years due in part to reductions in risk behaviors associated with HIV infection [7]. Yet in the late 1990s and early 2000s, higher rates of syphilis among MSM in North America, Western Europe, and Australia led researchers to hypothesize that sexual risk behaviors may be increasing again and could lead to increases in HIV infections among MSM [8,9].

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We previously examined this hypothesis by analyzing HIV trends from 1996 to 2005 in MSM from eight high-income countries in North America, Western Europe, and Australia [10]. HIV notification rates in MSM slightly declined from 1996 to 2000 and then increased by 3.3% per year from 2000 to 2005; increasing trends were consistent across all countries considered [10]. Other surveillance data supported that this increase was likely attributed to changing sexual behaviors because a simultaneous increase in syphilis diagnoses was observed and no consistent increasing trend in HIV testing was found [10]. These findings suggested a re-emerging HIV epidemic among MSM and encouraged interventions to reduce HIV transmission and risk behaviors in this population.

We sought to further our previous analysis by evaluating trends in HIV diagnoses in MSM through 2014 and by incorporating data from additional high-income countries in the regions of North America, Western Europe, and Australia. The 13 high-income countries included in this analysis have had established HIV surveillance systems since early in the HIV epidemic. An important drawback to existing analyses of HIV trends in MSM is that many assume one uniform linear trend over the entire period of interest [11]. Therefore, to advance our understanding and interpretation of trends across a diverse group of countries and regions, we aimed to (1) evaluate recent HIV trends among MSM from 2000 to 2014, allowing each country to vary individually in the number and direction of trend periods, (2) compare these trends across the 13 countries, and (3) categorize observed trend typologies to develop conclusions about recent HIV trends in MSM.

Methods

We obtained HIV, sexually transmitted infection (STI), and behavioral surveillance data from 13 high-income countries in North America, Western Europe, and Australia to evaluate HIV trends in MSM from 2000 to 2014. Data on annual HIV diagnosis rates among MSM aged 15 to 65 years were collected from HIV case surveillance systems in 13 countries (Australia, Belgium, Canada, Denmark, France, Germany, The Netherlands, Portugal, Spain [Catalonia only], Sweden, Switzerland, the United Kingdom, the United States). Annual HIV diagnosis rates were calculated as the number of HIV diagnoses among MSM aged 15 to 65 years per 100,000 same-aged males. The number of HIV diagnoses among all MSM was also reported by 5-year age categories. The annual proportion of HIV diagnoses occurring in young MSM was the number of diagnoses in young MSM (aged 15–24 years) divided by the total number of diagnoses in MSM of all ages. Additional secondary outcomes included the proportion of MSM reporting condomless anal sex (CAS) in the past 12 months overall and by partner type (steady/main, non-steady/casual), the proportion of MSM reporting HIV testing in past 12 months, as well as rates and male-to-female case ratios for STIs including primary and secondary syphilis and gonorrhea. Behavioral data came from HIV behavioral surveillance systems or local surveys in each country.

We sought to empirically identify significant changes in trends for each country while permitting each country to vary in the number and direction of trend periods. Therefore, we used Joinpoint regression software to determine unique trend periods in the data for each outcome and country, using standard software specifications [12,13]. The Joinpoint regression software applies Bayesian statistical methods including Monte Carlo permutation

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tests and grid search methods to statistically determine when significant changes in the trend occur [14]. Trends in the annual HIV diagnosis rates were analyzed using Poisson regression, with year as the main independent effect and the natural log of the population size of same-aged males as the offset. Trends in the proportion of diagnoses among young MSM were analyzed with a log-binomial model with year as the main effect. Secondary outcomes based on aggregate proportions were analyzed using log-normal regression. Beta estimates were transformed to obtain estimated annual percent changes (EAPCs) and their 95% confidence intervals for each trend period (EAPC = $(e^{\beta} - 1)*100$). Based on the identified trend periods using Joinpoint regression analyses and EAPCs, we then qualitatively assessed patterns in trends across the 13 countries. Four clear patterns emerged, and we categorized these as the most common HIV trend typologies across the 13 countries.

Because HIV surveillance systems operate slightly differently in each country, some indicators were not available for all countries in all years, and some reporting differences existed. For secondary outcomes, we included countries that had two or more data points. Details on data sources and availability are described in Supplementary Material–Table A. Figures were created using R's ggplot2 package; observed data points are depicted in the figures and lines represent the fitted trends.

Results

Trends in HIV diagnoses

Four trend typologies in HIV diagnosis rates among MSM were identified (Table 1, Fig. 1). One typology had two main trend periods, with an increasing trend from 2000 to 2007, followed by a stable trend through 2014 ("increasing, stable"; Belgium, Germany, Sweden). A second typology had a significant increasing trend from 2000 to 2008, followed by a significant decreasing trend from 2008 to 2014 ("increasing, decreasing"; Netherlands, Switzerland, United States). The United States trend was categorized as such based on the previous analyses documenting increasing trends in diagnoses among MSM through 2005, paired with our recent analyses of data from 2008 to 2014, as consistent trend data were only available for these years. A third typology was defined by one stable trend throughout the entire period in two countries ("stable"; Canada, Denmark). Five countries had an increasing trend in recent years ("recently increasing"; Australia, France, United Kingdom, Portugal, Spain [Catalonia]). More specifically, trends in Australia and France were characterized by three trend periods with an increasing trend from 2000 to 2005, a stable trend from 2005 to about 2009/2011, and an increasing trend from 2009/2011 to 2014. The United Kingdom rates steadily increased from 2000 to 2005, followed by a more gradual increase from 2005 to 2014. Spain and Portugal both experienced a single increasing trend over the 15-year period.

All 13 countries experienced an increasing trend in the proportion of HIV diagnoses that occurred in young MSM (Table 2, Fig. 2). The increasing trends in this proportion were characterized by an increasing number of cases in young MSM and stable or increasing number of total cases; trends were not characterized by consistent decreases in the denominator. Most countries ($n = 9$) experienced a single, significant increase of approximately 3% to 6% in the proportion of diagnoses occurring in young MSM per year.

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The other four countries all had increasing trends as well, with either two increasing trend periods (United States), one increasing and one stable trend period (Germany), or a single increasing trend that was only marginally significant (Spain, Denmark).

Trends in CAS, HIV testing, and STIs

CAS trends significantly increased overall and with steady and non-steady partners for nearly all countries (Supplementary Material–Table B, Fig. A). There was no consistent increase or decrease in recent HIV testing across the countries with available data (Supplementary Material–Table C, Fig. B). HIV testing in MSM remained stable for four countries (Germany, Spain, Sweden, United States), decreased for two countries (Australia, France), and increased for four countries (Canada, Denmark, United Kingdom, Switzerland).

Several countries ($n = 10$) were able to provide primary and secondary syphilis and/or gonorrhea data. For countries that had recent increasing HIV trends (Australia, Spain, United Kingdom), annual syphilis diagnosis rates followed similar patterns (Supplementary Material–Fig. C). Yet, syphilis rates also increased across most countries regardless of HIV trends, including those with current stable HIV trends (Germany, Sweden, Canada, and Denmark) and decreasing HIV trends (Switzerland). The male-to-female ratios for syphilis also increased for most countries ($n = 9$, Supplementary Material–Fig. D). The overall increase in syphilis male-to-female ratios was not specific to countries with increasing HIV trends but occurred across countries with heterogeneous HIV trends.

Annual rates of gonorrhea diagnoses in MSM remained relatively stable from 2000 to 2014 for countries with stable or declining HIV trends and mostly increased since 2008 in countries with increasing HIV trends (Australia, Spain, United Kingdom; Supplementary Material–Fig. E). However, trends in gonorrhea male-to-female ratios were more diverse and not specific to patterns of HIV trends (Supplementary Material–Fig. F).

Discussion

The 13 high-income countries in North America, Western Europe, and Australia that we considered differed in trend typologies representing how annual HIV diagnosis rates in MSM changed over time from 2000 to 2014. Half of the countries experienced an increasing trend from 2000 to about 2008 followed by either a stable or declining trend through 2014; some countries continued to have increasing trends. Most notably, the proportion of HIV diagnoses occurring in young MSM increased significantly across all countries during the 15-year period. Although we only document ecological trends in this analysis, our results serve to generate hypotheses for the heterogeneous HIV trends we observed among MSM overall and for the striking shift in HIV burden toward young MSM.

The increase we observed in HIV rates from 2000 to 2008 across nearly all countries underlines the re-emergence of the HIV epidemic in MSM previously documented and suggests that this increase continued until the mid-late 2000s but has since stabilized or declined in many high-income countries [10]. Mostly stable or increasing HIV testing in MSM from 2000 to 2014 indicate that increasing trends through 2008 and recent stable or decreasing HIV rates are not attributable to changes in testing. Increases in CAS with

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steady and non-steady partners and increases in STI diagnosis rates provide some evidence that rising HIV rates beginning in the early 2000s could be because of changes in sexual behavior. Yet, CAS and syphilis rates continued to increase in recent years, whereas annual HIV diagnosis rates stabilized and declined in several countries. This finding suggests that other mechanisms of HIV prevention apart from reductions in sexual behavior likely drove reductions in HIV rates for countries with recent stable and declining trends.

One hypothesis for this result is that increased effective use of antiretroviral therapy (ART) during the 2000s may have led to stable and decreasing HIV rates among MSM. Medically suppressed HIV replication in persons living with HIV can drastically reduce the risk of sexual transmission [15–17]. Simultaneously, ART regimens that lowered side effects and combined multiple drugs into single doses to improve adherence became more widely available during the early-mid 2000s. Over this period, the CD4 threshold for offering treatment also increased, with new treatment guidelines recommending ART to all persons with HIV. We hypothesize that, because of these advances, more MSM achieved viral suppression and became noninfectious to sexual partners, leading to reductions in HIV incidence at the population level [18]. Although it is difficult to prove a causal effect of ART on population-level HIV incidence, researchers have shown that increased ART coverage and adherence may contribute to reductions in community viral load [19] or other metrics of detectable viral load in the population [20,21]. Our study assesses ecological trends in annual HIV diagnosis rates, but our results coincide historically with these strategies and might reflect the population-level impact of biomedical advances and treatment-as-prevention efforts for MSM in countries with stable or declining HIV trends.

It is also important to note that five countries continued to have a recent increasing HIV trend among MSM through the year 2014. In the United Kingdom, we observed increases in HIV testing which may have contributed to increases in newly identified infections. We did not assess migration status; it is possible that increases in diagnoses in some countries could have been triggered by increasing immigration of HIV-positive MSM to these countries, who were counted as newly diagnosed cases in surveillance systems [22]. Similarly, increasing trends for some countries may be because of rising cases and disparities among subgroups of MSM, such as aboriginal MSM in Australia who may experience greater stigma and barriers to care [23]. Alternatively, interventions for MSM that focus on retention in care and treatment adherence may not yet be adequately scaled to reduce HIV transmission to partners. Other research has proposed that despite increases in ART coverage, HIV diagnoses may be increasing as a result of late diagnosis and/or acute-phase transmissions [24,25]. Modeling suggests that about 30% of new HIV transmissions are because of undiagnosed infections, and more than 20% may arise from acute-stage infections [26]. Thus, improving testing, test-and-treat policies, and interventions to educate MSM on the risk of acute-stage infection may be critical to reducing new HIV infections in MSM. Furthermore, the cost accessibility and uptake of biomedical interventions such as pre-exposure prophylaxis (PrEP) in these countries could be particularly important in preventing new infections that occur as a result of undiagnosed and/or acute-stage infections. Future research and prevention strategies should consider the role of early HIV infections on HIV transmission among MSM in these countries and the potential impact of bringing test-and-treat policies, ART retention programs, and PrEP to scale for MSM.

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Of most concern was our finding that young MSM are sharing an increasingly larger proportion of HIV diagnoses over the past 15 years across all 13 countries. Although some country-specific surveillance reports have suggested increasing HIV trends in young MSM, we document a consistent direction and magnitude of these increasing trends in young MSM across all three continents. One proposed explanation for this increase is a multifaceted cohort effect. Historical changes in the efficacy and availability of HIV treatment and in the social acceptance of same-sex relationships may have reduced anti-HIV and/or anti-gay stigma, leading current young MSM to engage in sexual behaviors or partnering that could be more conducive to HIV transmission compared with previous cohorts who directly experienced the devastating effects of the early HIV epidemic [27] and to possibly engage earlier in same-sex activities which could expose them to more transmission-relevant sexual acts during younger ages. Another hypothesis is that increasing use of the Internet (~2003) and mobile dating apps (~2013), particularly by young MSM, may have facilitated meeting greater numbers of sex partners including CAS partners [28]. These hypotheses are consistent with the observed increasing CAS trends, although we were not able to examine these by age. Alternatively, earlier anal sexual debut and/or increasing risk behaviors could lead to simultaneous increases in HIV testing in young MSM and, in turn, increasing HIV diagnoses in this subgroup. We did not observe consistent increases in recent HIV testing across all countries in the same way we observed increases in HIV diagnoses for young MSM. However, we did not have HIV testing data by age, and this hypothesis should be examined in future research.

Although we observed recent stable and declining HIV trends among MSM in several countries, the consistent increase in the proportion of HIV diagnoses in young MSM in all countries could also suggest that young MSM are not benefitting equally from treatment-as-prevention initiatives. Young MSM are less likely to be engaged in HIV care compared with older MSM [29]. A common hypothesis explaining the high number of HIV infections in young MSM is sex with older partners, who are more likely to have HIV infection. However, recent molecular epidemiology data from the United States suggest that most young MSM relationships are age-and race-assortative, so it may be that HIV-positive partners of young MSM are more likely to be young, recently HIV-infected, and not yet diagnosed, engaged in care, or virally suppressed [30]. These results demonstrate an urgent need to develop innovative strategies to improve timely diagnosis and care engagement of young MSM including point-of-care technologies for HIV and STI diagnosis and Internet-based outreach approaches. In addition, preventing HIV infections in young MSM will require stronger efforts among clinical and public health practitioners to provide early sexual education. In the countries we included from Europe, the average median age of sexual debut with a male partner among MSM was 17 years (mean interquartile range: 15–21) [31]. Pediatricians, adolescent health providers, and schools need to be trained to better equip MSM younger than 17 years with sexual health education and HIV prevention tools. This should include condom promotion and providing information and facilitating uptake of PrEP and postexposure prophylaxis (PEP). Although PrEP is not currently approved by all federal regulatory bodies for use in minors, findings on acceptability and effectiveness of PrEP in current trials of young MSM have been promising and have resulted in the recent United States Food and Drug Administration approval for use in adolescents [32]. Health educators

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and clinical providers will need to incorporate messages about PrEP for young MSM who are sexually active and indicated for use, particularly if HIV-negative young MSM are likely to be exposed to HIV through partners who are recently infected, undiagnosed, and virally unsuppressed. Furthermore, removing barriers of cost and insurance coverage of PrEP through generic PrEP drugs and cost-reduction programs will be critical to affording young MSM effective opportunities to reduce their risk of HIV infection.

This analysis is subject to several limitations. First, our outcome of HIV diagnoses may include transmissions that occurred in prior years but were undiagnosed and does not capture undiagnosed recent transmissions; therefore, it does not exclusively represent new infections. We chose to use diagnoses data because they were systematically collected and because methods for estimating HIV incidence differed across regions. Second, HIV outcomes were not examined by other demographic characteristics such as race/ ethnicity, geographical subunits, indigenous status, or recent migration, which vary considerably across countries and require local interpretation. Country-specific reports include these key demographics that could play an important role in explaining trends and disparities in each country. Third, we were not able to evaluate CAS, HIV testing, or STI outcomes by age. Thus, we could not directly correlate secondary outcomes with our HIV outcome in young MSM, limiting our hypotheses about age-specific trends. Furthermore, we know little about new HIV diagnoses among transfeminine youth using surveillance data, and transfeminine youth could have been classified as young MSM; this lack of data calls for better understanding and identification of new HIV cases among transfeminine youth. Finally, we acknowledge that we were not able to include data from all high-income countries but rather a subset of countries in North America, Western Europe, and Australia; this was done in an effort to include additional countries beyond those considered in the 2009 article but also maintain comparability within established HIV surveillance systems. Yet, we recognize that even established HIV surveillance systems in these high-income countries may differ in operational methods, available data, and indicators collected. We aimed to include outcomes that were comparable across most countries, and we describe the various data sources in the Supplementary Material. We respond to this limitation by encouraging an international collaboration to establish consistent HIV surveillance indicators across regions and continents to allow for robust evaluation of trends over time. In line with the Dublin Declaration and other International Agencies recommendations, we strongly recommend collecting and reporting these indicators stratified by age to monitor HIV trends among young MSM in years to come.

Public health implications

Using both formal HIV surveillance data and key secondary data on recent CAS, HIV testing, and STIs, our study makes important contributions to our global understanding of HIV trends in MSM over the past 15 years. In many high-income countries in North America, Western Europe, and Australia, recent treatment advancements and efforts to improve ART coverage and adherence may be contributing to reductions in HIV diagnosis rates among MSM. Nevertheless, the fact that CAS and STIs such as syphilis are still increasing in areas where HIV diagnoses are stable or decreasing suggests that exposure is high and increasing. Moreover, several countries still experience increasing HIV trends

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among MSM overall, and all countries have demonstrated increasing trends among young MSM suggesting that young MSM may not be equally benefitting from recent treatment-as-prevention and other prevention initiatives. A steady and proportional effort to promote overall sexual health among MSM as well as encourage early sexual education, reduce barriers to PrEP, and improve care engagement for young MSM will be critical to addressing current international HIV trends in this population.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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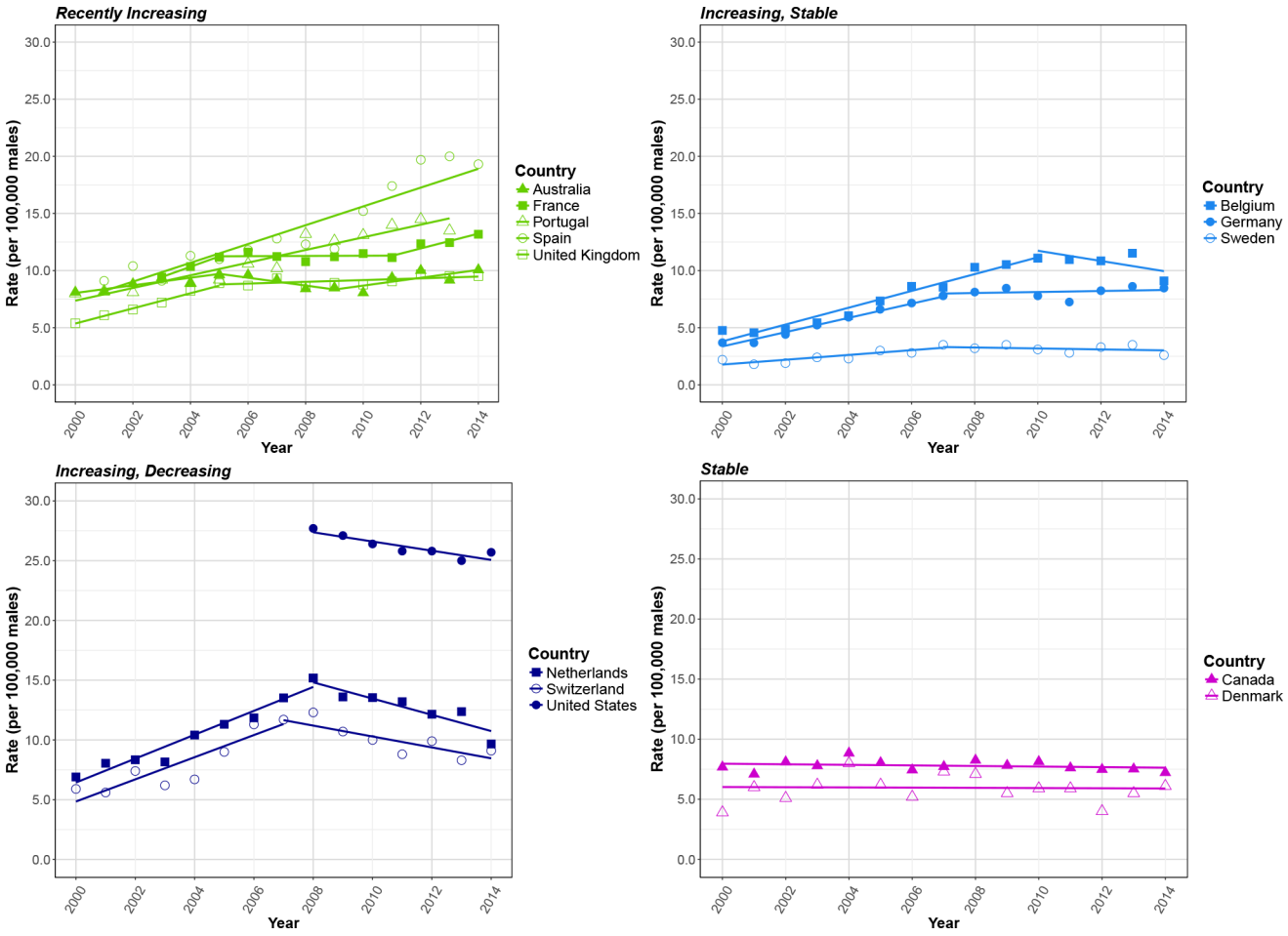

Fig. 1.

Country-specific trends in HIV diagnosis rates among men who have sex with men, 2000–2014.

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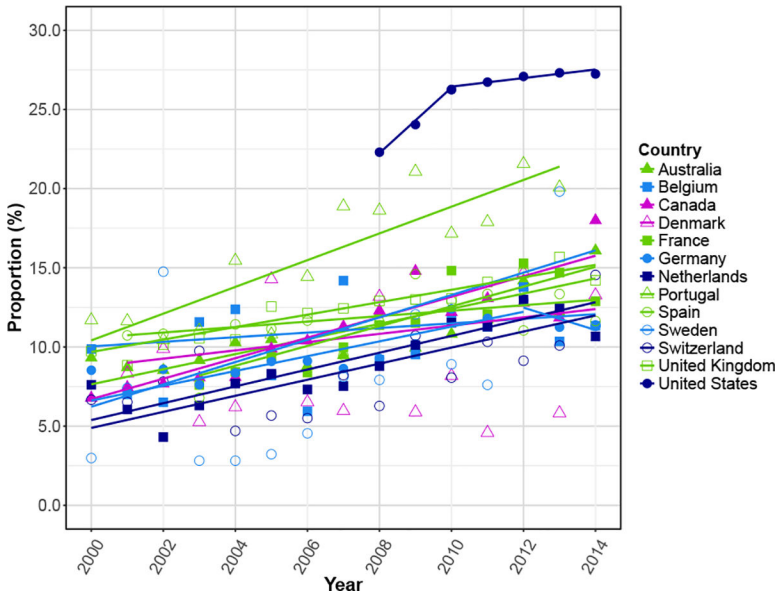

Fig. 2.

Country-specific trends in the proportion of HIV diagnoses in young men who have sex with men aged 15 to 24 y, 2000–2014.

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Table 1

Country-specific trends in HIV diagnosis rates among men who have sex with men, 2000–2014

Country	Joinpoint period	Years	EAPC	95% confidence interval		*P* value
				Lower	Upper	
Australia	1	2000–2005	3.48	1.76	5.23	<.01
	2	2005–2009	−3.80	−5.43	−2.14	<.01
	3	2009–2014	3.74	0.79	6.77	.01
Belgium	1	2000–2010	10.52	9.11	11.96	<.01
	2	2010–2014	−3.15	−8.08	2.04	.23
Canada	1	2000–2014	−0.32	−0.98	0.35	.35
Denmark	1	2000–2014	−0.02	−2.30	2.32	.99
France	1	2003–2005	8.91	7.87	9.97	<.01
	2	2005–2011	−0.13	−1.09	0.84	.80
	3	2011–2014	5.20	2.67	7.79	<.01
Germany	1	2000–2007	12.32	10.77	13.90	<.01
	2	2007–2014	0.88	−0.85	2.64	.32
Netherlands	1	2000–2008	10.17	8.76	11.59	<.01
	2	2008–2014	−5.54	−7.70	−3.32	<.01
Portugal	1	2000–2013	5.23	4.30	6.17	<.01
Spain	1	2001–2014	6.73	5.43	8.04	<.01
Sweden	1	2000–2007	8.77	5.02	12.65	<.01
	2	2007–2014	−2.13	−5.12	0.95	.17
Switzerland	1	2000–2007	11.97	7.63	16.48	<.01
	2	2007–2014	−4.80	−6.87	−2.68	<.01
United Kingdom	1	2000–2005	10.50	9.76	11.25	<.01
	2	2005–2014	0.96	0.27	1.65	<.01
United States	1	2008–2014	−1.46	−2.05	−0.85	<.01

EAPC = estimated annual percent change; HIV = human immunodeficiency virus.

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Table 2

Country-specific trends in the proportion of HIV diagnoses among young MSM aged 15–24 years, 2000–2014

Country	Joinpoint period	Years	EAPC	95% confidence interval		*P* value
				Lower	Upper	
Australia	1	2000–2014	3.98	2.60	5.37	<.01
Belgium	1	2000–2014	2.49	0.25	4.78	.03
Canada	1	2000–2014	5.87	4.49	7.27	<.01
Denmark	1	2000–2014	3.48	−0.53	7.66	.09
France	1	2003–2014	5.86	4.86	6.88	<.01
Germany	1	2000–2012	4.75	3.57	5.95	<.01
	2	2012–2014	−6.67	−13.77	0.98	.09
Netherlands	1	2000–2014	6.12	4.39	7.88	<.01
Portugal	1	2000–2013	5.39	3.74	7.07	<.01
Spain	1	2001–2014	1.95	−0.09	4.04	.06
Sweden	1	2000–2014	9.80	4.93	14.89	<.01
Switzerland	1	2000–2014	5.63	2.30	9.08	<.01
United Kingdom	1	2000–2014	3.41	2.74	4.08	<.01
United States	1	2008–2010	8.53	6.95	10.13	<.01
	2	2010–2014	0.95	0.33	1.58	<.01

EAPC = estimated annual percent change; MSM = men who have sex with men.

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