

# HIV Treatment Cascades that Leak: Correlates of Drop-off from the HIV Care Continuum among Men who have Sex with Men Worldwide

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## Abstract

**Objectives:** The health and prevention benefits of antiretroviral therapies (ART), delivered as part of comprehensive HIV care programs remain unrealized for men who have sex with men (MSM). This multilevel study explores the correlates of drop-off from the HIV care continuum in an international study of MSM, taking into account individual and regional differences in access to and utilization of care.

**Methods:** We conducted a study of the continuum of HIV diagnosis and care among 6095 MSM using data collected from an international online survey of MSM conducted in 2012. In this model of the HIV treatment cascade, we treated each point along the continuum as an outcome variable. We then investigated the relationships between clinical care outcomes and a set of demographic and psychosocial factors that were hypothesized to correlate with the outcomes using bivariate and multivariable statistical techniques.

**Results:** Among MSM living with HIV for longer than 12 months (n=632), 50%(n=319) were virologically suppressed. Among MSM recently infected with HIV (n=91), the proportion was relatively smaller at 33%. Significant correlates of being on ART and retained in care included: accessibility of HIV treatment; comfort with a healthcare provider; and engagement in a gay community. Perceptions of homophobia were negatively associated with being on ART and being retained in care.

**Conclusions:** These findings underscore the need for service delivery models that sensitively address HIV among MSM. Public health officials should adopt comprehensive HIV programs that include mutually reinforcing components and that address varying needs of MSM newly diagnosed and living with HIV. Comprehensive HIV programs must also support the critical role communities play in linking and retaining MSM into HIV services. Further studies validating the findings in country-specific contexts are warranted.

**Key words:** Men who have sex with men; MSM; HIV; HIV diagnosis; Access to care; HIV care continuum; HIV treatment cascade

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## Introduction

Men who have sex with men (MSM) are disproportionately affected by the human immunodeficiency virus (HIV) compared to the general population in nearly all countries reliably collecting surveillance data [1,2]. MSM have 19.3-fold greater odds of being infected with HIV compared with the general population in low- and middle-income country settings [3]. The prevalence of HIV among MSM across regions (North, South, and Central America; South and Southeast Asia; and Sub-Saharan Africa) ranges consistently between 14 and 18% [1]. In many high-income countries, the incidence of HIV among MSM remains unchanged over recent years, and in some cases, it is increasing even when HIV incidence in the general population is in decline [4]. For example, in the United States, the number of new HIV infections among MSM has been increasing at a rate of 8% per year since 2001 [5].

The health and prevention benefits of antiretroviral therapy (ART) in the management of HIV are now well documented [6-10]. Behavioral prevention programs, early diagnosis, prompt linkage to sustained care, retention in care, receipt of ART, and viral suppression constitute points along a comprehensive continuum of HIV care [11]. The effective implementation of a comprehensive continuum of care, including unfettered access to and utilization of ART, is associated with reduced morbidity, reduced mortality, and reduced onward

transmission of HIV [12-14]. However, current service delivery models are less than optimal in linking and retaining socially marginalized groups, resulting in drop-offs in the treatment cascade and failure to fully realize the health and prevention benefits of ART [15,16]. These gaps are particularly true for MSM as evidenced by persistently high HIV prevalence and incidence rates. For MSM, HIV responses at the country level continue to be seriously hampered by daily experiences of stigma, discrimination, violence and criminalization [17-20]. MSM who live in countries that criminalize homosexuality have higher mean scores on perceived homophobia scales and decreased access to basic HIV services, including access to ART, compared to MSM who live in countries with more supportive legal frameworks [21].

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In 2012, an international multi-lingual online questionnaire was designed to identify and examine barriers and facilitators of HIV service access and utilization among MSM, the Global Men's Health and Rights Survey (GMHR). In a previous study, we found that homophobia (perceptions of societal stigma associated with homosexuality), disclosure of sexual identity ("outness"), and service provider stigma were significantly associated with reduced access to HIV services. Conversely, we found that engagement in the local gay community and comfort with service providers were associated with increased access to services [22].

The aim of the present study is to quantify the HIV treatment cascade and to explore the correlates of drop-off from the HIV care continuum among an international convenience sample of MSM. Consistent with Gardner et al, we define the HIV treatment cascade as a visual and conceptual representation of MSM living with HIV receiving services at various points along the continuum of HIV care [11,15]. We hypothesized that drop-off from the HIV care continuum would be worse in lower income countries and among younger men. In this study we focused on country income because it determines eligibility for international development and HIV/AIDS funding, which in turn may impact access to services. We also hypothesized that experiences of sexual stigma (homophobia) and stigma among health care providers would be negatively associated with HIV testing, being linked to care, being on ART, being retained in care, and being virologically suppressed [23]. In addition, we posited that comfort with one's healthcare provider, engagement in gay community, participation in HIV risk reduction programs, access to HIV treatment, and provider knowledge of HIV would be positively associated with engagement in each stage of the HIV care continuum.

## Methods

Data from the 2012 GMHR, a cross-sectional online survey implemented from April to August, 2012 were used to construct a continuum of HIV care. The methods of the parent study, are published in detail elsewhere [22]. In summary, 6095 participants were recruited from 145 countries via networks of MSM community-based organizations and MSM online websites and list serves. The parent study was exploratory in nature and therefore no formal sample size calculations were conducted. The analyses were limited to survey participants with complete data on variables of interest (n=4192), including 723 participants living with HIV. The institutional review board of the Research Triangle Institute International approved study procedures.

Respondents were asked if they had ever been tested for HIV, the time since their most recent test, and the most recent test result. We calculated the proportions of respondents who had been diagnosed with HIV within the past 12 months and the proportion greater than 12 months. We identified stages of the HIV care continuum and measured the proportion of respondents that were in each stage.

For those living with HIV, we used generally accepted standards of clinical care for HIV infection to create measures assessing various points along the care continuum. We stratified the analysis by 'time since diagnosis' (within or greater than 12 months from the survey response) because standards of clinical care for a person newly diagnosed with HIV are different from those used for persons living with HIV for longer periods of time. In addition, the same measures could have different meanings across these two groups. For example, having accessed HIV treatment at least once in the past 12 months can indicate linkage to care for a respondent who was diagnosed with HIV 3 months prior to taking the survey but it could also indicate retention

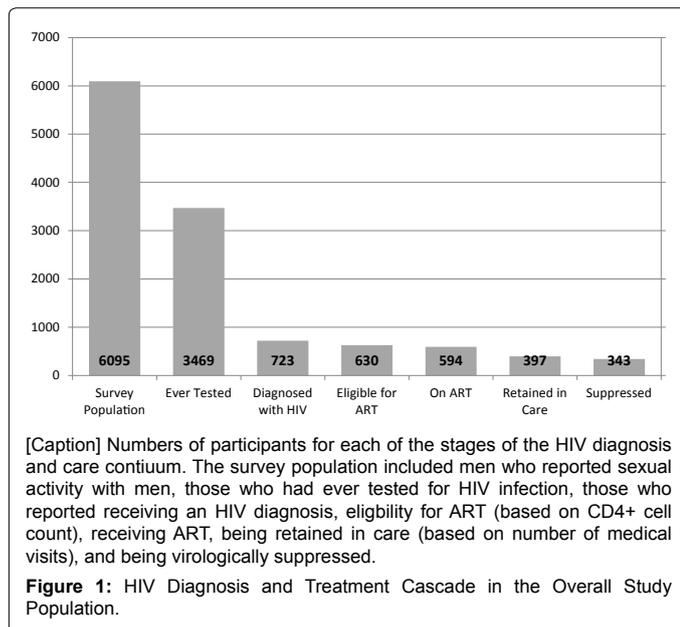
in care for a respondent who was diagnosed with HIV infection 5 years prior to the survey. This also prompted us to create two different measures for retention in care – one specific to each group.

For respondents diagnosed with HIV within 12 months of the survey, the stages were: being linked to care (having accessed medical services at least once in the past 12 months); being eligible for ART (CD4+ cell count < 350 cells/mm<sup>3</sup>) among those who were linked to care; receiving ART among those who were eligible for ART; being retained in HIV care (having completed 6 or more medical visits and accessing HIV treatment at least once with the past 12 months) among those who initiated HIV treatment; and being virologically suppressed (viral load < 1000 copies/ml) among those who were retained [23]. Similarly, for respondents who were diagnosed more than 12 months prior to the survey, the stages were: eligible (CD4 < 350 cells/mm<sup>3</sup>) or currently on ART; being retained in HIV care (having complete one or more medical visits and accessing HIV treatment at least once within the past 12 months); and being virologically suppressed. Respondents who did not have access to virological testing or who did not know their viral load were excluded from the calculated proportions of virological suppression.

To investigate the determinants of drop-off from the HIV care continuum, we treated each of the stages of the continuum as dichotomous outcome variables and investigated the relationships between these and a set of demographic and psychosocial predictor variables. Psychosocial predictor variables were measured using multi-item scales. All scales ranged from 1 to 5 and were assessed for reliability. Cronbach's alpha coefficients were calculated, stratified by survey language and by participants' region of residence. The overall reliability of scales used in the analyses was acceptable (alpha levels ranged from 0.71 to 0.85). Predictors of interest were: country income derived from World Bank classifications; comfort with provider (e.g., *In your country, how comfortable would you feel discussing HIV with your health care provider?*); previous experiences of stigma by providers (e.g., *In your country, has a health care provider ever treated you poorly because of your sexuality?*); participation in risk-reduction programs designed for MSM (e.g., *In the last 12 months, how often did you participate in risk reduction programs designed for MSM?*); engagement with gay community (e.g., *During the past 12 months, how often have you participated in gay social groups?*); sexual stigma (perceptions of homophobia, e.g., *In your country, how many people believe that a person who is gay/MSM cannot be trusted?*); and accessibility of HIV treatment and accessibility of medical care (with the lowest level indicating complete inaccessibility and the highest level indicating complete accessibility). In addition, respondents reported their age (measured in decades here), country of residence, and housing status.

We carried out bivariate and multivariable analysis for each outcome variable. To account for clustering at the level of region, generalized estimating equation (GEE) models were fitted in the bivariate analysis with participants' region as a clustering variable. This approach allowed us to calculate associations between the predictor and outcome variables of interest. Wald tests were used to determine the statistical significance of predictors.

In the multivariable analysis, we included variables that were significant at the p<0.1 level in bivariate analyses. We then eliminated predictors that were non-significant in the multivariable analyses. To control for contextual variables that occur at the level of the region, random effects models were fitted, with random intercepts corresponding to participants' regions. Logistic regression models were fitted in each case. Approximate confidence intervals were calculated



based on the standard error of estimated coefficients and the assumption that coefficient estimators were normally distributed.

## Results

### Upstream of the HIV Care Continuum: HIV Testing

There were 6095 survey participants, of whom 3469 (57%) reported ever having tested for HIV (Figure 1). Of those ever tested, 2152 (62%) tested within the past 12 months. From the total study population, 723 (12%) reported having been diagnosed with HIV, of whom 91 (13%) had been diagnosed within the last 12 months.

In the bivariate analysis, country income was a significant predictor of HIV testing. Compared with respondents living in high-income countries, MSM in low income countries were 2.08 times more likely to have had an HIV test (95% confidence interval [CI]: 1.19 – 3.65,  $p=0.001$ ). Survey respondents from upper middle income countries were less likely to report testing for HIV than respondents from high income countries (odds ratio [OR]=0.79, 95%CI: 0.66 – 0.95,  $p=0.001$ ).

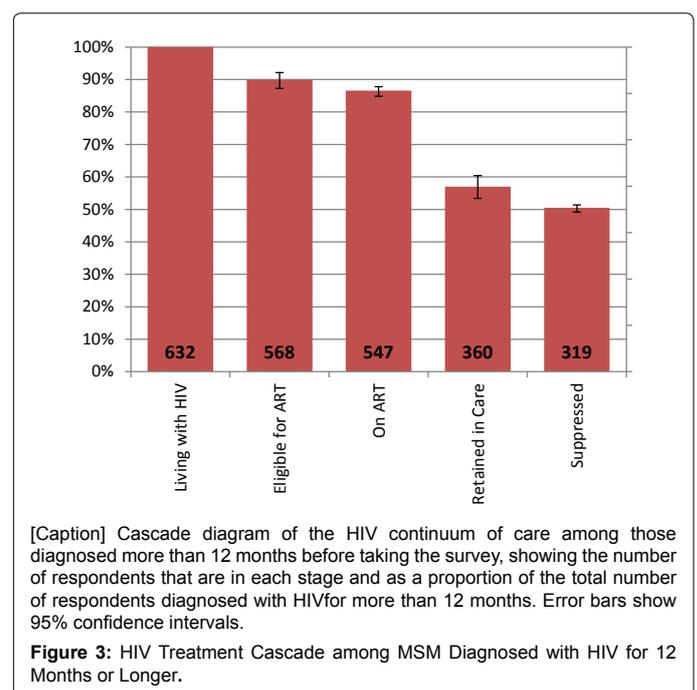
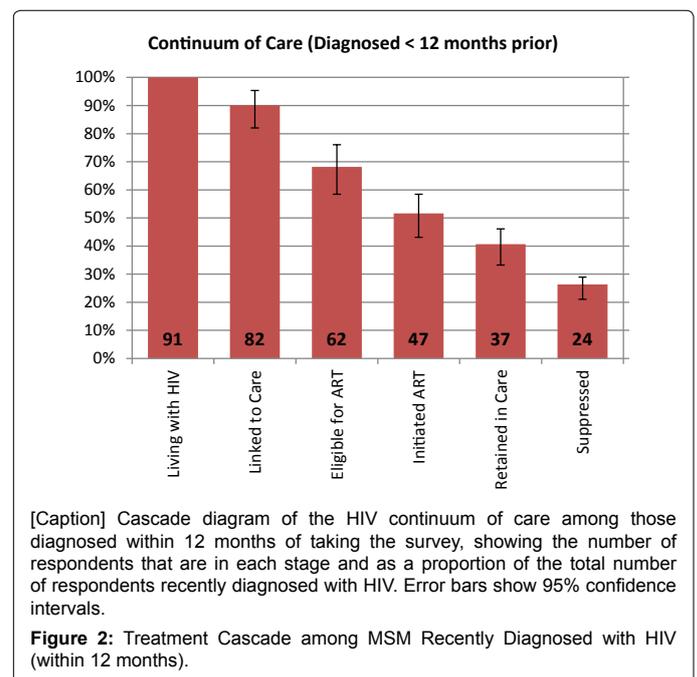
Participants who reported higher levels of comfort with provider (OR=1.32, 95%CI: 1.23 – 1.43,  $p<0.001$ ), participation in risk-reduction programs (OR=1.94, 95%CI: 1.69 – 2.23,  $p<0.001$ ), higher accessibility of medical care (OR=1.10, 95%CI: 1.04 – 1.16,  $p<0.001$ ), and higher community engagement (OR=2.18, 95%CI: 1.86 – 2.55,  $p<0.001$ ) were more likely to have been tested. Those who reported higher homophobia were less likely to have been tested (OR=0.81, 95%CI: 0.74 – 0.90,  $p<0.001$ ). Those who reported ever having experienced stigma related to HIV (OR=1.46, 95%CI: 1.16 – 1.84,  $p=0.001$ ) or stigma related to same sex sexuality (OR=1.63, 95%CI: 1.33 – 2.00,  $p<0.001$ ) were also more likely to have been tested for HIV.

In the multivariable analysis, comfort with provider (adjusted odds ratio [AOR]=1.27, 95%CI: 1.15 – 1.40,  $p<0.001$ ), participation in risk-reduction programs (AOR=1.66, 95% CI: 1.49 – 1.87,  $p<0.001$ ) and engagement in gay community (AOR=1.38, 95%CI: 1.17 – 1.62,  $p<0.001$ ) continued to be significant and positive predictors of HIV testing. Those who had experienced provider stigma related to same-sex sexuality were also more likely to have been tested (AOR=1.45, 95%CI: 1.15 – 1.82,  $p=0.002$ ).

### HIV Treatment Cascade among MSM Diagnosed with HIV

Of those who recently tested, 91 (4%) were found to be positive (Figure 2). Eighty-two (90%) of the recently diagnosed MSM were linked to HIV care. Of those, 62 (76%) were eligible for ART. Forty-seven (76%) of those eligible for ART were currently receiving on ART. Of those who recently initiated ART, 37 (79%) were retained in HIV care, among whom 24 (65%) were virologically suppressed at the time they took the survey. These 24 respondents represent 26% of all MSM recently tested positive for HIV.

Of 632 MSM who had been living with HIV for more than 12

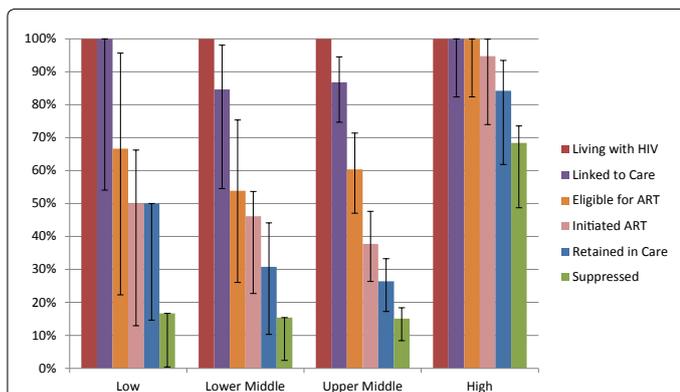


months, 568 (90%) were eligible for ART (CD4+<350 cells/mm<sup>3</sup>) (Figure 3). 547 (96%) of those who were eligible were taking ART. Of those who were on ART, 360 (66%) were retained in HIV care. Among those, 319 (97%) – or 50% of all MSM living with HIV for more than 12 months – were virologically suppressed.

Among those recently diagnosed, 10 respondents out of 37 (27%) who were retained in care did not have viral load data. Removing them from the calculation for virological suppression in our representation of the treatment cascade assumes that none of them were virologically suppressed. Had we assumed that all of them are virologically suppressed the total number of suppressed would be 34 (or 37% of all those who were recently diagnosed).

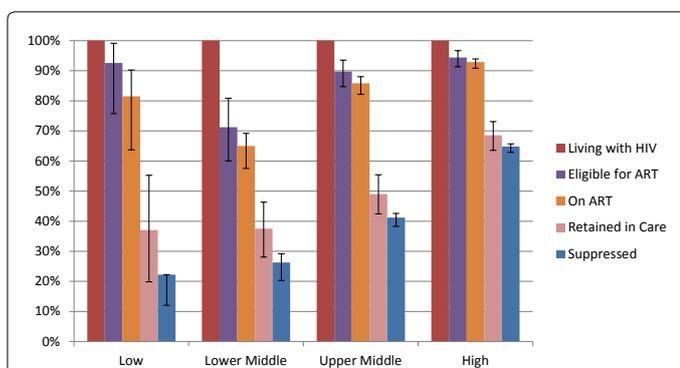
Similarly, among those living with HIV for more than 12 months, 30 respondents out of 360 (8%) who were retained in care did not have viral load data. Had we assumed that all of them are virologically suppressed, the overall number of suppressed would be 349 (or 55%) of all participants who were diagnosed for more than 12 months prior).

Figures 4-7 show the treatment cascades, stratified by country



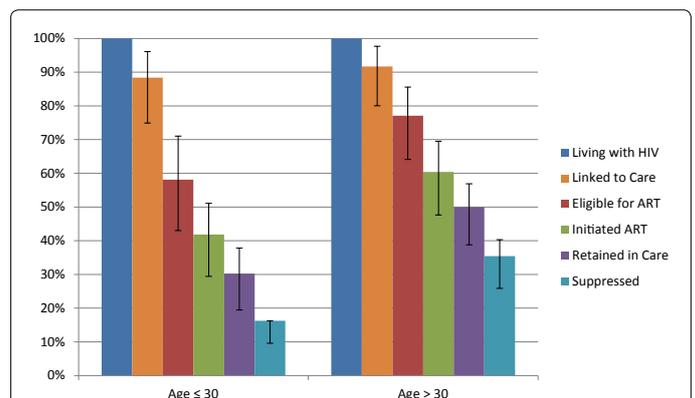
[Caption] Cascade diagram of the HIV continuum of care stratified by country income, among those recently diagnosed with HIV. The figure shows the number of respondents that are in each stage and as a proportion of the total number of respondents recently diagnosed. Error bars show 95% confidence intervals.

**Figure 4:** HIV Treatment Cascade by Country Income for MSM Recently Diagnosed with HIV (n=91).



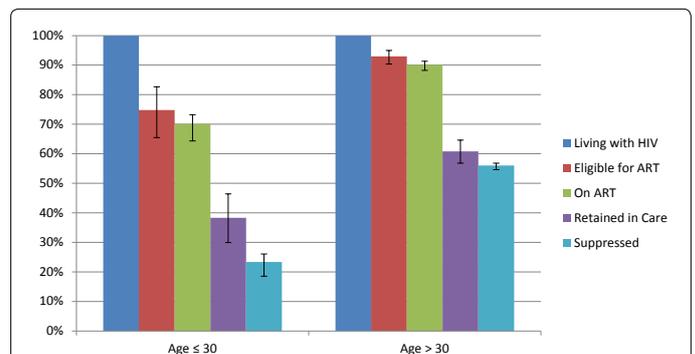
[Caption] Cascade diagram of the HIV continuum of care stratified by country income, among those diagnosed for at least 12 months, showing the number of respondents that are in each stage and as a proportion of the total number of respondents diagnosed with HIV more than 12 months. Error bars show 95% confidence intervals.

**Figure 5:** HIV Treatment Cascade by Country Income for MSM Diagnosed with HIV for 12 Months or Longer (n=632).



[Caption] Cascade diagram of the HIV continuum of care stratified by age group among those recently diagnosed with HIV, showing the number of respondents that are in each stage and as a proportion of the total number of respondents recently diagnosed. Error bars show 95% confidence intervals.

**Figure 6:** HIV Treatment Cascade by Age for MSM Recently Diagnosed with HIV (n=91).



[Caption] Cascade diagram of the HIV continuum of care stratified by age group among those diagnosed with HIV for more than 12 months, showing the number of respondents that are in each stage and as a proportion of the total number of respondents diagnosed with HIV for more than 12 months. Error bars show 95% confidence intervals.

**Figure 7:** Continuum of Care by Age Category for MSM Diagnosed with HIV 12 Months or Longer (n=632).

income and then by age. The treatment cascades by country income show that survey respondents in low income countries experience steeper drop-off from the HIV care continuum compared to participants in higher income countries. This is true both for recently diagnosed respondents and for respondents living with HIV for more than 12 months.

The analysis of the treatment cascade by age suggests that MSM above age 30 have higher engagement in the care continuum than MSM younger 30, among both recently diagnosed men as well as those living with HIV for more than 12 months. Among men living with HIV for more than 12 months, there was a sharp decrease in the proportion who were still retained in care compared to the proportion who were on ART. In contrast, the cascade among men who were recently diagnosed shows a steadier decline across the different stages of the cascade.

### Correlates of Drop-off along the HIV Care Continuum

**MSM Recently Diagnosed with HIV:** In the bivariate analysis, accessibility of HIV treatment (OR=1.89, 95%CI: 1.26 – 2.85, p=0.002) was positively associated with being linked to HIV care, among respondents who were recently diagnosed with HIV. Comfort with

provider (OR=2.18, 95%CI: 1.20 – 3.95, p=0.010), participation in risk reduction programs (OR=3.71, 95%CI: 1.03 – 13.38, p=0.045) and accessibility of HIV treatment (OR=1.71, 95%CI: 1.15 – 2.55, p=0.008) were positively associated with being put on ART (among those eligible for ART). Homophobia was negatively associated with being retained in care (OR=0.32, 95%CI: 0.12 – 0.85, p=0.022).

In the multivariable analysis, accessibility of HIV treatment remained positively associated with being linked to care (AOR=2.23, 95%CI: 1.26 - 3.96, p=0.006).

**MSM Living with HIV for 12 months or Longer:** Among respondents who were diagnosed with HIV more than 12 months before taking the survey, country income was significantly associated with being on ART (p=0.05) and retention in care (p<0.001) in the bivariate analysis. Compared to participants in high-income countries, survey participants living in low income countries were less likely to report being on ART (OR=0.16, 95%CI: 0.03 – 0.89) and being retained in care (OR=0.26, 95%CI: 0.10 – 0.65). Comfort with provider was positively associated with being on ART (OR=1.83, 95%CI: 1.16 – 2.87, p=0.009), and retention in care (OR=1.47, 95%CI: 1.17 – 1.85, p=0.001). Community engagement was positively associated with being on ART (OR=3.04, 95%CI: 1.29 – 7.12, p=0.011) and accessibility of medical care was positively associated with being retained in care (OR=1.44, 95%CI: 1.21 – 1.72, p<0.001). Homophobia was negatively related with being on ART (OR=0.50, 95%CI: 0.31 – 0.81, p=0.005) and being retained in care (OR=0.64, 95%CI: 0.50 – 0.82, p<0.001). Younger

age was negatively associated with being on ART (OR=0.55, 95%CI: 0.40 – 0.75, p<0.001), being retained in care (OR=0.71, 95%CI: 0.60 – 0.83, p<0.001) and being virologically suppressed (OR=0.49, 95%CI: 0.30 – 0.80, p=0.004).

In the multivariable analysis, community engagement AOR=1.38, 95%CI: 1.01-1.90, p=0.45) remained positively associated with retention in care and younger age was negatively associated with retention in care (AOR=0.78, 95%CI: 0.63 – 0.94, p=0.012). Finally, younger age was negatively associated with being virologically suppressed (AOR= 0.54, 95%CI: 0.29 – 0.98, p=0.044). Correlates to end points along the HIV care continuum from bivariate and multivariable analysis are presented in Tables 1 and 2.

## Discussion

To our knowledge, this study is the first attempt to visually represent drop-off in the HIV care continuum in a global sample of MSM. Given the health benefits and prevention potential of ART, global efforts to curb the HIV pandemic must give focus to building comprehensive service delivery models that ensure meaningful engagement and retention of MSM at every point of the HIV care continuum.

Our study findings indicate a global treatment cascade that is porous, with drop-off at every point of the continuum among MSM. Drop-off is most dramatic among younger MSM and MSM living in lower income countries. Drop-off may be linked to inequities in access

	Linked			On ART			Retained in Care			Suppressed			
	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	
Diagnosed < 12 months prior	Comfort with provider	1.24	(0.68-2.27)	0.485	<b>2.18</b>	<b>(1.20-3.95)</b>	<b>0.010</b>	2.09	(0.92-4.72)	0.078	0.65	(0.31-1.39)	0.267
	Past experience of MSM-related provider stigma	1.89	(0.27-13.26)	0.522				1.69	(0.31-9.13)	0.541			
	Past experience of HIV-related provider stigma	2.03	(0.28-14.83)	0.484	3.67	(0.44-30.55)	0.230	1.29	(0.24-7.02)	0.772			
	Participation in risk-reduction Programs	1.56	(0.59-4.15)	0.370	<b>3.71</b>	<b>(1.03-13.38)</b>	<b>0.045</b>	1.12	(0.65-1.95)	0.680	1.49	(0.53-4.16)	0.445
	Accessibility of HIV treatment	<b>1.89</b>	<b>(1.26-2.85)</b>	<b>0.002</b>	<b>1.71</b>	<b>(1.15-2.55)</b>	<b>0.008</b>	1.38	(0.90-2.13)	0.141	0.89	(0.52-1.52)	0.667
	Community engagement	2.45	(0.59-10.18)	0.219	<b>3.12</b>	<b>(0.81-12.02)</b>	<b>0.099</b>	1.48	(0.54-4.00)	0.444	1.94	(0.36-10.43)	0.440
	Homophobia	1.02	(0.46-2.24)	0.963	0.51	(0.21-1.24)	0.135	<b>0.32</b>	<b>(0.12-0.85)</b>	<b>0.022</b>	0.73	(0.18-2.98)	0.665
	Younger age (in decades)	0.80	(0.37-1.70)	0.559	0.65	(0.35-1.18)	0.154	0.82	(0.44-1.53)	0.533	1.37	(0.59-3.20)	0.468
	Unstable housing	0.71	(0.14-3.68)	0.687	0.77	(0.21-2.83)	0.695	1.48	(0.26-8.60)	0.661			
Diagnosed > 12 Months Prior	Country Income												
	Low income				<b>0.16</b>	<b>(0.03-0.89)</b>		<b>0.26</b>	<b>(0.10-0.65)</b>				
	Lower-middle income				<b>0.19</b>	<b>(0.05-0.73)</b>		<b>0.45</b>	<b>(0.24-0.81)</b>				
	Upper-middle income				<b>0.42</b>	<b>(0.14-1.30)</b>		<b>0.47</b>	<b>(0.29-0.77)</b>				
	Comfort with provider				<b>1.83</b>	<b>(1.16-2.87)</b>	<b>0.009</b>	<b>1.47</b>	<b>(1.17-1.85)</b>	<b>0.001</b>	<b>1.88</b>	<b>(0.97-3.63)</b>	<b>0.062</b>
	Past experience of MSM-related provider stigma				1.64	(0.58-4.63)	0.350	1.03	(0.69-1.53)	0.895	0.90	(0.23-3.55)	0.884
	Past experience of HIV-related provider stigma				1.13	(0.44-2.90)	0.792	1.14	(0.77-1.68)	0.511	0.72	(0.19-2.69)	0.624
	Participation in risk-reduction Programs				1.09	(0.78-1.51)	0.613	0.97	(0.84-1.11)	0.638	0.79	(0.51-1.2)	0.267
	Community engagement				<b>3.04</b>	<b>(1.29-7.12)</b>	<b>0.011</b>	1.37	(0.96-1.94)	0.079	1.46	(0.46-4.62)	0.522
	Accessibility of medical care				1.00	(0.71-1.40)	0.986	<b>1.44</b>	<b>(1.21-1.72)</b>	<b>&lt;0.001</b>	0.90	(0.49-1.65)	0.730
	Accessibility of HIV treatment				1.22	(0.87-1.70)	0.255	1.14	(0.97-1.34)	0.104	1.19	(0.68-2.08)	0.543
	Homophobia				<b>0.50</b>	<b>(0.31-0.81)</b>	<b>0.005</b>	<b>0.64</b>	<b>(0.50-0.82)</b>	<b>&lt;0.001</b>	0.72	(0.31-1.68)	0.447
	Younger age (in decades)				<b>0.55</b>	<b>(0.40-0.75)</b>	<b>&lt;0.001</b>	<b>0.71</b>	<b>(0.60-0.83)</b>	<b>&lt;0.001</b>	<b>0.49</b>	<b>(0.30-0.80)</b>	<b>0.004</b>
	Unstable housing				<b>0.33</b>	<b>(0.13-0.83)</b>	<b>0.018</b>	0.62	(0.36-1.06)	0.080	0.51	(0.1-2.52)	0.408

\*The reference group for country income analysis is "High" income.

Notes: OR = odds ratio. CI = confidence interval

Table 1: Bivariate Associations with Care Continuum End Points among MSM Diagnosed with HIV.

		Linked			On ART			Retained in Care			Suppressed		
		OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value	OR	95%CI	p-value
Diagnosed < 12 Months Prior	Comfort with provider				2.31	(0.83-6.38)	0.108	1.79	(0.55-5.80)	0.330			
	Participation in risk-reduction programs				5.42	(0.93-31.60)	0.061						
	Accessibility of HIV treatment	<b>2.23</b>	<b>(1.26-3.96)</b>	<b>0.006</b>	1.67	(0.85-3.28)	0.135						
	Community engagement				1.33	(0.21-8.34)	0.762						
Diagnosed > 12 Months Prior	Comfort with provider				1.43	(0.85-2.41)	0.179	1.24	(0.99-1.55)	0.057	1.43	(0.7-2.94)	0.327
	Community engagement				2.54	(0.93-6.96)	0.069	<b>1.38</b>	<b>(1.01-1.90)</b>	<b>0.045</b>			
	Younger age (in decades)				0.65	(0.41-1.04)	0.071	<b>0.78</b>	<b>(0.63-0.94)</b>	<b>0.012</b>	<b>0.54</b>	<b>(0.29-0.98)</b>	<b>0.044</b>
	Unstable housing				0.69	(0.23-2.10)	0.514	1.02	(0.61-1.71)	0.931	0.85	(0.17-4.26)	0.845

Notes: AOR = adjusted odds ratio. CI = confidence interval

Table 2: Multivariate Associations with End Points of the Care Continuum Among MSM Diagnosed with HIV.

to HIV services that are in-turn driven by the relative lack of resources and social disenfranchisement [25,26]. Resource constrained countries may be investing less in their health infrastructures [27]. However, poorer countries are more likely to receive international funds to support their HIV response than middle income countries [28] This may explain why in our study MSM in lower income countries were more likely to have tested for HIV. Moreover, health systems are less responsive to the needs of young people in general and to the needs of young MSM in particular [29,30].

Our findings also corroborate previous research documenting the inadequacies of HIV service delivery for different, socially disenfranchised sub-populations of MSM worldwide. For example, Millet (2012) found significant drop-off from the HIV care continuum among Black MSM in Canada, the United Kingdom, and the United States [31].

Our data revealed important correlates to drop-off from the HIV care continuum among MSM worldwide. MSM who are engaged in gay community and who participate in risk reduction programs were more likely to have tested for HIV. Being engaged in gay community was also strongly associated with being retained in care among MSM living with HIV 12 months or more. These findings highlight the importance of a comprehensive approach to HIV for MSM, one that views community-led and risk reduction programs as critically integral to successful and sustained service provision along the HIV care continuum [32,33].

Among MSM newly diagnosed with HIV, accessibility of HIV treatment and comfort with health care provider were positively associated with being linked to care and being on ART, respectively. These associations underscore the interdependent nature of the different points along the HIV care continuum. Moreover, our findings illustrate the importance of provider sensitivity and the need for specialized training of health care professionals. This point is supported by others who have written about the importance of provider sensitivity for optimizing HIV treatment [34-36].

Among MSM living with HIV for more than 12 months in our sample, we found that younger men were less likely to be retained in care and virologically suppressed than their older counterparts. This may just be an artifact associated with aging; the longer one lives with HIV the higher the probability one will need or be in care, and resulting in a greater likelihood of being virologically suppressed. As mentioned earlier, this finding could also reflect health systems that are inadequately prepared to specifically and effectively engage young MSM.

There were several study limitations that are important to highlight.

First, the survey data was gathered using a convenience sample, creating the possibility of selection bias for MSM who are more socially connected to MSM organizations or online MSM communities. As a result, levels of participation were limited among MSM in regions where internet access is generally difficult. Although our findings are consistent with findings from other surveys conducted with MSM [37,38], they may not be generalizable to all MSM. However, it is striking to note in a sample of MSM who are relatively better linked to MSM organizations and MSM-focused websites, drop-off for the HIV care continuum is still unacceptably high.

Second, linkage to care was measured using frequency of use of medical care services. This overestimates the number of people who were linked to HIV chronic care. 70% of HIV negative respondents accessed medical care services in the past 12 months and 93% of HIV positive respondents accessed medical care services. Some of the HIV positive respondents who accessed medical care might have done so for services other than HIV chronic care. Our estimate of linkage to care is therefore very optimistic. In addition, our definition of retention in care might have been too narrow: study participants had to report accessing medical care *and* accessing HIV treatment in order to be considered engaged. We adopted a strict definition in the absence of a better measure of retention in care. Future research should strive for better measures of HIV service engagement, utilization and retention.

Third, in the analysis among recently infected, non-significance of predictor variables might be caused by low power. In these models, the number of participants ranges from 34 to 91. Furthermore, some significant correlates of HIV care continuum indicators have 95%CI's that approach 1 and/or have wide confidence intervals (e.g., participation in risk reduction programs, OR=3.71, 95%CI: 1.03 – 13.38). Thus, these estimates should be interpreted with caution and may not be as robust as other correlates we observed.

Fourth, we used self-reported CD to determine eligibility for ART. It is difficult to use CD as a criterion for ART eligibility in a cross-sectional study because CD changes over time. This is especially true for individuals living with HIV for longer periods of time. Moreover, ART eligibility is irrelevant for study participants who reported already being on ART, as they may have experienced a low CD4 nadir followed by an increase after starting ART. For MSM recently diagnosed with HIV, we used CD4<350 mm<sup>-3</sup> to determine eligibility for ART. For study participants who were diagnosed more than 12 months ago, we included participants who reported already being ART *or* who reported CD4<350 mm<sup>-3</sup>. Longitudinal designs are better suited for studying drop-off from the continuum of HIV care. Finally, the sensitivity analysis for viral suppression (the final stage of the cascade)

suggests that missing data in that variable creates uncertainty around our estimate of the proportion of participants who are truly virologically suppressed. The estimates we presented should be understood as the worst-case scenarios where all participants with missing viral load data are not suppressed. Access to viral load testing remains a challenge in resource limited settings, which may explain some of the lack of data [23]. In the best case scenario (all participants with missing viral load data are virologically suppressed) the overall proportion of suppression is close to the overall proportion of retention in care. In reality, the true proportion of virologically suppressed MSM in our sample lies somewhere in between these extremes. In addition, those who initiated treatment more recently may have not been on ART long enough to experience virological suppression, as the typical time to suppression after starting ART is 24 weeks.

The study findings remain cause for concern given the disproportionate HIV disease burden MSM continue to shoulder around the world. Findings also suggest strategies for improving service delivery models to address HIV among MSM. Public health officials should design and adopt comprehensive HIV programs that include mutually reinforcing components [39]. Comprehensive HIV programs must also acknowledge and support the critical role that communities play in linking and retaining MSM in prevention, testing, treatment and care [40]. Strategies used for linking and retaining MSM in the HIV continuum of care may need to consider the specific needs of MSM newly diagnosed with HIV as well as the needs of MSM living with HIV over longer durations of time. Special attention should be given to sensitizing health professionals and making health systems more responsive to the needs of all MSM, particularly those of young MSM.

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