IJQHC Communications, 2022, **2(2)**, 1–11
DOI:https://doi.org/10.1093/ijcoms/lyac013
Advance Access Publication: 8 August 2022
Original Article

The continuum of care for people living with HIV in Suriname: identifying factors influencing the care delivery process

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Abstract

Background: Identifying gaps along the human immunodeficiency virus (HIV) continuum of care is essential in reaching viral suppression.

Objective: The aim of this study aims to identify sociodemographic and clinical factors influencing HIV diagnosis, linkage to care, antiretroviral therapy (ART) initiation and retention, and viral suppression in Suriname.

Method: Adults, over 15 years, enrolled as HIV positive in the national surveillance system from 2010 to 2015, were included. Multiple regression looking into sociodemographic and clinical factors was executed. Indicators evaluated were 'knowing HIV status', people initiating ART, 1-year ART retention, and viral suppression with ART.

Results: There were 2939 registered adults registered. Based on yearly average, of the 52% (95% confidence interval (CI), 52–53%) of estimated people living with HIV, 4950 knew their HIV status; 63% (95% CI, 62–64%) of these diagnosed initiated ART; and 81% (95% CI, 22–32%) of those on ART were virally suppressed. If tested positive at a non-voluntary counseling testing (VCT) site, better linkage to care (adjusted odds ratio (aOR), 1.6; 95% CI, 1.2–2.1) is seen. Although better linked to care (aOR, 1.5; 95% CI, 1.2–1.8), no difference was noted in viral suppression (aOR, 0.8; 95% CI, 0.6–1.0) for men compared to women. Men initiate treatment at a more advanced stage of disease (CD4 $\leq$ 200) than women (47.4% versus 31.4%), leading to higher mortality rates. People from the interior were less likely linked to care (aOR, 0.6; 95% CI, 0.4–0.8) than those from urban regions but did not display significant differences in treatment initiation.

Conclusion: In each step, the continuum shows a significant drop. Innovative interventions with a particular focus on men and people living in the interior are needed. Also, a more proactive system of linking people in care, especially at VCT sites, is needed.

Key words: HIV, Suriname, continuum of care

Introduction

'Human immunodeficiency virus' (HIV) remains in the top 10 of the leading causes of the global disease burden. In 2010, it was mentioned still as the most important cause of disease among people between 30 and 44 years [1]. Globally an estimated 36.9 (95% confidence interval (CI), 31.1–43.9) million people are living with HIV [2]. The Caribbean is the second most affected region worldwide with a prevalence among people between 15 and 49 years of age of 1.4% [3]. Globally, a decrease in mortality is seen due to the scale-up of 'antiretroviral therapy' (ART).

The HIV 'cascade of care', first described by Garner et al. [4], is a framework to identify gaps along the continuum of care and enables interventions to improve HIV care quality and outcomes [5]. Steps within this framework are iterative until reaching the ultimate goal. The Joint United Nations Program on HIV/AIDS (UNAIDS) goals of 90–90–90 by 2020 (i.e. 90% of people living with HIV (PLHIV) knowing their HIV status, 90% of diagnosed persons on ART, and 90% of those on ART reaching viral suppression) were also derived from this continuum of care. Data availability is an essential prerequisite in the calculation and understanding of such public health goals. However, in Latin America and the Caribbean, limited data relevant to the 90–90–90 targets are available [6]. This is directly related to difficulties with the surveillance systems. In Suriname, HIV remains one of the leading causes of mortality [7] with a mortality rate of 14.9 per 100 000 in 2017 [8]. With 1.5 more men dying compared to women, while among new diagnoses the male to female ratio was 1.1. The health authorities could not calculate the HIV care cascade and had no information on impacting factors for reaching viral suppression. The creation of a unified HIV case registry [9] facilitated a more comprehensive HIV care cascade analysis. The first attempt calculating the HIV

Received: 27 May 2021; **Accepted:** 7 August 2022

cascade for 2007–2012 showed 72% linkage to care, 35% ART initiation, and 25% viral suppression [10]. A study in France Guyana, bordering Suriname, using similar definitions, found 89%, 54%, and 34%, respectively, for linkage, ART initiation, and viral suppression [11].

Objectives

The present study examines the continuum of HIV care and treatment in Suriname with the identification of risk factors, starting from the diagnosis to linkage to care, treatment initiation, retention, and ultimately reaching viral suppression.

Methods

Study design

Cross-sectional study. Using data that were collected between 2010 and 2015, indicators of the HIV cascade were constructed.

Setting

The Republic of Suriname, situated in the northern part of South America, consists of 567.300 inhabitants from different ethnic backgrounds [12]. In the last census, the three most prominent ethnic groups were those of African (38%), Indian (27%), and Javanese descent (14%) [13]. The female to male ratio was 1:1 [12]. Suriname has 10 administrative districts, of which 2 are urban, 6 are rural, and 2 are interior areas. The two urban districts, including the capital Paramaribo, cover only 0.5% of the land surface but contain 70% of the total population [7]. The tropical rainforest in the interior is scarcely populated and hard to reach. Although Suriname classifies as an upper-middle-income country, the country is battling a recession [7]. With an estimated 5200 (95% CI, 4300–6600) PLHIV in 2020, the prevalence is 1.1% [14]. HIV testing is widely available through voluntary counseling and testing (VCT) sites and private and hospital laboratories [15]. Clients visiting the laboratories are usually referred by their physician, while anyone can visit the VCT sites for an HIV test. When tested positive, people are responsible for seeking further counseling and care from their family physician. Treatment is free of charge [15]. During the study period, treatment was initiated when CD4 dropped below 200 cells/μl. Treat all was initiated in 2018. CD4 and viral load (VL) test results are reported monthly to the Ministry of Health. Data regarding HIV-infected pregnant women are reported to the PMTCT (prevention of mother-to-child transmission) focal point.

Sampling and participants

Adults, classified as those 15 years and older, who were enrolled in Suriname's HIV case-based surveillance system from January 2010 to December 2015, were included. For the 90–90–90 analysis, the total number of people, still actively seen in the surveillance database, was used, regardless of inclusion date.

Variables and definitions

The Continuum of Care analysis

The primary outcomes evaluated are diagnosis, linked to care, ART initiation, 12-month ART retention, and viral suppression. The study's definitions are based on the different HIV continuum of care monitoring frameworks described by Pan American Health Organization (PAHO), Center for Disease Control and Prevention, and UNAIDS [4, 16–21] and further adjusted to the local context and availability of data.

Indicators and their definitions for the calculation of the HIV continuum of care.

Indicator	Definition
1. Diagnosed	Included (first appearance in at least one of the data sources) in the surveillance system from 2010 to 2015
2. Linked to care	CD4 -, VL result or ART dispense on record
3. ART initiation	The date of treatment initiation on record was classified as having initiated treatment
4. ART 1-year retention	Treatment initiated and still on treatment one year or longer after the start
5. Viral suppression	The last recorded VL result is 1000 copies/ml or less among those initiating ART with a VL result on record: irrespective of the date this last VL

For the steps along the continuum, several independent factors were considered such as sex (female/male), age (15–24/25+ years), living area (urban/rural/rural interior), year of enrollment (2010–2015), initial CD4 in categories (<50/ 50–200/ 201–350/ 351–500/ >500 cells/μl), and ethnicity. For ethnicity, Creole and Maroon were clustered into African descent and compared with the remaining different ethnicities, categorized as non-African descent. For linked to care, the type of laboratory facility was also considered (VCT and non-VCT). ART initiation was also assessed as an independent variable for viral suppression.

The 90–90–90 target analysis

International recommended definitions were used to allow for comparison with other studies and to acquire an update for Suriname on the 90–90–90 targets. The 90–90–90 targets are taking the cumulative number of people for a certain period.

Indicators and their definitions for the calculation of the results for the 90–90–90 targets:

Percentage of PLHIV knowing their status (diagnosed)	Everybody who still appears in the surveillance system in a specific year against the estimated PLHIV in that specific year
Percentage diagnosed on treatment	The number on ART in a specific year against the number diagnosed in the same year
Percentage receiving ART that is virally suppressed*	Last VL result of <1000 copies/ml among those diagnosed and on ART in that same year[a]

[a]According to UNAIDS guidance [14] for countries with VL coverage between 50% and 90%, the percentage used for suppression corresponds to those with a result on record.

Data sources

The primary source of information used was the national HIV 'Patient Master Index' (PMI) [9] version 12 February 2018, which contains the national set of de-duplicated unique patient codes of people diagnosed with HIV in Suriname. The PMI was established through probabilistic (fuzzy) matching, linking the HIV test-, treatment-, CD4/VL-, and the PMTCT databases to each other, thus creating an HIV case-based surveillance system. These clinical individual data are routinely updated, and some contain data since 2000. Regularly, the databases are matched, thus creating an updated version of the national HIV population in Suriname.

For the estimated number of PLHIV, the UNAIDS SPECTRUM [20] software 2020 [4, 16–19] was the data source. Using national data, this modeling software is yearly updated producing updated estimates.

Statistical analysis

Descriptive statistics are provided. For each step in the continuum, the average over the 5 years was calculated. For the numbers in each step, also the 95% CI was determined using the normal approximation method. The 90–90–90 targets over the 5 years were calculated by taking the overall average from the yearly results of 2010–2015. The 95% CI for proportion was calculated.

The different outcomes were calculated according to the sociodemographic and clinical characteristics. Missing data were assigned to the category 'unknown'. In a univariate logistic regression, the odds ratio (OR) for each independent factor was calculated against the different outcomes. Adjusted OR (aOR) were calculated in a multivariate regression model, and factors with a P value <0.05 were considered significant. Analyses were performed using SPSS version 25. Four alternative methods were compared in the sensitivity analysis. By classifying the unknown variables as missing, three additional models were performed in a multivariate regression model. In the first model, all categories were included in the analysis. In the second model, only the variables turning significant in the univariate analysis were included. In the final model, the variables living district, ethnicity, and diagnostic laboratory facility, containing lots of missing variables, were excluded from the analysis. The models were applied to all steps of the continuum of care. The results of these models are shown as complementary data as the overall conclusions remain the same.

STROBE criteria were considered for the reporting of results. The complete checklist can be found in Appendix 1.

Results

From 2010 to 2015, 2939 adults were enrolled in Suriname's national HIV surveillance (Table 1), thus defining the number of diagnosed adults.

Annually, a mean of 490 people was enrolled (range from 469 to 541). Of the persons with known ethnicities ($n = 1463$), the majority (73.7%) were of African descent. Of the diagnosed PLHIV, 80.3% ($n = 2361$; 95% CI, 2292–2430) were linked to care (Figure 1), 53.9% ($n = 1583$; 95% CI, 1519–1648) initiated treatment, and 33.1% ($n = 972$; 95% CI, 1028–1130) were virally suppressed. Of the diagnosed PLHIV, 39.9% had a late diagnosis (initial CD4 of 200 or less cells/μl). Where treatment was initiated, the median ART duration is 2.5 years (inter quartile range (IQR) 0.4–4.3).

The estimated average number of adult PLHIV for the years 2010 to 2015 from SPECTRUM 2018 was 4950 (95% CI, 4083–5850). The average number active in that period, based on appearance in any surveillance source, was 2579. Looking at the 90–90–90 targets, taking the yearly average, 52.1% (51.5–52.7%) of estimated PLHIV knew their HIV status (Figure 2). Almost two-thirds (63.1%; 95% CI, 62.4–63.9%) of those knowing their HIV status were on treatment. With treatment, a viral suppression of 80.9% (95% CI, 80.0–81.8%) was reached.

Linked to care

Men were better linked to care, despite a higher average of late diagnosis (initial CD4 ≤ 200) of 47.4% versus 31.4% for females. In the multivariate analysis, people testing at a non-VCT were almost two times more likely to be linked. People from the interior were 40% less likely to be linked ($P < 0.01$) than people from urban regions (Table 2).

ART initiated

Treatment was initiated for 67% of those linked. Considering the national eligibility criteria during the study period for starting treatment (CD4 ≤ 200 copies/ml), the ART coverage was 70.1%. In 2014 and 2015, the treatment initiation increased with the initiation being, respectively, 1.3 and 1.8 times higher in 2014 and 2015 than in 2010 ($P < 0.05$) (Table 3).

One-year ART retention

The median ART retention period was 2 years (IQR, 0–4). The ART retention was declined by year of enrollment with people enrolled in 2015 being 70% less likely to still be on treatment after a year (aOR = 0.33; 95% CI, 0.22–0.49). The retention also decreased with an initial CD4 > 500 from 57.0% to 68.9%, for those with a CD4 less than 50 (Table 4).

Viral suppression

The factor being significantly associated with viral suppression in the multivariate model is the initial CD4 category. Higher initial CD4 revealed an increased likelihood ($P < 0.01$) of being virally suppressed (respectively, aOR of 1.4, 2.2, 2.0, and 2.8 for CD4 categories 50–200, 201–350, 350–500, and >500 cells/μl). There was a median time of 2 years (IQR, 1–3) between enrollment and the last VL.

Of the people initiating ART, 20% had no VL result on record. Of those with a result, 76.9% ($n = 972$) were virally suppressed. The multivariate model shows that ART initiation gives a seven-time increased likelihood of being virally suppressed (Table 5).

Discussion

Principal findings

The cumulative calculation for determining progress toward reaching the 90–90–90 and moving toward 2030, even 95–95–95 targets, shows a result of 52–64–81 for the period 2010–2015. With viral suppression as the goal, HIV test coverage resulting in identifying PLHIV is a major gap. Even so,

Table 1 Demographic and clinical features related to linkage in care, ART initiation, and viral suppression for HIV-infected adults enrolled from 2010 to 2015

Variable	1. Diagnosed (column %)	2. Linked (%) †	3. ART initiation (%) †	4. One-year ART retention (%) †	Number of PLHIV initiating ART with VL test result	5. VL suppression (%)[a]
Total	2939	2361 (80.3)	1583 (67.0)	1169 (73.8)	1264	972 (76.9)
Sex						
Female	1442 (49.1)	1107 (76.8)	751 (67.8)	456 (60.7)	605	484 (80.0)
Male	1457 (49.6)	1223 (83.9)	801 (65.5)	494 (61.7)	659	488 (74.1)
unknown	40 (1.4)	31 (77.5)	31 (100)	1 (3.2)	0	0
Age at enrollment (years)						
15–24	430 (14.6)	330 (72.7)	232 (70.3)	125 (53.9)	189	143(75.7)
25+	2509 (85.4)	2031 (75.7)	1351 (66.5)	826 (61.1)	1075	829 (77.1)
Ethnicity						
African descent	1078 (36.7)	830 (77.0)	609 (73.4)	426 (70.0)	560	421 (75.2)
Non-African descent	385 (13.1)	284 (73.8)	219 (77.1)	133 (60.7)	195	153 (78.5)
Unknown	1476 (50.2)	1247 (85.1)	755 (60.5)	392 (51.9)	509	398 (78.2)
Living district						
Urban	1116 (38.0)	832 (74.6)	615 (73.9)	404 (65.7)	553	412 (74.5)
Rural	195 (6.6)	135 (69.2)	101 (74.8)	71 (70.3)	90	70 (77.8)
Rural interior	163 (5.5)	101 (62.0)	67 (66.3)	49 (73.1)	63	53 (84.1)
unknown	1465 (49.8)	1293 (88.3)	800 (61.9)	427 (53.4)	558	437 (78.3)
Enrollment year						
2010	493 (16.8)	384 (77.9)	248 (64.6)	165 (66.5)	189	140 (74.1)
2011	486 (16.5)	390 (80.2)	264 (67.7)	188 (71.2)	219	167 (76.3)
2012	541 (18.4)	401 (74.1)	258 (64.3)	179 (69.4)	216	164 (75.9)
2013	469 (16.0)	382 (81.4)	251 (65.7)	143 (57.0)	197	146 (74.1)
2014	525 (17.9)	436 (83.0)	301 (69.0)	180 (59.8)	248	197 (79.4)
2015	425 (14.5)	368 (86.6)	261 (70.9)	96 (36.8)	195	158 (81.0)
Testing facility for HIV diagnosis						
Non-VCT	1400 (47.6)	1043 (74.5)	753 (72.2)	493 (65.5)	911	582 (63.9)
VCT	496 (16.9)	344 (69.4)	261 (75.9)	170 (65.1)	283	188 (66.4)
Unknown	1043 (35.5)	974 (93.4)	569 (58.4)	288 (50.6)	501	302 (60.3)
First CD4 category (cells/μl)						
<50	331 (11.3)	331 (100)	212 (64.0)	146 (68.9)	196	130 (66.3)
50–200	493 (16.8)	493(100)	366 (74.2)	258 (70.5)	346	253 (73.1)
201–350	410 (14.0)	410 (100)	302 (73.7)	210 (69.5)	295	238 (80.7)
351–500	355 (12.1)	355 (100)	209 (58.9)	133 (63.6)	202	160 (79.2)
>500	475 (16.2)	475 (100)	221 (46.5)	126 (57.0)	214	181 (84.6)
unknown	875 (29.8)	297 (33.9)	273 (91.9)	78 (28.6)	11	10 (90.9)
ART initiation						
On ART	1583 (53.9)	1583 (100)	1583 (100)	NA	1264	972 (76.9
No ART	1356 (46.1)	778 (57.4)	NA	NA	NA	NA

[a]Percentage of the previous column.

assuring the continuity of care after diagnosis is a problem. Almost a quarter of those diagnosed is not linked to care, a prerequisite for starting treatment. People testing at VCT sites and living in the most remote areas show low linkage, while their continued steps are in line with other groups. A third of diagnosed adults living with HIV in Suriname is reaching viral suppression with gender disparities throughout the care continuum.

Comparison with international literature

Similar attrition rates were found for French Guyana, USA, and the Caribbean [21]. The Netherlands, Suriname's former colonizer, where more than half a million first-, second-, and third-generation Surinamese live [22], already reached 53% viral suppression in 2010 [23]. They were even successful in reaching the target of 90% viral suppression in 2016 [24], despite a similar 53% late diagnosis from 1996 to 2014 [25]. Possible explanations for their success are the high linkage to care and treatment initiation in the Netherlands, which they attribute to the mandatory insurance card and accredited monitoring of clinics regarding HIV treatment and care [26]. On the other hand, Suriname, like most Latin American countries, faces challenges such as stigma, poor communication between patients and providers, economic limitations, bureaucratic inefficiencies, and fragmented health systems [6]. Analyses of the HIV situation in the Caribbean showed that poverty, marginalization, and cultural issues are the basis of its high prevalence in the Caribbean. Also, stigma during clinical interactions and lack of training of physicians when interacting with different vulnerable groups can result in suboptimal outcomes throughout the continuum of care [27].

In different countries, gender disparities are found throughout the cascade, starting as early as the initial step and reaching the first 90 target [28]. In South Africa, for example, the testing response rate for men compared to women was found to be 48.7% to 63% ($P < 0.001$), while 88.7% of women compared to 78.2% ($P < 0.001$) of men were aware of their HIV

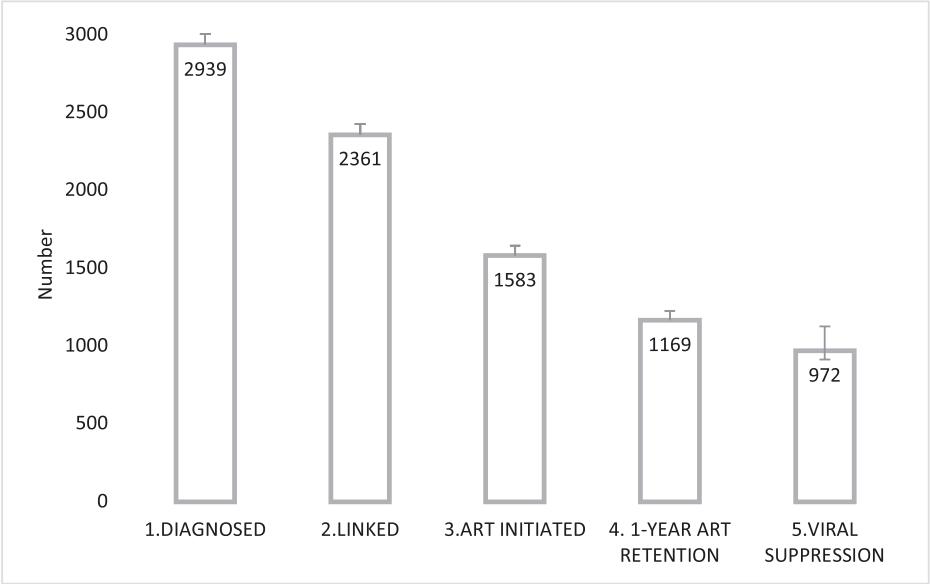

Figure 1 'HIV continuity of care': number of people, 15 and older and enrolled from 2010 to 2015, diagnosed, linked, initiating ART, reaching 1-year ART retention, and viral suppression in Suriname.

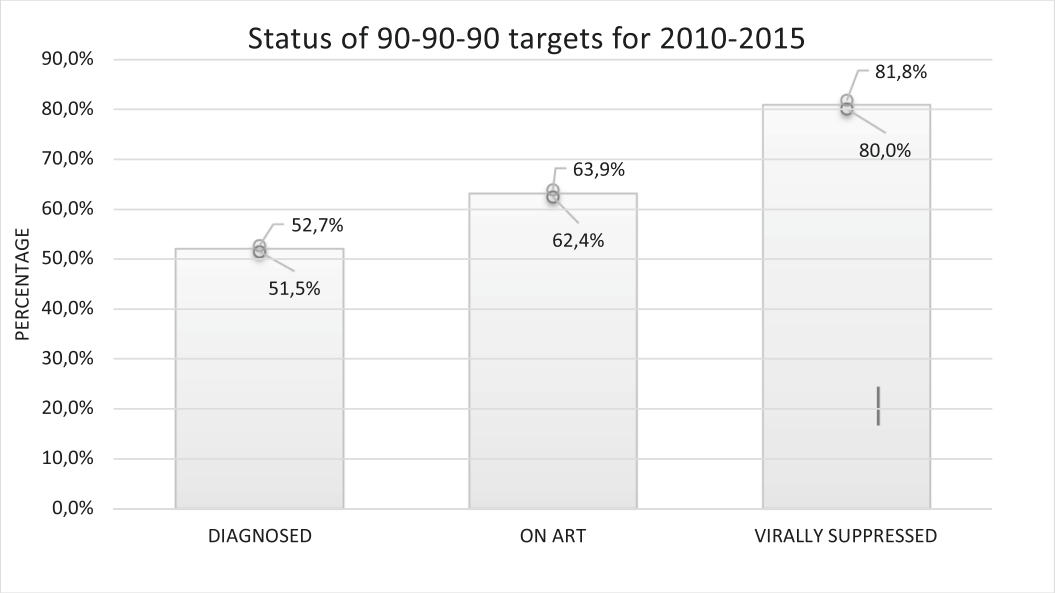

Figure 2 Status of 90–90–90, including 95% CI for Suriname in the period 2010–2015.

status [29]. More men came in with World Health Organization (WHO) stage III/IV and had a higher lost-to-follow-up rate than women. Men, although better linked in care, have less initiation of ART with worse outcomes manifested in 1.5 men to women HIV mortality ratio [10]. Contrary to findings in Belgium [30], where the clinical reason for testing on HIV was associated with higher ART initiation, we found no difference in treatment initiation between men and women. The low percentage of people knowing their HIV status and the accompanied gender disparity, with consistent late diagnosis of men, are probably related to men testing when already sick. This is supported by the more than two times testing positivity rate of men compared to women [31]. HIV testing in women is more often related to testing during pregnancy. In different countries, a similar situation is seen, where the percentage of testing is lower in men compared to women [32–34]. It seems that expectations of HIV-related stigma and lack of discussions regarding HIV are related to a decreased chance of going for testing among men [32, 34]. A study executed in Canada also found that HIV testing was more seen as a routine part of women's health services, e.g. prenatal services, routine pap smear, etc. Men felt they were not offered HIV testing [33].

Lower linkage to care was seen for people living in the interior and those testing at VCT sites. At VCT sites, people are responsible for contacting their physician for further

Table 2 Correlates of linkage to HIV care among patients in Suriname, 2010–2015

	Bivariate		Multivariate	
Variable	OR	95% CI	aOR	95% CI
Sex				
Female	1		1	
Male	1.582	1.314–1.904	1.501	1.231–1.830[a]
unknown	1.042	0.491–2.211	0.282	0.127–0.624[a]
Age at enrollment (years)				
15–24	1		1	
25+	1.288	1.008–1.645	1.112	0.854–1.449
Ethnicity				
Creole, Maroon	1		1	
Non-Creole/ Maroon	0.84	0.643–1.098	0.812	0.612–1.076
Unknown	1.627	1.332–1.997	0.428	0.319–0.575[a]
Living district				
Urban	1		1	
Rural	0.768	0.551–1.071	0.75	0.528–1.068
Rural interior	0.556	0.394–0.784	0.587	0.408–0.845[a]
Unknown	2.566	2.083–3.161	1.517	1.116–2.063[a]
Enrollment year				
2010	1		1	
2011	1.153	0.847–1.57	1.065	0.771–1.472
2012	0.813	0.610–1.083	0.8288	0.608–1.129
2013	1.246	0.909–1.708	1.147	0.824–1.598
2014	1.391	1.018–1.899	1.199	0.862–1.669
2015	1.833	1.290–2.603	1.463	1.002–2.135*
Testing facility for HIV diagnosis				
VCT lab	1			
Non-VCT lab	1.291	1.03–1.618	1.6	1.239–2.066[a]
unknown	6.237	4.575–8.503	9.203	6.018–14.072[a]

[a]$P < 0.05$.

Table 3 Univariate and multivariate logistic regression for factors related to ART initiation

	Bivariate regression		Multivariate regression	
Variable	OR	95% CI	OR	95% CI
Sex				
Female	1		1	
Male	1.123	0.971–1.300	0.883	0.750–1.040
Unknown	3.169	1.498–6.704	8.912	4.125–19.257[a]
Age category				
15–24	1		1	
25+	0.996	0.811–1.223	0.813	0.648–1.020
Ethnicity				
Creole & Maroon	1		1	
Non-Maroon/ Creole	1.016	0.803–1.285	1.019	0.785–1.322
Unknown	0.806	0.689–0.944	0.678	0.526–0.872[a]
Living district				
Urban	1		1	
Rural	0.875	0.645–1.187	0.951	0.679–1.334
Rural interior	0.569	0.407–0.794	0.635	0.439–0.919
Unknown	0.98	0.838–1.146	1.209	0.937–1.560
Enrollment year				
2010	1		1	
2011	1.175	0.914–1.510	1.140	0.869–1.495
2012	0.901	0.705–1.150	0.945	0.723–1.236
2013	1.137	0.883–1.465	1.139	0.864–1.500
2014	1.327	1.037–1.700	1.334	1.018–1.748
2015	1.572	1.208–2.046	1.812	1.354–2.425[a]
First CD4 category (cells/μl)				
<50	1		1	
50–200	1.618	1.196–2.188	1.694	1.216–2.237[a]
201–350	1.57	1.146–2.149	1.533	1.115–2.107[a]
351–500	0.804	0.590–1.094	0.754	0.550–1.033
>500	0.488	0.366–0.651	0.460	0.341–0.619[a]
Unknown	0.255	0.195–0.332	0.223	0.169–0.294[a]

[a]$P < 0.05$.

care. Different studies have shown improvement of linkages when persons are guided to the system or easy linkage is facilitated by teamwork, onsite availability, and healthcare system efficiencies [35]. People living remotely, mostly Maroons and Amerindians, have higher treatment initiation, 1-year retention, and viral suppression. A possible explanation is the fact that the Medical Mission, the primary health care organization providing health services in the interior, is closer to the communities than doctors in urban areas, thus allowing closer monitoring. However, the communities are small, which intensifies the fear of stigma and discrimination. All this could explain the lower linkage to care. A study implemented in a rural area in Tanzania also mentions fear of stigma, lack of disclosure, denial, and cultural and spiritual beliefs as factors hindering linkage to care for HIV [36]. Information provided by the Medical Mission states that people prefer not to receive HIV medication and services in the village.

The continuity of care for HIV needs to be looked at as only one-third of diagnosed reach viral suppression. For those where treatment is initiated, the suppression rate is 80%. This leads to the conclusion that treatment initiation and adherence are areas where the focus needs to be. In this study, mainly the level of the initial CD4 was correlated with the initiation of ART. That people with a CD4 lower than 350 were more prone to have initiated ART is not strange, being that in the period under research treatment was primarily initiated if CD4 was 200 or less. We also see that in time the treatment initiation increases, being almost twice as much in 2015 compared to 2010. Social factors such as stigma, discrimination, health insurance, and economic status are not included in this study. As previously mentioned, these play an important part in determining access to care and outcome.

Limitations and strengths

One of the limitations of our study has to do with data quality issues. These are related to the unique identifier code used. Errors in formulation and data entry at different levels can cause the existence of different codes for one person. Also, two people can end up with the same code. Also, bias could have been introduced by linking errors. To deal with some of these issues, probabilistic matching is incorporated into the development process of the HIV PMI. The probabilistic matching of the PMI is repeatedly done at each upload of newly available clinical data to continuously re-evaluate and improve the quality of the linkage.

Another data quality issue is missing information. Many of the factors evaluated have missing information for which a category 'unknown' has been included. The variables with the biggest number of unknowns such as living district are

Table 4 Univariate and multivariate logistic regression for factors related to ART retained after 1 year

	Bivariate regression		Multivariate regression	
Variable	OR	95% CI	OR	95% CI
Sex				
Female	1		1	
Male	1.041	0.849–1.277	0.912	0.726–1.146
Unknown	0.022	0.003–0.159	0.059	0.008–0.443[a]
Age category				
15–24	1		1	
25+	1.347	1.018–1.783	1.228	0.896–1.681
Ethnicity				
Creole & Maroon	1		1	
Not Maroon/ Creole	0.664	0.482–0.917	0.634	0.448–0.897[a]
Unknown	0.464	0.371–0.581	0.74	0.518–1.056
Living district				
Urban	1		1	
Rural	1.236	0.782–1.954	1.580	0.964–2.590
Rural interior	1.422	0.808–2.502	1.274	0.707–2.295
Unknown	0.598	0.481–0.743	1.143	0.802–1.630
Enrollment year				
2010	1		1	
2011	1.244	0.855–1.810	1.292	0.70–1.917
2012	1.14	0.784–1.656	1.243	0.836–1.849
2013	0.666	0.463–0.958	0.762	0.517–1.123
2014	0.748	0.527–1.062	0.78	0.535–1.137
2015	0.293	0.203–0.421	0.327	0.221–0.485[a]
First CD4 category (cells/μl)				
<50	1		1	
50–200	1.08	0.748–1.559	1.067	0.730–1.560
201–350	1.032	0.706–1.509	1.036	0.698–1.538
351–500	0.791	0.528–1.186	0.81	0.529–1.239
>500	0.6	0.404–0.889	0.621	0.409–0.944[a]
Unknown	0.181	0.122–0.268	0.234	0.153–0.357[a]

[a] $P < 0.05$.

Table 5 Univariate and multivariate logistic regression for factors related to 'VL suppression'

	Bivariate regression		Multivariate regression	
Variable	OR	95% CI	OR	95% CI
Sex				
Female	1		1	
Male	0.713	0.548–0.930	0.787	0.595–1.042
Age category				
15–24	1		1	
25+	1.084	0.755–1.556	1.350	0.920–1.981
Ethnicity				
Creole & Maroon	1		1	
Non-Maroon/ Creole	1.203	0.813–1.779	1.253	0.833–1.884
Unknown	1.184	0.891–1.574	1.071	0.708–1.621
Living district				
Urban	1		1	
Rural	1.198	0.703–2.040	1.110	0.637–1.932
Rural interior	1.814	0.899–3.661	1.810	0.884–3.704
Unknown	1.236	0.936–1.632	1.122	0.743–1.695
Enrollment year				
2010	1		1	
2011	1.124	0.717–1.763	1.073	0.678–1.698
2012	1.104	0.703–1.732	1.112	0.702–1.763
2013	1.002	0.635–1.580	0.932	0.584–1.485
2014	1.352	0.864–2.116	1.356	0.852–2.157
2015	1.495	0.921–2.424	1.447	0.874–2.395
First CD4 category (cells/μl)				
<50	1		1	
50–200	1.381	0.945–2.019	1.399	0.953–2.054
201–350	2.120	1.401–3.207	2.217	1.454–3.380[a]
351–500	1.934	1.232–3.036	2.006	1.259–3.195[a]
>500	2.785	1.732–4.477	2.843	1.736–4.655[a]
Unknown	5.077	0.636–40.511	5.064	0.628–40.810

[a] $P < 0.05$.

collected in the surveillance system from the information coming from the early steps of the cascade. In this regard, data quality needs to be improved. The expectation is although that these inconsistencies are there throughout the years of collecting data and are random and not specifically linked to the outcomes. Lack of data on the mortality status can underestimate achievements, as most definitions for the continuum of care recommend the removal of deaths from the cohort. Also, it is known that vulnerable populations such as sex workers, transpersons, and men having sex with men play a key role in the HIV epidemic in Suriname [8] but are often undercounted. In our study, key factors such as key population (KP) status, socioeconomic factors, and psychosocial support were not considered. Those could provide more insight into factors influencing the outcome.

Recommendations to public policy

Despite the previously mentioned limitations, the national character of the analyzed data and the consistent method of data collection over the years provide confidence for good representativeness of the Surinamese situation and analogously also for countries with similar context. These are the first results on the PLHIV continuum of care for Suriname, including identified gaps using an affordable way of merging different surveillance data sources.

Innovative interventions for reaching men with HIV testing are needed. Further, different strategies for improving linkage to care are needed. Other studies mention the importance of improving linkage to care using the seek, test, treat, and retain strategy [37]. This strategy emphasizes that linkage should happen as soon as possible, preferably within 1 month. The implementation of a tracking system in Suriname reiterated the necessity to create a proactive system, in which people testing positive are immediately teamed up with somebody that can guide them through the system [38], especially for those testing at VCT sites. More tailored interventions can be implemented after reasons for late or no linkage to care is identified.

This initial analysis forms a sound basis for decision-making, and our data platform should be enhanced by including, e.g. KP and psychosocial information. Also, the time taken to move from one step to the other in the continuum of care should be considered.

As mentioned in other studies [37, 39] for the calculation of the HIV care cascade, it is important to guarantee a good working data system with the integration of different sources. This is to identify different factors such as service delay, drug resistance, and transfer among others that can influence the cascade. For Suriname, the current analysis gives

a good insight into the overall HIV cascade. Improvement regarding data quality and timeliness is needed. For identifying the social determinants and getting to timely actions where people are falling out of the cascade, data systems at the local clinical level should be implemented. Adaptation of the indicators to include clinical visits is needed. Also, the time it takes people to go from one step to the other in the continuum should be considered. This will enrich the information available to develop interventions aimed at reaching the 95–95–95 targets in 2030.

Conclusions

There is a lag in diagnosing and initiating treatment for PLHIV in Suriname. Findings indicate the need to prioritize HIV testing for men. Strategies to improve linking and retention to treatment need to be reviewed and strengthened. As 'treat all' only has been introduced since January 2018, full implementation needs to be accelerated, next to increased adherence support for achieving viral suppression. More research is needed to find out deeper underlying reasons for gaps found in the continuum of care for HIV to facilitate evidence-based interventions in the HIV response in Suriname.

Supplementary material

Supplementary material is available at *INTQHC Communications* online.

Authors' contributions

D.S. and W.S. both participated in the design of the study. D.S., W.S., and M.M. were mainly responsible for the analysis with feedback from all authors. D.S. and W.S., a statistician, were both responsible for the statistical analysis. D.S. drafted the manuscript. All authors critically revised the manuscript. The final manuscript was read and approved by all authors.

Ethical approval

Adhering to local procedures, permission was obtained by the director of the Ministry of Health.

Funding

No funding was provided for this study. The initial development of the HIV Patient Master Index though was established and refined with funds from the Center for Disease Control and Prevention and Control under the PEPFAR grant and funds from the Global Fund to Fight AIDS, Tuberculosis and Malaria.

Conflict of interest

All authors report no competing interests or conflicts of interest.

Data availability

Some of the data sources, e.g. estimates from UNAIDS, aggregated data, etc., are publicly available. The majority though of the data used in this study comes from clinical case-based surveillance, collecting individual patient information, including patient demographics. Although coded, guaranteeing the confidentiality, the data cannot be made publicly available. This data can be available on request and approval of the Ministry of Health Suriname

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Appendix 1 STROBE statement—Filled checklist of items that should be included in reports of 'cross-sectional studies'

	Item no.	Recommendation	Page no.
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	1
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	2
Objectives	3	State-specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3–4
Participants	6	(a) Give the eligibility criteria and the sources and methods of selection of participants	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	4–6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	13 included in limitation
Study size	10	Explain how the study size was arrived at	4 sampling
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	7
		(b) Describe any methods used to examine subgroups and interactions	7
		(c) Explain how missing data were addressed	7
		(d) If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—e.g. numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analyzed	8
		(b) Give reasons for nonparticipation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (e.g. demographic, clinical and social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	Tables
Outcome data	15*	Report numbers of outcome events or summary measures	9
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g. 95% CI). Make clear which confounders were adjusted for and why they were included	9 tables
		(b) Report category boundaries when continuous variables were categorized	
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—e.g. analyses of subgroups and interactions and sensitivity analyses	Complementary data
Discussion			
Key results	18	Summarize key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	10–13 comparison of international literature

(continued)

(Continued)

	Item no.	Recommendation	Page no.
Generalizability	21	Discuss the generalizability (external validity) of the study results	14 under recommendation to public policy
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15–16