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HIV Prevalence among Men Who Have Sex with Men following the Implementation of the HIV Preventive Guideline in Tanzania: Respondent Driven Sampling Survey

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ABSTRACT

Objectives: To estimate the prevalence of HIV infection among men who have sex with men (MSM) in Dar es Salaam, Tanzania following nearly half a decade of implementation of the comprehensive guideline of HIV interventions for key populations (CHIP).

Design: A cross-sectional survey using respondent-driven sampling

Setting: Dar es Salaam, Tanzania's largest city.

Participants: Men who occasionally or regularly have sex with another man (men who have sex with men; MSM), aged 18 years and above and living in Dar es Salaam city.

Primary outcome measure: HIV prevalence was the primary outcome. Independent risk factors for HIV infection were examined using weighted logistics regression modelling.

Results: A total of 777 MSM with a mean age of 26 years took part in the study. The weighted HIV prevalence was 8.3% (95%CI: 6.3-10.9) as compared to 22.3% (95%CI: 18.7-26.4) observed in a similar survey in 2013. Half of the participants had had sex with more than 2 partners in the month preceding the survey. Among those who had engaged in transactional sex, 80% had used a condom during last anal sex with a paying partner. Participants aged 25 and above had 4 times higher odds of being infected than those aged 15-19. HIV infection was associated with multiple sexual partnerships (AOR, 3.0; 95%CI: 1.8-12.0), not having used condom during last sex with non-paying partner (AOR, 4.1; 95%CI: 1.4-7.8), and ever having engaged in group sex (AOR, 3.4; 95%CI: 1.7-13.6).

Conclusion: HIV prevalence among MSM in Dar es Salaam has decreased by more than half over the past 5 years, coinciding with implementation of the CHIP. It is nonetheless twice as high as that of men in the general population. To achieve the 2030 goal, behavioral change interventions and roll-out of new intervention measures such as pre-exposure prophylaxis are urgently needed.

Keywords: Men who have sex with men, HIV prevalence, sexual risk behaviors, Tanzania

Strengths and limitations of this study

- This is the largest respondent driven sampling survey among MSM in Tanzania.
- Study participants were recruited from diverse strata of the population.
- The results were weighted to control for network size and clustering resulting from variations in selection probability and network sizes in respondent driven sampling
- Comparisons are made with HIV prevalence estimates generated in a methodologically comparable survey conducted before the launch of the CHIP.
- Data on sexual behavior is subject to social desirability bias.
- The study did not measure biological risk factors for HIV infection which might have provided more insight into the risk profile of this population.

Background

Since 2004, the rate of HIV infection has been declining globally including in Tanzania [1]. The Tanzania HIV Indicator and Impact Surveys indicate that the HIV prevalence among persons aged 15-49 decreased from 7% in 2004 to 4.7% in 2016 [2, 3]. The observed decrease has been attributed to concerted efforts to promote condom use and to an improved HIV testing coverage with 90.9% linkage to antiretroviral therapy (ART) among those who test positive for HIV and 87.7% viral suppression [2].

While evidence of declining overall HIV infection rates have been mounting, populations at higher risk of HIV infection, such as MSM, have continued to carry a disproportionate burden of HIV in Africa and beyond. Studies from Africa have indicated that the HIV prevalence among MSM are 2 to 20 times higher than that in the general population [4-12]. Recent studies have estimated the HIV prevalence among MSM in Tanzania to range from 12.5% in Zanzibar to 22.3% in Dar es Salaam and 11.1% in Tanga [4, 6, 13]. Practices associated with increased risk of HIV, such as multiple sexual partnerships, unprotected anal

sex, group sex, alcohol and drug use, and commercial sex have been commonly reported among MSM [4, 9, 13-16]. A high prevalence of sexually transmitted infections, such as herpes simplex virus type 2, has also been associated with high infection rates among MSM [4, 6, 10, 12, 14].

Populations at increased risk of HIV infection have been estimated to contribute up to 30% of new HIV infections in sub-Saharan Africa, making it impossible to leave them behind if we are to achieve the ambitious third sustainable development goal and end the HIV epidemic by 2030 [7, 17].

In 2014, Tanzania launched the CHIP coupled with training of healthcare workers and the embracement of a multi-sectorial approach to control the HIV epidemic [18]. Nearly half a decade later, no study has evaluated the state of the HIV epidemic in key populations. Given the notable decrease in HIV infection rates in Tanzania's general population, it is important that the dynamic of the HIV epidemic is tracked also in these populations as to inform government efforts aiming to achieve the 2030 goal [2]. This study seeks to provide information on the prevalence of HIV and associated sexual behavior-related risk factors among MSM in Dar es Salaam following nearly half a decade of implementation of CHIP.

METHODS

Design and setting

This was a cross sectional integrated bio-behavioral surveillance (IBBS) survey among MSM conducted between October and December 2017 in Dar es Salaam, the largest city in Tanzania. The location was chosen because it has a large population of MSM and a high prevalence of HIV, and also because baseline data were available for comparison (i.e., data on HIV prevalence and associated risk factors among MSM before the implementation of the CHIP started [19]). Dar es Salaam is a fast-growing city and currently has a population of about 5 million. The estimated overall HIV prevalence among adults aged 15-49 is 6.3% [2].

Study population

MSM aged 18 and above were invited to participate in this survey. Participation required that the person had engaged in same-sex sex during the last 3 months preceding the survey. Also, participants needed to have had an address in, and lived in, Dar es Salaam for at least six months before recruitment commenced.

Sample size estimation

The sample size aimed at achieving desired precision around point estimates for HIV infection among MSM. According to 2013 estimates for Dar es Salaam, the prevalence of HIV was 22% among MSM [4]. With a desired precision of 5%, taking into account a design effect (DEFF) of 3, based on the median DEFF found for key variables in similar RDS surveys in the region [5-9], the estimated sample size for this study was 759.

Sampling and recruitment

Since there was no sampling frame for MSM, eligible study participants were recruited using respondent-driven sampling (RDS) [20]. RDS is a chain referral sampling method that incorporates a recruitment strategy to offset oversampling of certain population groups to minimize traditional snowballing bias [21]. Initially, selected members of the target population (referred to as "seeds") refer other members of the same population to the study team for possible participation in a succession of waves until the desired sample size is achieved. Seeds were identified from different strata of MSM among our previous study contacts and through a meeting with the key population community advisory board. Characteristics that were taken into account in selection of seeds were age, socio-economic status, locality and sexual preference (preference for insertive or receptive anal sex).

Data collection tool and data collection procedures

A questionnaire validated in previous IBBS surveys conducted by our research group and others was used in this study [4]. The questionnaire contained questions on socio-demographic characteristics and sexual practices and was administered in Swahili, the language spoken by all Tanzanians. Six seeds were identified and represented different groups of MSM. Participants were invited to a recruitment centre where they were provided with information about the study and asked if they would consent to participate in it. All study participants gave informed consent to take part in the research, and face-to-face interviews using Android tablets equipped with an Open Data Kit (ODK) for recording of data. Following the interviews, HIV pre-test counseling was carried out before participants were offered to test for HIV. All participants received health education and condoms after the interview and were compensated for their transportation to the study site at a rate of TZS 8000 (equivalent to US$ 4) per person, as agreed upon with MSM representatives and approved by the ethical committee of the Muhimbili University of Health and Allied Sciences (MUHAS).

Patients and public involvement

Not patients were involved in this study

Laboratory testing

HIV testing followed the national testing algorithm. All samples were tested using the SD Bioline HIV-1/2 3.0 rapid test (Standard Diagnostics, Inc., Korea). Non-reactive results were considered negative for HIV whereas reactive results were subsequently tested with Uni-Gold™ HIV-1/2 (Trinity Biotech Plc, Ireland). Discrepant results were resolved by Enzygnost HIV Integral II Antibody/Antigen ELISA (Siemens, Germany).

Data analysis

STATA version 15 and the RDSAT statistical package were used for analysis of data emanating from this survey. Data were weighted to control for network size and the clustering resulting from variations

in selection probability and networks sizes [20]. Categorical variables were summarized by calculating weighted proportions, and differences in proportions were examined using χ^2 test. Median and inter-quartile range (IQR) were used to summarize continuous variables. Bivariate analyses and multivariate logistic regression models were used to measure associations between various risk factors and HIV infection. All exposure variables with a $p \leq 0.2$ in bivariate analysis were included into a multivariate model. Crude and adjusted odds ratios (OR and AOR, respectively) for potential confounders with corresponding 95% confidence intervals (95%CI) are reported. All analyses were two-tailed and the significance level was set at 5%.

Ethical considerations

The protocol for this survey was reviewed and approved by the ethical review committee of the Muhimbili University of health and allied sciences (MUHAS). Permission to conduct the study was thereafter sought from local authorities. All participants provided written informed consent to participate, separately for interviews and blood sample collection. Participants who tested positive for HIV were referred to care and treatment for further management.

RESULTS

During the study period, 777 eligible MSM consented to participate in the study and gave blood for HIV testing. Their overall mean age was 26.0 years (standard deviation 7.1) with the largest proportion (34.8%) being 20-24 years old. A majority had competed either primary (44.8%) or secondary (48.4%) education. Three quarters (78.9%) reported to never have married, 71.1% were born and raised in Dar es Salaam, and half (50.6%) lived with their family. The median monthly income was 160,000 Tanzanian shillings (IQR 80,000-300,000), with a third (34.3%) reporting a monthly income above 200,000 shillings (Table 1).

Table 1: Comparison of HIV prevalence by Socio-demographic Characteristics among MSM in Dar es Salaam,

Tanzania (N=777)

Variable	Category	n (%)	HIV Positive n (%)	p-value
Age groups (years)	15-19	134 (17.3)	6 (4.45)	0.004
	20-24	271 (34.8)	28 (10.3)	
	25-29	152 (19.6)	24 (15.8)	
	30-34	105 (13.5)	18 (17.0)	
	≥ 35	115 (14.8)	20 (17.4)	
Education level	No formal	21 (2.7)	3 (14.3)	0.385
	Primary	348 (44.8)	43 (12.4)	
	Secondary	376 (48.4)	43 (11.4)	
	Above secondary	32 (4.1)	7 (21.9)	
Marital Status	Never married	613 (78.9)	67 (10.9)	0.114
	Married/cohabiting	84 (10.8)	14 (16.7)	
	Divorced/separated	80 (10.3)	35 (20.0)	
Time lived in Dar es Salaam	Born and raised	552 (71.1)	63 (11.4)	0.380
	Not born	225 (28.9)	33 (14.7)	
Income past month (TZS)	<50,000	133 (17.1)	18 (13.5)	0.841
	50,000-120,000	151 (19.4)	20 (13.3)	
	120,001-200,000	227 (29.2)	29 (12.8)	
	>200,000	266 (34.3)	29 (10.9)	
Currently living with	Alone	304 (39.1)	39 (12.8)	0.219
	Family	393 (50.6)	42 (10.7)	
	Boyfriend	50 (6.4)	11 (22.0)	
	Wife/girlfriend	30 (3.9)	4 (14.3)	

Sexual practices and risks

The median age at anal sexual debut was 16 years (IQR: 14-18). Half (51.1%) of the study participants reported to have had sex with a woman. Of those who had had sex with a non-paying male partner in the past month, more than half reported to have had either insertive (57.3%) or receptive (64.3%) sex with 2 or more partners. Use of condoms during last anal sex with a receptive non-paying partner was reported

by 9.3%. Transactional sex was common among the study participants, with one-third (32.6%) reporting to have paid another man for sex during the past month prior to the survey, and nearly three quarters (69.5%) reported to have sold sex in the same period. A total of 80.2% had sold sex during the one-year period preceding the survey. While the proportion of participants who had used condoms with paid partners in the past month was 28.7%, condom use with paying partners in the past month was as high as 80.0%. About 15% of participants reported to have experienced condom breakage while having anal sex during the past month. Just above a quarter (26.2%) said they had engaged in group sex at least once in their lifetime (Table 2).

Table 2: HIV Prevalence by Selected Sexual Behavior Characteristics among MSM in Dar es Salaam, Tanzania (N=777)

Variable	Category	N (%)	HIV Positive n(%)	p-value
Age at first sexual intercourse				
	<15	348 (43.4)	49 (8.3)	0.979
	16-18	266 (33.9)	29 (8.0)	
	>18	163 (22.7)	18 (8.7)	
Had sex with a woman in past one year				
	Yes	377 (51.1)	29 (5.5)	0.023
	No	400 (48.9)	67 (11.2)	
Bought sex past one year				
	Yes	320 (37.6)	41 (9.6)	0.376
	No	457 (62.4)	55 (7.5)	
Sold sex past one year				
	Yes	644 (80.2)	84 (9.1)	0.108
	No	133 (19.8)	12 (5.0)	
Number of non-paying insertive male partners past month				
	1	109 (42.7)	10 (7.9)	0.067
	2 and above	184 (57.3)	19 (10.3)	
Number of non-paying receptive male partners in past month				
	1	46 (35.7)	12 (29.3)	0.489
	2 and above	109 (64.3)	37 (33.9)	
Used a condom with last receptive non-paying partner				
	Yes	73 (9.3)	25 (34.2)	0.002
	No	450 (90.7)	54 (12.0)	
Paid another man for anal sex past month				
	Yes	191 (32.6)	13 (6.9)	0.717
	No	586 (67.4)	30 (5.1)	

Variable	Category	N (%)	HIV Positive n(%)	p-value
Used a condom with last paid male partner				
	No	554 (71.3)	75 (13.5)	0.059
	Yes	223 (28.7)	21 (9.4)	
Sold sex to another man in past month				
	Yes	540 (69.5)	54 (10.0)	0.771
	No	237 (30.5)	21 (8.9)	
Used a condom with last paying male partner				
	No	108 (20.0)	8(7.4)	0.041
	Yes	432 (80.0)	60 (13.9)	
Had a condom break during anal sex in past month				
	Yes	102 (15.1)	31 (24.1)	<0.001
	No	395 (84.9)	49 (7.7)	
Ever participated in group sex				
	Yes	232 (26.2)	43 (13.0)	0.015
	No	545 (73.8)	53 (6.6)	

HIV prevalence

The weighted prevalence of HIV was 8.3% (95%CI: 6.3-10.9). The prevalence increased linearly with age and was significantly higher among those who had had sex with a woman in the past year (11.1% versus 5.5%, p=0.023), among those who had used a condom with their last non-paying partner (34.2% versus 12.0%, p=0.002), among those who had not used a condom with last paying partner (13.9 versus 7.4%, p=0.041) and among those reporting condom breakage during last anal sex (24.1% versus 7.7%, p<0.0001). Having engaged in group sex was also associated with higher HIV prevalence (13.0% versus 6.6%, p=0.015).

Comparison of HIV prevalence between 2013 and 2017

In 2013, 753 MSM participated in a survey conducted by the same research group that carried out the present study. The mean age in 2013 was 26.5 years (95%CI: 26.1-27.1) while the mean age in 2017 was 26.0 years (95%CI: 25.5-26.5). The age composition of samples therefore did not differ between the two surveys (p<0.0001). No significant statistical differences in other socio-demographic characteristics were

observed between the two samples (Table 3). However, the estimated HIV prevalence in 2017 was less than half that of 2013 (8.3% versus 22.3%, p<0.001)

Table 3: Comparison of Socio-Demographic Characteristics of the 2013 and 2017 Survey Samples

Demographic Characteristic	2013 (%)	2017 (%)
Age (years)		
≤ 24	46.3	52.1
25-34	41.2	33.1
≥ 35	12.4	14.8
Level of education		
No formal education	1.1	2.7
Some or completed primary education	42.9	44.8
Some or completed secondary education	52.9	48.4
Post-secondary education	3.1	4.1
Marital status		
Single	83.2	78.9
Married/cohabiting	5.9	10.8
Separated/divorced/widower	6.9	10.3
Current living arrangement		
With family	52.5	50.6
Alone	35.3	39.1
Boyfriend	5.7	6.4
Wife/girlfriend	6.0	3.9
Occupation		
Petty trader	39.8	39.1
Employed	17.9	22.4
Self employed	33.2	42.3
Other	6.5	9.3

Independent risk factors for HIV

The results of bivariate and multivariate logistic regression of independent risk factors for HIV infection are presented in Table 4 and 5. HIV prevalence increased with age, with men aged 25 years and above having 4 times higher risk of infection than those who were between 15 and 19 years. Having had 2 or more receptive non-paying male sexual partners in the last month before the survey was associated with higher odds of HIV infection (AOR=3.0; 95%CI: 1.8-12.0). Having used a condom during last sex with a non-paying partner was also associated with increased risk of testing positive for HIV (AOR=4.1; 95%CI:

1.4-7.8) and those who had ever engaged in group sex had 3 times higher odds of being HIV positive (AOR=3.4; 95%CI: 1.7-13.6). On the other hand, condom use during last anal sex with a paying partner (AOR=0.4, 95%CI: 0.2-0.9) was associated with 60% lower odds of HIV infection.

Table 4: Weighted Logistic Regression Modelling of the Association between Socio-Demographic Factors and HIV among MSM in Dar es Salaam, Tanzania

Variable	Category	OR (95%CI)	AOR (95%CI)[χ]	p-value*
Age groups (years)	15-19	1	1	
	20-24	2.3 (0.9;5.4)	2.3 (0.9;5.6)	0.061
	25-29	3.5 (1.5;8.4)	3.9 (1.6;9.5)	0.003
	30-34	3.8 (1.6;9.3)	4.1(1.6;10.4)	0.003
	35+	3.9 (1.6;9.3)	4.0 (1.4;5.3)	0.004
Education level	No formal	1		
	Primary	0.9 (0.3;2.5)		
	Secondary	1.8 (0.3;2.4)		
	Above secondary	1.5 (0.5;5.3)		
Marital Status	Never married	1	1	
	Married/cohabiting	0.5(0.9;1.6)	1.0 (0.5;2.2)	0.990
	Divorced/separated	1.7(1.1;2.9)	1.3 (0.7;2.3)	0.375
Time lived in Dar es salaam	Born and raised	0.4(0.1;1.1)	0.4 (0.1;1.3)	0.117
	1-5 years	0.6(0.2;1.0)	0.6 (0.2;1.3)	0.386
	6 and above years	0.5(0.2;1.6)	0.4 (0.1;1.2)	0.147
Income past month (TZS)	<50,000	1		
	50,000-120,000	1.0(0.5;1.8)		
	121,000-200,000	0.9(0.6;1.6)		
	>200,000	0.8(0.5;1.4)		
Currently living with	Alone	1		
	Family	0.8(0.6;1.5)		
	Boyfriend	1.7(0.9;3.1)		
	Wife/girl friend	1.1(0.4;2.9)		

[χ] Adjusted for all variables in the table with p-value of ≤0.2 in the bivariate model; * p-value for adjusted OR

Table 5: Weighted Logistic Regression Modelling of Association between Sex-Related Risk Factors and HIV among MSM in Dar es Salaam, Tanzania

Variable	Category	OR (95%CI)	AOR (95%CI)χ	p-value*
Age at sexual debut	≤ 15	1		
	16-18	0.8(0.5;1.2)		
	>18	0.8(0.5;1.3)		
Had sex with a woman past 12 months	No	1	1.	
	Yes	0.5(0.3;0.7)	0.9(0.6;1.2)	0.861
Bought sex past one year	No	1	1	
	Yes	1.1(0.7;1.4)	1.7(0.6;3.0)	0.370
Sold sex past one year	Yes	1		
	No	0.8(0.2;5.1)		
Number of male receptive partners where no payment is involved past month	1	1	1	
	2 and above	1.6(1.1;7.5)	3.0(1.8;12.0)	0.000
Number of non-paying insertive male partners past month	1	1	1	
	2 and above	1.5(0.5;11.2)	1.6(0.4;23.1)	0.531
Used a condom with last receptive non-paying partner	No	1	1	
	Yes	3.1(1.2;7.2)	4.1(1.4;7.8)	0.000
Paid another man for anal sex past month	No	1	1	
	Yes	1.5(0.5;9.2)	1.6(0.6;11.8)	0.142
Used a condom with last paid male partner	Yes	1	1	
	No	1.1(0.5;2.1)	1.5(0.7;3.0)	0.284
Used a condom with last paying male partner	Yes	1	1	
	No	0.6(0.3;1.0)	0.4(0.2;0.9)	0.000
Sold sex to another man past month	No	1	1	
	Yes	1.3(0.7;2.2)	2.5(0.7;8.5)	0.156
Had a condom break during anal sex in past month	No			
	Yes	1.5(1.7;3.6)	1.2(0.7;2.1)	0.431
Ever participated in group sex	No	1	1	
	Yes	3.1(1.2;15.6)	3.4(1.7;13.6)	0.000

χ Adjusted for all variables in the table with p-value of ≤0.2 in the bivariate model; * p-value for adjusted OR

DISCUSSION

This study examined HIV prevalence among MSM in Dar es Salaam after the national guideline on CHIP had been under implementation in Tanzania since 2014. The estimated HIV prevalence was 8.3% (95%CI: 6.3-10.9), as compared to 22.3% (95%CI: 18.7-26.4) in 2013 [4]. This observation suggests that the HIV prevalence in this population has decreased by 62 percent over the past 5 years. The observed decline is substantial and statistically significant. The socio-demographic characteristics of the 2013 and 2017 survey samples did not differ significantly, suggesting that differences in the study population structure may not explain the observed decline. The difference from 2013 would be even greater if our current estimates were compared to another study conducted among MSM in Dar es Salaam that year. That study (albeit based on a sample of only 200 MSM) reported an HIV prevalence of 30.2% among MSM [6].

The present survey is the first study ever to report declining HIV prevalence among MSM in Tanzania. The decline echoes the dynamic of the overall HIV situation in Tanzania, where HIV prevalence in the general population has been steadily decreasing over the past decade, from 7.0% in 2003 to 4.7% in 2016 [2, 3]. Similar trends of decreasing HIV prevalence in key population groups alongside that in the general population have also been reported elsewhere [7, 9, 22].

Despite the reported decrease, the HIV prevalence among MSM is still twice as high as that among men in the general population in Dar es Salaam. For this reason, recent calls for continued efforts to address HIV in high-risk populations made by the authors of a systematic review of the global epidemiology of HIV among MSM [8] is still very relevant also in Dar es Salaam.

Sexual practices associated with HIV risk continue to be common among MSM in Dar es Salaam, and were significantly associated with HIV seropositivity. A substantial proportion of men have multiple

sexual partnerships and engage in group sex, as has also been reported earlier both in Tanzania and elsewhere in Sub-Saharan Africa [4, 5, 12, 23, 24].

Men aged 25 and above had higher HIV prevalence than those who were younger in this study, similar to what has been reported earlier in Dar es Salaam and elsewhere in Africa [4, 5, 10, 11]. A higher HIV prevalence among older men may reflect accumulation of risk over time and/or higher survival following ongoing efforts to improve linkage to care for people testing positive for HIV. The most recent AIDS indicator survey in Tanzania reported that 90.9% of persons who were between 15 and 64 years of age and who knew their HIV status indicated that they were on antiretroviral treatment, and 87.7% were virally suppressed [2]. However, HIV testing coverage in the country is still low with only 52.2% of people living with HIV knowing their HIV status (in the 15-64 age bracket) [2].

More than half of our study participants reported to have had sex with more than 2 partners. Moreover, transactional sex was very common in this population, with 64% reporting to have paid for sex during the past month, and 79% reporting to have sold sex during the last month. However, a striking finding was that condom use was very common among MSM who engaged in commercial sex. Condom use during last commercial sex was reported by a total of 80% of the study participants as compared to 49% in 2013 [4]. A significant increase in condom use among MSM following preventive education has recently been reported in a cohort of MSM in West Africa [22]. We found that condom use with paying partners (commercial sex) was associated with a 60% lower likelihood of HIV infection in this study. This increase in protected commercial sex may partly explain the decreased HIV prevalence observed in this study.

On the other hand, condom use with regular (non-paying) partners was low in this study (9.3%), but comparable to that found in other studies of key populations in Tanzania [25]. Low perceived susceptibility and a sense of trusting a regular partner are factors that have been associated with

condom-less sex [26, 27]. Worth noting in this study is the finding that condom use with regular partners was significantly associated with HIV seropositivity. It is possible that this reflects that some HIV positive MSM use condoms when they engage in sex to ensure the safety of their partners. This has also been reported in other studies in Asia and Africa [16, 28, 29].

As was the case in our 2014 study among MSM in Dar es Salaam, nearly one-third of the study participants reported to have engaged in group sex [4], and group sex was associated with HIV infection. This underscores the need for tailored preventive messaging addressing safer group sex in implementing the CHIP [2, 17].

CONCLUSION

The HIV prevalence among MSM in Dar es Salaam has decreased by more than half over the past 5 years, coinciding with the implementation of the CHIP in Tanzania. Despite of the considerable decrease, the HIV prevalence in this population still remains twice as high as that among men in general. More condom protected anal sex could have played a role in the declining HIV prevalence among MSM. Efforts to promote safer sex among men who engage in multiple sexual partnerships and group sex are called for. The roll out of new intervention measures, such as pre-exposure prophylaxis, could significantly contribute in the ongoing efforts to end the epidemic

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Competing interest statement

Authors declare that they have no competing interest.

Authors contributions

AM analyzed data, interpreted results and drafted the manuscript. EJM designed the study, analyzed data and interpreted results. KM, GHL, TL, NM, AR, MTL, DM and BT designed the study and interpreted the results. SL and MM, collected data and interpreted the results. All authors revised and approved the final version of the manuscript.

Data availability

Data are available from the corresponding authors upon reasonable request.

Participants consent

All participants provided written informed consent before interview or blood specimen collection.

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STROBE Statement—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	01
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	02
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	03
Objectives	3	State specific objectives, including any prespecified hypotheses	04
Methods			
Study design	4	Present key elements of study design early in the paper	04
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	04
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	05
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
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	*5-7*
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	05
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6-7
		(*e*) Describe any sensitivity analyses	6-7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7-8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
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 (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12

		(*b*) Report category boundaries when continuous variables were categorized	12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12-13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
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	03
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
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	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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HIV Prevalence among Men Who Have Sex with Men following the Implementation of the HIV Preventive Guideline in Tanzania: Respondent Driven Sampling Survey

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ABSTRACT

Objectives: To estimate HIV prevalence and associated risk factors among men who have sex with men (MSM) in Dar es Salaam, Tanzania following nearly half a decade of implementation of the comprehensive package for HIV interventions for key populations (CHIP).

Design: A cross-sectional survey using respondent-driven sampling

Setting: Dar es Salaam, Tanzania's largest city.

Participants: Men who occasionally or regularly have sex with another man (men who self-reported to have ever had sex with other men in the past three months preceding the study), aged 18 years and above and living in Dar es Salaam city at least six months preceding the study.

Primary outcome measure: HIV prevalence was the primary outcome. Independent risk factors for HIV infection were examined using weighted logistics regression modelling.

Results: A total of 777 MSM with a mean age of 26 years took part in the study. The weighted HIV prevalence was 8.3% (95%CI: 6.3-10.9) as compared to 22.3% (95%CI: 18.7-26.4) observed in a similar survey in 2014. Half of the participants had had sex with more than 2 partners in the month preceding the survey. Among those who had engaged in transactional sex, 80% had used a condom during last anal sex with a paying partner. Participants aged 25 and above had 4 times higher odds of being infected than those aged 15-19. HIV infection was associated with multiple sexual partnerships (AOR, 3.0; 95%CI: 1.8-12.0), not having used condom during last sex with non-paying partner (AOR, 4.1; 95%CI: 1.4-7.8), and ever having engaged in group sex (AOR, 3.4; 95%CI: 1.7-13.6).

Conclusion: HIV prevalence among MSM in Dar es Salaam has decreased by more than half over the past 5 years, coinciding with implementation of the CHIP. It is nonetheless twice as high as that of men in the general population. To achieve the 2030 goal, behavioral change interventions and roll-out of new intervention measures such as pre-exposure prophylaxis are urgently needed.

Keywords: Men who have sex with men; HIV prevalence; risk behaviors; comprehensive intervention package; Tanzania

Strengths and limitations of this study

- This is the largest respondent driven sampling survey among MSM in Tanzania and study participants were recruited from diverse strata of the population.
- The results were weighted to control for network size and clustering resulting from variations in selection probability and network sizes in respondent driven sampling
- Comparisons are made with HIV prevalence estimates generated in a methodologically comparable survey conducted before the launch of the comprehensive package for HIV prevention and care for key population.
- Data on sexual behavior is subject to social desirability bias.
- Data on sexual behavior is subject to social desirability bias and this study did not measure biological risk factors for HIV infection which might have provided more insight into the risk profile of this population.

Background

Since 2004, the rate of HIV infection has been declining globally including in Tanzania [1]. The Tanzania HIV Indicator and Impact Surveys indicate that the HIV prevalence among persons aged 15-49 decreased from 7% in 2004 to 4.7% in 2016 [2, 3]. The observed decrease has been attributed to concerted efforts to promote condom use and to an improved HIV testing coverage with 90.9% linkage to antiretroviral therapy (ART) among those who test positive for HIV and 87.7% viral suppression [2].

While evidence of declining overall HIV infection rates has been mounting, populations at higher risk of HIV infection, such as MSM, have continued to carry a disproportionate burden of HIV in Africa and beyond. Studies from Africa have indicated that the HIV prevalence among MSM are 2 to 20 times higher than that in the general population [4-12]. Recent studies have estimated the HIV prevalence among MSM in Tanzania to range from 12.5% in Zanzibar to 22.3% in Dar es Salaam and 11.1% in Tanga [4, 6, 13]. Practices associated with increased risk of HIV, such as multiple sexual partnerships, unprotected anal sex, group sex, alcohol and drug use, and commercial sex have been commonly reported among MSM [4, 9, 13-16]. A high prevalence of sexually transmitted infections, such as herpes simplex virus type 2, has also been associated with high infection rates among MSM [4, 6, 10, 12, 14].

Populations at increased risk of HIV infection have been estimated to contribute up to 30% of new HIV infections in sub-Saharan Africa, making it impossible to leave them behind if we are to achieve the ambitious third sustainable development goal and end the HIV epidemic by 2030 [7, 17].

In 2014, Tanzania launched a comprehensive package for HIV prevention and care among key population (CHIP) coupled with training of healthcare workers and the embracement of a multi-sectorial approach to

control the HIV epidemic [18]. CHIP provided a detailed description of preventive, curative and psychosocial interventions key population including MSM should receive when seeking healthcare services. Nearly half a decade later, no study has evaluated the state of the HIV epidemic in key populations. Given the notable decrease in HIV infection rates in Tanzania's general population, it is important that the dynamic of the HIV epidemic is tracked also in these populations as to inform government efforts aiming to achieve the 2030 goal [2]. This study seeks to provide information on the prevalence of HIV and associated sexual behavior-related risk factors among MSM in Dar es Salaam following nearly half a decade of implementation of CHIP.

METHODS

Design and setting

This was a cross sectional integrated bio-behavioral surveillance (IBBS) survey among MSM conducted between October and December 2017 in Dar es Salaam, the largest city in Tanzania. The location was chosen because it has a large population of MSM and a high prevalence of HIV, and also because baseline data were available for comparison (i.e., data on HIV prevalence and associated risk factors among MSM before the implementation of the CHIP started [19]). Dar es Salaam is a fast-growing city and currently has a population of about 5 million. The estimated overall HIV prevalence among adults aged 15-49 is 6.3% [2].

Study population

MSM aged 18 and above were invited to participate in this survey. Participation required that the person had engaged in same-sex sex during the last 3 months preceding the survey. Also, participants needed to have had an address in, and lived in, Dar es Salaam for at least six months before recruitment commenced.

Sample size estimation

We used the formula by Fleiss et al to calculate the sample size which aimed at achieving desired precision around point estimates for HIV infection among MSM [3]. According to the 2014 estimates for Dar es Salaam, the prevalence of HIV was 22% among MSM [4]. With a desired precision of 5%, taking into account a design effect (DEFF) of 3, based on the median DEFF found for key variables in similar RDS surveys in the region [5-9], the estimated sample size for this study was 759.

Sampling and recruitment

Since there was no sampling frame for MSM, eligible study participants were recruited using respondent-driven sampling (RDS) [20]. RDS is a chain referral sampling method that incorporates a recruitment strategy to offset oversampling of certain population groups to minimize traditional snowballing bias [21]. Initially, selected members of the target population (referred to as "seeds") refer other members of the same population to the study team for possible participation in a succession of waves until the desired sample size is achieved. Seeds were identified from different strata of MSM among our previous study contacts and through a meeting with the key population community advisory board. Characteristics that were taken into account in selection of seeds were age, socio-economic status, locality and sexual preference (preference for insertive or receptive anal sex). Recruitment networks by age groups for this study are presented in figure 1.

Data collection tool and data collection procedures

A questionnaire validated in previous IBBS surveys conducted by our research group and others was used in this study [4]. The questionnaire contained questions on socio-demographic characteristics and sexual practices and was administered in Swahili, the language spoken by all Tanzanians. Seeds were identified and represented different groups of MSM. Participants were invited to a recruitment centre where they were provided with information about the study and asked if they would consent to participate in it. All

study participants gave informed consent to take part in the research, and face-to-face interviews using Android tablets equipped with an Open Data Kit (ODK) for recording of data. Following the interviews, HIV pre-test counseling was carried out before participants were offered to test for HIV. All participants received health education and condoms after the interview and were compensated for their transportation to the study site at a rate of TZS 8000 (equivalent to US$ 4) per person, as agreed upon with MSM representatives and approved by the ethical committee of the Muhimbili University of Health and Allied Sciences (MUHAS).

Patients and public involvement

Not patients were involved in this study

Laboratory testing

HIV testing followed the national testing algorithm. All samples were tested using the SD Bioline HIV-1/2 3.0 rapid test (Standard Diagnostics, Inc., Korea). Non-reactive results were considered negative for HIV whereas reactive results were subsequently tested with Uni-Gold™ HIV-1/2 (Trinity Biotech Plc, Ireland). Discrepant results were resolved by Enzygnost HIV Integral II Antibody/Antigen ELISA (Siemens, Germany).

Data analysis

STATA version 15 and the RDSAT statistical package were used for analysis of data emanating from this survey. Data were weighted to control for network size and the clustering resulting from variations in selection probability and networks sizes [20]. Categorical variables were summarized by calculating weighted proportions, and differences in proportions were examined using χ^2 test. Median and inter-quartile range (IQR) were used to summarize continuous variables. Bivariate analyses and multivariate logistic regression models were used to measure associations between various risk factors and HIV infection. All exposure variables with a $p \leq 0.2$ in bivariate analysis were included into a multivariate

model. Crude and adjusted odds ratios (OR and AOR, respectively) for potential confounders with corresponding 95% confidence intervals (95%CI) are reported. All analyses were two-tailed and the significance level was set at 5%.

Ethical considerations

The protocol for this survey was reviewed and approved by the ethical review committee of the Muhimbili University of health and allied sciences (MUHAS). Permission to conduct the study was thereafter sought from local authorities. All participants provided written informed consent to participate, separately for interviews and blood sample collection. Participants who tested positive for HIV were referred to care and treatment for further management.

RESULTS

During the study period, 777 eligible MSM consented to participate in the study and gave blood for HIV testing. Their overall mean age was 26.0 years (standard deviation ± 7.1) with the largest proportion (34.8%) being 20-24 years old. A majority had competed either primary (44.8%) or secondary (48.4%) education. Three quarters (78.9%) reported to have never married,71.1% were born and raised in Dar es Salaam, and half (50.6%) lived with their family. The median monthly income was 160,000 Tanzanian shillings (IQR 80,000-300,000), with a third (34.3%) reporting a monthly income above 200,000 shillings (Table 1).

Table 1: Comparison of HIV prevalence by Socio-demographic Characteristics among MSM in Dar es Salaam,

Tanzania (N=777)

Variable	Category	n (%)	HIV Positive n (%)	p-value
Age groups (years)	15-19	134 (17.3)	6 (4.45)	0.004
	20-24	271 (34.8)	28 (10.3)	
	25-29	152 (19.6)	24 (15.8)	
	30-34	105 (13.5)	18 (17.0)	
	≥ 35	115 (14.8)	20 (17.4)	
Education level	No formal	21 (2.7)	3 (14.3)	0.385
	Primary	348 (44.8)	43 (12.4)	
	Secondary	376 (48.4)	43 (11.4)	
	Above secondary	32 (4.1)	7 (21.9)	
Marital Status	Never married	613 (78.9)	67 (10.9)	0.114
	Married/cohabiting	84 (10.8)	14 (16.7)	
	Divorced/separated	80 (10.3)	35 (20.0)	
Time lived in Dar es Salaam	Born and raised	552 (71.1)	63 (11.4)	0.380
	Not born	225 (28.9)	33 (14.7)	
Income past month (TZS)	<50,000	133 (17.1)	18 (13.5)	0.841
	50,000-120,000	151 (19.4)	20 (13.3)	
	120,001-200,000	227 (29.2)	29 (12.8)	
	>200,000	266 (34.3)	29 (10.9)	
Currently living with	Alone	304 (39.1)	39 (12.8)	0.219
	Family	393 (50.6)	42 (10.7)	
	Boyfriend	50 (6.4)	11 (22.0)	
	Wife/girlfriend	30 (3.9)	4 (14.3)	

Sexual practices and risks

The median age at anal sexual debut was 16 years (IQR: 14-18). Half (51.1%) of the study participants reported to have had sex with a woman. Of those who had had sex with a non-paying male partner in the past month, more than half reported to have had either insertive (57.3%) or receptive (64.3%) sex with 2 or more partners. Use of condoms during last anal sex with a receptive non-paying partner was reported

by 9.3%. Transactional sex was common among the study participants, with one-third (32.6%) reporting to have paid another man for sex during the past month prior to the survey, and nearly three quarters (69.5%) reported to have sold sex in the same period. A total of 80.2% had sold sex during the one-year period preceding the survey. While the proportion of participants who had used condoms with paid partners in the past month was 28.7%, condom use with paying partners in the past month was as high as 80.0%. About 15% of participants reported to have experienced condom breakage while having anal sex during the past month. Just above a quarter (26.2%) said they had engaged in group sex at least once in their lifetime (Table 2).

Table 2: HIV Prevalence by Selected Sexual Behavior Characteristics among MSM in Dar es Salaam, Tanzania (N=777)

Variable	Category	N (%)	HIV Positive n(%)	p-value
Age at first sexual intercourse				
	<15	348 (43.4)	49 (8.3)	0.979
	16-18	266 (33.9)	29 (8.0)	
	>18	163 (22.7)	18 (8.7)	
Had sex with a woman in past one year				
	Yes	377 (51.1)	29 (5.5)	0.023
	No	400 (48.9)	67 (11.2)	
Bought sex past one year				
	Yes	320 (37.6)	41 (9.6)	0.376
	No	457 (62.4)	55 (7.5)	
Sold sex past one year				
	Yes	644 (80.2)	84 (9.1)	0.108
	No	133 (19.8)	12 (5.0)	
Number of non-paying insertive male partners past month				
	1	109 (42.7)	10 (7.9)	0.067
	2 and above	184 (57.3)	19 (10.3)	
Number of non-paying receptive male partners in past month				
	1	46 (35.7)	12 (29.3)	0.489
	2 and above	109 (64.3)	37 (33.9)	
Used a condom with last receptive non-paying partner				
	Yes	73 (9.3)	25 (34.2)	0.002
	No	450 (90.7)	54 (12.0)	
Paid another man for anal sex past month				
	Yes	191 (32.6)	13 (6.9)	0.717
	No	586 (67.4)	30 (5.1)	

Variable Category	N (%)	HIV Positive n(%)	p-value
Used a condom with last paid male partner			
No	554 (71.3)	75 (13.5)	0.059
Yes	223 (28.7)	21 (9.4)	
Sold sex to another man in past month			
Yes	540 (69.5)	54 (10.0)	0.771
No	237 (30.5)	21 (8.9)	
Used a condom with last paying male partner			
No	108 (20.0)	8(7.4)	0.041
Yes	432 (80.0)	60 (13.9)	
Had a condom break during anal sex in past month			
Yes	102 (15.1)	31 (24.1)	<0.001
No	395 (84.9)	49 (7.7)	
Ever participated in group sex			
Yes	232 (26.2)	43 (13.0)	0.015
No	545 (73.8)	53 (6.6)	

HIV prevalence

The weighted prevalence of HIV was 8.3% (95%CI: 6.3-10.9). The prevalence increased linearly with age and was significantly higher among those who had had sex with a woman in the past year (11.1% versus 5.5%, p=0.023), among those who had used a condom with their last non-paying partner (34.2% versus 12.0%, p=0.002), among those who had not used a condom with last paying partner (13.9 versus 7.4%, p=0.041) and among those reporting condom breakage during last anal sex (24.1% versus 7.7%, p<0.0001). Having engaged in group sex was also associated with higher HIV prevalence (13.0% versus 6.6%, p=0.015).

Comparison of HIV prevalence between 2014 and 2017

In 2014, 753 MSM participated in a survey conducted by the same research group that carried out the present study. The mean age in 2014 was 26.5 years (95%CI: 26.1-27.1) while the mean age in 2017 was 26.0 years (95%CI: 25.5-26.5). The age composition of samples therefore did not differ between the two surveys (p<0.0001). No significant statistical differences in other socio-demographic characteristics were

observed between the two samples (Table 3). However, the estimated HIV prevalence in 2017 was less than half that of 2014 (8.3% versus 22.3%, p<0.001)

Table 3: Comparison of Socio-Demographic Characteristics of the 2014 and 2017 Survey Samples

Demographic Characteristic	2014 (%)	2017 (%)
Age (years)		
≤ 24	46.3	52.1
25-34	41.2	33.1
≥ 35	12.4	14.8
Level of education		
No formal education	1.1	2.7
Some or completed primary education	42.9	44.8
Some or completed secondary education	52.9	48.4
Post-secondary education	3.1	4.1
Marital status		
Single	83.2	78.9
Married/cohabiting	5.9	10.8
Separated/divorced/widower	6.9	10.3
Current living arrangement		
With family	52.5	50.6
Alone	35.3	39.1
Boyfriend	5.7	6.4
Wife/girlfriend	6.0	3.9
Occupation		
Petty trader	39.8	39.1
Employed	17.9	22.4
Self employed	33.2	42.3
Other	6.5	9.3

Independent risk factors for HIV

The results of bivariate and multivariate logistic regression of independent risk factors for HIV infection are presented in Table 4 and 5. HIV prevalence increased with age, with men aged 25 years and above having 4 times higher risk of infection than those who were between 15 and 19 years. Having had 2 or more receptive non-paying male sexual partners in the last month before the survey was associated with higher odds of HIV infection (AOR=3.0; 95%CI: 1.8-12.0). Having used a condom during last sex with a non-paying partner was also associated with increased risk of testing positive for HIV (AOR=4.1; 95%CI:

1.4-7.8) and those who had ever engaged in group sex had 3 times higher odds of being HIV positive (AOR=3.4; 95%CI: 1.7-13.6). On the other hand, condom use during last anal sex with a paying partner (AOR=0.4, 95%CI: 0.2-0.9) was associated with 60% lower odds of HIV infection.

Table 4: Weighted Logistic Regression Modelling of the Association between Socio-Demographic Factors and HIV among MSM in Dar es Salaam, Tanzania

Variable	Category	OR (95%CI)	AOR (95%CI)$^{\chi}$	p-value*
Age groups (years)	15-19	1	1	
	20-24	2.3 (0.9;5.4)	2.3 (0.9;5.6)	0.061
	25-29	3.5 (1.5;8.4)	3.9 (1.6;9.5)	0.003
	30-34	3.8 (1.6;9.3)	4.1(1.6;10.4)	0.003
	35+	3.9 (1.6;9.3)	4.0 (1.4;5.3)	0.004
Education level	No formal	1		
	Primary	0.9 (0.3;2.5)		
	Secondary	1.8 (0.3;2.4)		
	Above secondary	1.5 (0.5;5.3)		
Marital Status	Never married	1	1	
	Married/cohabiting	0.5(0.9;1.6)	1.0 (0.5;2.2)	0.990
	Divorced/separated	1.7(1.1;2.9)	1.3 (0.7;2.3)	0.375
Time lived in Dar es salaam	Born and raised	0.4(0.1;1.1)	0.4 (0.1;1.3)	0.117
	1-5 years	0.6(0.2;1.0)	0.6 (0.2;1.3)	0.386
	6 and above years	0.5(0.2;1.6)	0.4 (0.1;1.2)	0.147
Income past month (TZS)	<50,000	1		
	50,000-120,000	1.0(0.5;1.8)		
	121,000-200,000	0.9(0.6;1.6)		
	>200,000	0.8(0.5;1.4)		
Currently living with	Alone	1		
	Family	0.8(0.6;1.5)		
	Boyfriend	1.7(0.9;3.1)		
	Wife/girl friend	1.1(0.4;2.9)		

$^{\chi}$ Adjusted for all variables in the table with p-value of ≤0.2 in the bivariate model; * p-value for adjusted OR

Table 5: Weighted Logistic Regression Modelling of Association between Sex-Related Risk Factors and HIV among MSM in Dar es Salaam, Tanzania

Variable	Category	OR (95%CI)	AOR (95%CI)χ	p-value*
Age at sexual debut	≤ 15	1		
	16-18	0.8(0.5;1.2)		
	>18	0.8(0.5;1.3)		
Had sex with a woman past 12 months	No	1	1.	
	Yes	0.5(0.3;0.7)	0.9(0.6;1.2)	0.861
Bought sex past one year	No	1	1	
	Yes	1.1(0.7;1.4)	1.7(0.6;3.0)	0.370
Sold sex past one year	Yes	1		
	No	0.8(0.2;5.1)		
Number of male receptive partners where no payment is involved past month	1	1	1	
	2 and above	1.6(1.1;7.5)	3.0(1.8;12.0)	0.000
Number of non-paying insertive male partners past month	1	1	1	
	2 and above	1.5(0.5;11.2)	1.6(0.4;23.1)	0.531
Used a condom with last receptive non-paying partner	No	1	1	
	Yes	3.1(1.2;7.2)	4.1(1.4;7.8)	0.000
Paid another man for anal sex past month	No	1	1	
	Yes	1.5(0.5;9.2)	1.6(0.6;11.8)	0.142
Used a condom with last paid male partner	Yes	1	1	
	No	1.1(0.5;2.1)	1.5(0.7;3.0)	0.284
Used a condom with last paying male partner	Yes	1	1	
	No	0.6(0.3;1.0)	0.4(0.2;0.9)	0.000
Sold sex to another man past month	No	1	1	
	Yes	1.3(0.7;2.2)	2.5(0.7;8.5)	0.156
Had a condom break during anal sex in past month	No			
	Yes	1.5(1.7;3.6)	1.2(0.7;2.1)	0.431
Ever participated in group sex	No	1	1	
	Yes	3.1(1.2;15.6)	3.4(1.7;13.6)	0.000

χ Adjusted for all variables in the table with p-value of ≤0.2 in the bivariate model; * p-value for adjusted OR

DISCUSSION

This study examined HIV prevalence among MSM in Dar es Salaam after the national guideline on CHIP had been under implementation in Tanzania since 2014. The estimated HIV prevalence was 8.3% (95%CI: 6.3-10.9), as compared to 22.3% (95%CI: 18.7-26.4) in 2013 [4]. This observation suggests that the HIV prevalence in this population has decreased by 62 percent over the past 5 years. The observed decline is substantial and statistically significant. The socio-demographic characteristics of the 2013 and 2017 survey samples did not differ significantly, suggesting that differences in the study population structure may not explain the observed decline. The difference from 2013 would be even greater if our current estimates were compared to another study conducted among MSM in Dar es Salaam that year. That study (albeit based on a sample of only 200 MSM) reported an HIV prevalence of 30.2% among MSM [6].

The present survey is the first study ever to report declining HIV prevalence among MSM in Tanzania. The decline echoes the dynamic of the overall HIV situation in Tanzania, where HIV prevalence in the general population has been steadily decreasing over the past decade, from 7.0% in 2003 to 4.7% in 2016 [2, 3]. Similar trends of decreasing HIV prevalence in key population groups alongside that in the general population have also been reported elsewhere [7, 9, 22].

Despite the reported decrease, the HIV prevalence among MSM is still twice as high as that among men in the general population in Dar es Salaam. For this reason, recent calls for continued efforts to address HIV in high-risk populations made by the authors of a systematic review of the global epidemiology of HIV among MSM [8] is still very relevant also in Dar es Salaam.

Sexual practices associated with HIV risk continue to be common among MSM in Dar es Salaam, and were significantly associated with HIV seropositivity. A substantial proportion of men have multiple

sexual partnerships and engage in group sex, as has also been reported earlier both in Tanzania and elsewhere in Sub-Saharan Africa [4, 5, 12, 23, 24].

Men aged 25 and above had higher HIV prevalence than those who were younger in this study, similar to what has been reported earlier in Dar es Salaam and elsewhere in Africa [4, 5, 10, 11]. A higher HIV prevalence among older men may reflect accumulation of risk over time and/or higher survival following ongoing efforts to improve linkage to care for people testing positive for HIV. The most recent AIDS indicator survey in Tanzania reported that 90.9% of persons who were between 15 and 64 years of age and who knew their HIV status indicated that they were on antiretroviral treatment, and 87.7% were virally suppressed [2]. However, HIV testing coverage in the country is still low with only 52.2% of people living with HIV knowing their HIV status (in the 15-64 age bracket) [2].

More than half of our study participants reported to have had sex with more than 2 partners. Moreover, transactional sex was very common in this population, with 64% reporting to have paid for sex during the past month, and 79% reporting to have sold sex during the last month. However, a striking finding was that condom use was very common among MSM who engaged in commercial sex. Condom use during last commercial sex was reported by a total of 80% of the study participants as compared to 49% in 2013 [4]. A significant increase in condom use among MSM following preventive education has recently been reported in a cohort of MSM in West Africa [22]. We found that condom use with paying partners (commercial sex) was associated with a 60% lower likelihood of HIV infection in this study. This increase in protected commercial sex may partly explain the decreased HIV prevalence observed in this study.

On the other hand, condom use with regular (non-paying) partners was low in this study (9.3%), but comparable to that found in other studies of key populations in Tanzania [25]. Low perceived susceptibility and a sense of trusting a regular partner are factors that have been associated with condom-

less sex [26, 27]. Worth noting in this study is the finding that condom use with regular partners was significantly associated with HIV seropositivity. It is possible that this reflects that some HIV positive MSM use condoms when they engage in sex to ensure the safety of their partners. This has also been reported in other studies in Asia and Africa [16, 28, 29].

As was the case in our 2014 study among MSM in Dar es Salaam, nearly one-third of the study participants reported to have engaged in group sex [4], and group sex was associated with HIV infection. This underscores the need for tailored preventive messaging addressing safer group sex in implementing the CHIP [2, 17].

The results of this study should be interpreted in light of the following limitations. Firstly, the cross-sectional nature of the survey limit causal inference of the risk factors for HIV infection identified. However, most of the risk factors reported have also been studied and reported in well-designed longitudinal studies. Secondly, participants were recruited using respondent driven sampling methodology which is not a random sampling methodology. Despite the fact that we used special statistical software (RDSAT) and controlled for network sizes during analysis, we acknowledge the potential for bias. And thirdly, we collected sensitive sexual behavior data which are subject to desirability bias. The design of the questionnaire, interviewers training, privacy setting of interview venues and establishment of good rapport with participants were put in place to reduce desirability reporting.

CONCLUSION

The HIV prevalence among MSM in Dar es Salaam has decreased by more than half over the past 5 years, coinciding with the implementation of the CHIP in Tanzania. Despite of the considerable decrease, the HIV prevalence in this population still remains twice as high as that among men in general. More condom protected anal sex could have played a role in the declining HIV prevalence among MSM. Efforts to

promote safer sex among men who engage in multiple sexual partnerships and group sex are called for. The roll out of new intervention measures, such as pre-exposure prophylaxis, could significantly contribute in the ongoing efforts to end the epidemic

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Competing interest statement

Authors declare that they have no competing interest.

Authors contributions

AM analyzed data, interpreted results and drafted the manuscript. EJM designed the study, analyzed data and interpreted results. KM, GHL, TL, NM, AR, MTL, DM and BT designed the study and interpreted the results. SL and MM, collected data and interpreted the results. All authors revised and approved the final version of the manuscript.

Data availability

Data are available from the corresponding authors upon reasonable request.

Participants consent

All participants provided written informed consent before interview or blood specimen collection.

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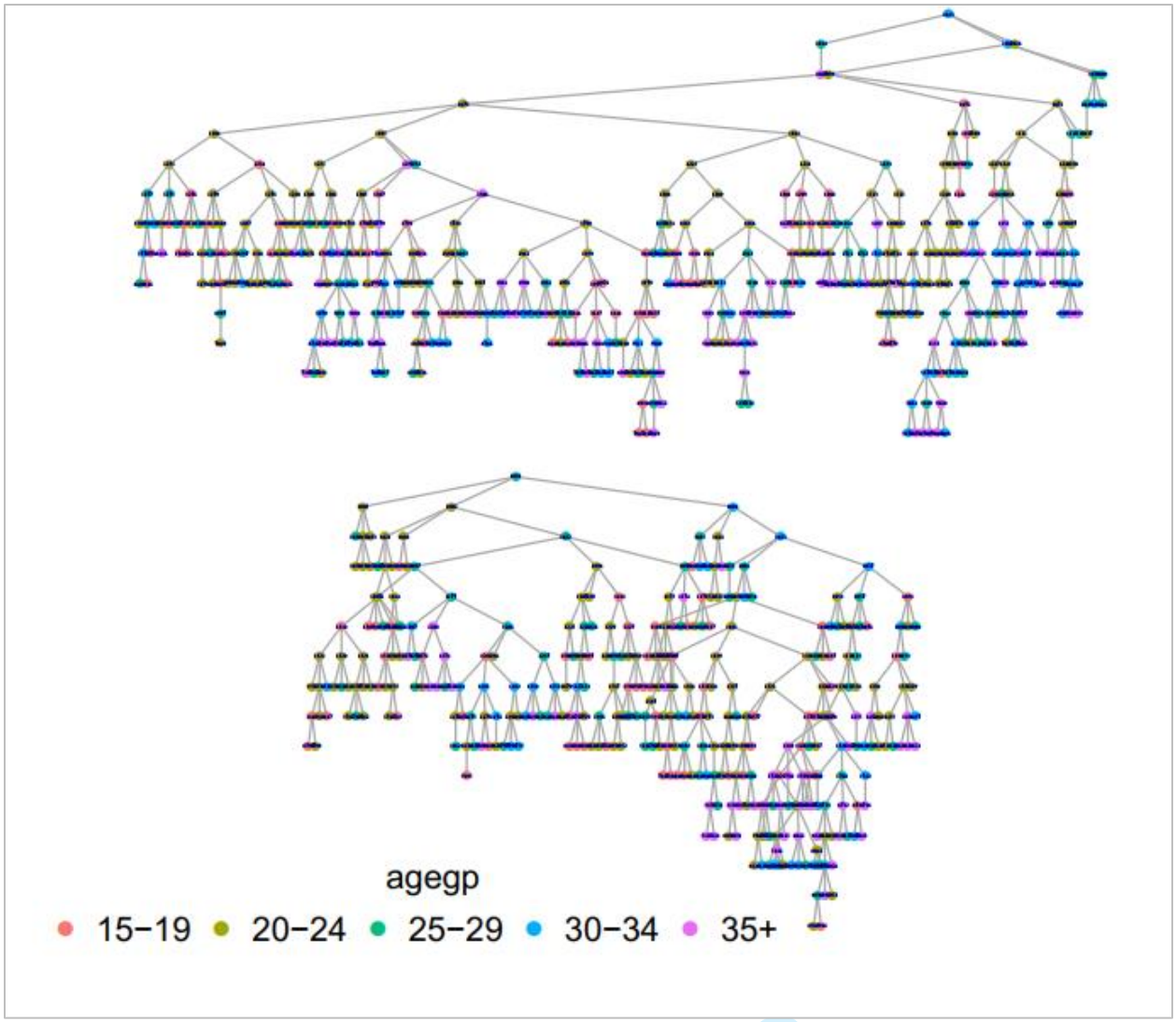

Figure 1: Recruitment networks by age groups

STROBE Statement—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	01
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	02
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	03
Objectives	3	State specific objectives, including any prespecified hypotheses	04
Methods			
Study design	4	Present key elements of study design early in the paper	04
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	04
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	05
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
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	*5-7*
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	05
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6-7
		(*e*) Describe any sensitivity analyses	6-7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7-8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
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 (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12

		(*b*) Report category boundaries when continuous variables were categorized	12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12-13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
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	03
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
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	16

*Give information separately for exposed and unexposed groups.

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HIV Prevalence among Men Who Have Sex with Men following the Implementation of the HIV Preventive Guideline in Tanzania: Respondent Driven Sampling Survey

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HIV Prevalence among Men Who Have Sex with Men following the Implementation of the HIV Preventive Guideline in Tanzania: Respondent Driven Sampling Survey

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ABSTRACT

Objectives: To estimate HIV prevalence and associated risk factors among men who have sex with men (MSM) in Dar es Salaam, Tanzania following the implementation of the national comprehensive package of HIV interventions for key populations (CHIP).

Design: A cross-sectional survey using respondent-driven sampling

Setting: Dar es Salaam, Tanzania's largest city.

Participants: Men who occasionally or regularly have sex with another man, aged 18 years and above and living in Dar es Salaam city at least six months preceding the study.

Primary outcome measure: HIV prevalence was the primary outcome. Independent risk factors for HIV infection were examined using weighted logistics regression modelling.

Results: A total of 777 MSM with a mean age of 26 years took part in the study. The weighted HIV prevalence was 8.3% (95%CI: 6.3-10.9) as compared to 22.3% (95%CI: 18.7-26.4) observed in a similar survey in 2014. Half of the participants had had sex with more than 2 partners in the month preceding the survey. Among those who had engaged in transactional sex, 80% had used a condom during last anal sex with a paying partner. Participants aged 25 and above had 4 times higher odds of being infected than those aged 15-19. HIV infection was associated with multiple sexual partnerships (AOR, 3.0; 95%CI: 1.8-12.0), not having used condom during last sex with non-paying partner (AOR, 4.1; 95%CI: 1.4-7.8), and ever having engaged in group sex (AOR, 3.4; 95%CI: 1.7-13.6).

Conclusion: HIV prevalence among MSM in Dar es Salaam has decreased by more than a half over the past 5 years, coinciding with implementation of the CHIP. It is nonetheless twice as high as that of men in the general population. To achieve the 2030 goal, behavioral change interventions and roll-out of new intervention measures such as pre-exposure prophylaxis are urgently needed.

Keywords: Men who have sex with men; HIV prevalence; risk behaviors; National guideline for comprehensive package of HIV intervention for key population; Tanzania

Strengths and limitations of this study

- This is the largest respondent driven sampling survey among MSM in Tanzania and study participants were recruited from diverse strata of the population.
- The results were weighted to control for network size and clustering resulting from variations in selection probability and network sizes in respondent driven sampling
- Comparisons are made with HIV prevalence estimates generated in a methodologically comparable survey conducted before the launch of the National guideline for comprehensive package of HIV intervention for key population (CHIP).
- Data on sexual behavior is subject to social desirability bias.
- This study did not measure biological risk factors for HIV infection which might have provided more insight into the risk profile of this population.

Background

Since 2004, the rate of HIV infection has been declining globally including in Tanzania [1]. The Tanzania HIV Indicator and Impact Surveys indicate that the HIV prevalence among persons aged 15-49 decreased from 7% in 2004 to 4.7% in 2016 [2, 3]. The observed decrease has been attributed to concerted efforts to promote condom use and to an improved HIV testing coverage with 90.9% linkage to antiretroviral therapy (ART) among those who test positive for HIV and 87.7% viral suppression [2].

While evidence of declining overall HIV infection rates has been mounting, populations at higher risk of HIV infection, such as MSM, have continued to carry a disproportionate burden of HIV in Africa and beyond. Studies from Africa have indicated that the HIV prevalence among MSM are 2 to 20 times higher than that in the general population [4-12]. Recent studies have estimated the HIV prevalence among MSM in Tanzania to range from 12.5% in Zanzibar to 22.3% in Dar es Salaam and 11.1% in Tanga [4, 6, 13]. Practices associated with increased risk of HIV, such as multiple sexual partnerships, unprotected anal sex, group sex, alcohol and drug use, and commercial sex have been commonly reported among MSM [4, 9, 13-16]. A high prevalence of sexually transmitted infections, such as herpes simplex virus type 2, has also been associated with high infection rates among MSM [4, 6, 10, 12, 14].

Populations at increased risk of HIV infection have been estimated to contribute up to 30% of new HIV infections in sub-Saharan Africa, making it impossible to leave them behind if we are to achieve the ambitious third sustainable development goal and end the HIV epidemic by 2030 [7, 17].

In 2014, Tanzania launched a National guideline for comprehensive package of HIV intervention for key population (CHIP) coupled with training of healthcare workers and the embracement of a multi-sectorial approach to control the HIV epidemic [18]. CHIP provided a detailed description of preventive, curative and psycho-social interventions key population including MSM should receive when seeking healthcare services. Specifically, the guideline directed health care workers to provide HIV counseling and testing,

screening for sexually transmitted infections, condoms, Male health education, and pre-and post-exposure prophylaxis as part of the preventive package. Screening for tuberculosis and other opportunistic infections, vaccination and treatment of viral hepatitis, anti-retroviral therapy and nutrition were among the treatment and care package services. Psycho-social support component of the package included mental health services, legal advices, personal development and empowerment as well as establishment of peer support groups. The roll out of CHIP alongside training of healthcare workers aimed to reduce stigma, increase service access with the ultimate goal of reduction in HIV infection rate among MSM.

Nearly half a decade later, no study has evaluated the state of the HIV epidemic in key populations. Given the notable decrease in HIV infection rates in Tanzania's general population, it is important that the dynamic of the HIV epidemic is tracked also in these populations as to inform government efforts aiming to achieve the 2030 goal [2]. This study seeks to provide information on the prevalence of HIV and associated sexual behavior-related risk factors among MSM in Dar es Salaam following nearly half a decade of implementation of CHIP.

METHODS

Design and setting

This was a cross sectional integrated bio-behavioral surveillance (IBBS) survey among MSM conducted between October and December 2017 in Dar es Salaam, the largest city in Tanzania. The location was chosen because it has a large population of MSM and a high prevalence of HIV, and also because baseline data were available for comparison (i.e., data on HIV prevalence and associated risk factors among MSM before the implementation of the CHIP started [19]). Dar es Salaam is a fast-growing city and currently has a population of about 5 million. The estimated overall HIV prevalence among adults aged 15-49 is 6.3% [2].

Study population

MSM aged 18 and above were invited to participate in this survey. Participation required that the person had engaged in same-sex sex during the last 3 months preceding the survey. Also, participants needed to have had an address in, and lived in, Dar es Salaam for at least six months before recruitment commenced.

Sample size estimation

We used the formula by Fleiss et al to calculate the sample size which aimed at achieving desired precision around point estimates for HIV infection among MSM [3]. According to the 2014 estimates for Dar es Salaam, the prevalence of HIV was 22% among MSM [4]. With a desired precision of 5%, taking into account a design effect (DEFF) of 3, based on the median DEFF found for key variables in similar RDS surveys in the region [5-9], the estimated sample size for this study was 759.

Sampling and recruitment

Since there was no sampling frame for MSM, eligible study participants were recruited using respondent-driven sampling (RDS) [20]. RDS is a chain referral sampling method that incorporates a recruitment strategy to offset oversampling of certain population groups to minimize traditional snowballing bias [21]. Initially, selected members of the target population (referred to as "seeds") refer other members of the same population to the study team for possible participation in a succession of waves until the desired sample size is achieved. Seeds were identified from different strata of MSM among our previous study contacts and through a meeting with the key population community advisory board. Characteristics that were taken into account in selection of seeds were age, socio-economic status, locality and sexual preference (preference for insertive or receptive anal sex). Recruitment networks and waves by age groups for this study are presented in figure 1. To attain equilibrium, recruitment waves ranged from 5-14 waves depending on the seed.

Data collection tool and data collection procedures

A questionnaire validated in previous IBBS surveys conducted by our research group and others was used in this study [4]. The questionnaire contained questions on socio-demographic characteristics and sexual practices and was administered in Swahili, the language spoken by all Tanzanians. Seeds were identified and represented different groups of MSM. Participants were invited to a recruitment centre where they were provided with information about the study and asked if they would consent to participate in it. All study participants gave informed consent to take part in the research, and face-to-face interviews using Android tablets equipped with an Open Data Kit (ODK) for recording of data. Following the interviews, HIV pre-test counseling was carried out before participants were offered to test for HIV. All participants received health education and condoms after the interview and were compensated for their transportation to the study site at a rate of TZS 8000 (equivalent to US$ 4) per person, as agreed upon with MSM representatives and approved by the ethical committee of the Muhimbili University of Health and Allied Sciences (MUHAS). Evidence indicate that water-based lubricants are effective in HIV prevention when used during anal sexual intercourse. However, we could not provide such commodities in this study due to the fact that they were not part of HIV preventive commodities listed in the 2016 revised National guideline for comprehensive package of HIV intervention for key population of which the project abided to.

Patients and public involvement

Participants were involved in the design of the respondent driven sampling, study implementation and dissemination. Results from this study were presented in the key population advisor board meeting where the study population is represented.

Laboratory testing

HIV testing followed the national testing algorithm. All samples were tested using the SD Bioline HIV-1/2 3.0 rapid test (Standard Diagnostics, Inc., Korea). Non-reactive results were considered negative for HIV whereas reactive results were subsequently tested with Uni-Gold™ HIV-1/2 (Trinity Biotech Plc, Ireland). Discrepant results were resolved by Enzygnost HIV Integral II Antibody/Antigen ELISA (Siemens, Germany).

Data analysis

STATA version 15 and the RDSAT statistical package were used for analysis of data emanating from this survey. Data were weighted to control for network size and the clustering resulting from variations in selection probability and networks sizes [20]. Categorical variables were summarized by calculating weighted proportions, and differences in proportions were examined using χ^2 test. Median and inter-quartile range (IQR) were used to summarize continuous variables. Bivariate analyses and multivariate logistic regression models were used to measure associations between various risk factors and HIV infection. All exposure variables with a $p \leq 0.2$ in bivariate analysis were included into a multivariate model. Crude and adjusted odds ratios (OR and AOR, respectively) for potential confounders with corresponding 95% confidence intervals (95%CI) are reported. All analyses were two-tailed and the significance level was set at 5%.

Ethical considerations

The protocol for this survey was reviewed and approved by the ethical review committee of the Muhimbili University of health and allied sciences (MUHAS). Permission to conduct the study was thereafter sought from local authorities. All participants provided written informed consent to participate, separately for interviews and blood sample collection. Participants who tested positive for HIV were referred to care and treatment for further management.

RESULTS

During the study period, 777 eligible MSM consented to participate in the study and gave blood for HIV testing. Their overall mean age was 26.0 years (standard deviation ± 7.1) with the largest proportion (34.8%) being 20-24 years old. A majority had competed either primary (44.8%) or secondary (48.4%) education. Three quarters (78.9%) reported to have never married,71.1% were born and raised in Dar es Salaam, and half (50.6%) lived with their family. The median monthly income was 160,000 Tanzanian shillings (IQR 80,000-300,000), with a third (34.3%) reporting a monthly income above 200,000 shillings (Table 1).

Table 1: Comparison of HIV prevalence by Socio-demographic Characteristics among MSM in Dar es Salaam, Tanzania (N=777)

Variable	Category	n (%)	HIV Positive n (%)	p-value
Age groups (years)	15-19	134 (17.3)	6 (4.45)	0.004
	20-24	271 (34.8)	28 (10.3)	
	25-29	152 (19.6)	24 (15.8)	
	30-34	105 (13.5)	18 (17.0)	
	≥ 35	115 (14.8)	20 (17.4)	
Education level	No formal	21 (2.7)	3 (14.3)	0.385
	Primary	348 (44.8)	43 (12.4)	
	Secondary	376 (48.4)	43 (11.4)	
	Above secondary	32 (4.1)	7 (21.9)	
Marital Status	Never married	613 (78.9)	67 (10.9)	0.114
	Married/cohabiting	84 (10.8)	14 (16.7)	
	Divorced/separated	80 (10.3)	35 (20.0)	
Time lived in Dar es Salaam	Born and raised	552 (71.1)	63 (11.4)	0.380
	Not born	225 (28.9)	33 (14.7)	
Income past month (TZS)	<50,000	133 (17.1)	18 (13.5)	0.841
	50,000-120,000	151 (19.4)	20 (13.3)	
	120,001-200,000	227 (29.2)	29 (12.8)	
	>200,000	266 (34.3)	29 (10.9)	

Currently living with	Alone	304 (39.1)	39 (12.8)	0.219
	Family	393 (50.6)	42 (10.7)	
	Boyfriend	50 (6.4)	11 (22.0)	
	Wife/girlfriend	30 (3.9)	4 (14.3)	

Sexual practices and risks

The median age at anal sexual debut was 16 years (IQR: 14-18). Half (51.1%) of the study participants reported to have had sex with a woman. Of those who had had sex with a non-paying male partner in the past month, more than half reported to have had either insertive (57.3%) or receptive (64.3%) sex with 2 or more partners. Use of condoms during last anal sex with a receptive non-paying partner was reported by 9.3%. Transactional sex was common among the study participants, with one-third (32.6%) reporting to have paid another man for sex during the past month prior to the survey, and nearly three quarters (69.5%) reported to have sold sex in the same period. A total of 80.2% had sold sex during the one-year period preceding the survey. While the proportion of participants who had used condoms with paid partners in the past month was 28.7%, condom use with paying partners in the past month was as high as 80.0%. About 15% of participants reported to have experienced condom breakage while having anal sex during the past month. Just above a quarter (26.2%) said they had engaged in group sex at least once in their lifetime (Table 2).

Table 2: HIV Prevalence by Selected Sexual Behavior Characteristics among MSM in Dar es Salaam, Tanzania (N=777)

Variable	Category	N (%)	HIV Positive n(%)	p-value
Age at first sexual intercourse				
	<15	348 (43.4)	49 (8.3)	0.979
	16-18	266 (33.9)	29 (8.0)	
	>18	163 (22.7)	18 (8.7)	
Had sex with a woman in past one year				
	Yes	377 (51.1)	29 (5.5)	0.023
	No	400 (48.9)	67 (11.2)	

Variable	Category	N (%)	HIV Positive n(%)	p-value
Bought sex past one year				
	Yes	320 (37.6)	41 (9.6)	0.376
	No	457 (62.4)	55 (7.5)	
Sold sex past one year				
	Yes	644 (80.2)	84 (9.1)	0.108
	No	133 (19.8)	12 (5.0)	
Number of non-paying insertive male partners past month				
	1	109 (42.7)	10 (7.9)	0.067
	2 and above	184 (57.3)	19 (10.3)	
Number of non-paying receptive male partners in past month				
	1	46 (35.7)	12 (29.3)	0.489
	2 and above	109 (64.3)	37 (33.9)	
Used a condom with last receptive non-paying partner				
	Yes	73 (9.3)	25 (34.2)	0.002
	No	450 (90.7)	54 (12.0)	
Paid another man for anal sex past month				
	Yes	191 (32.6)	13 (6.9)	0.717
	No	586 (67.4)	30 (5.1)	
Used a condom with last paid male partner				
	No	554 (71.3)	75 (13.5)	0.059
	Yes	223 (28.7)	21 (9.4)	
Sold sex to another man in past month				
	Yes	540 (69.5)	54 (10.0)	0.771
	No	237 (30.5)	21 (8.9)	
Used a condom with last paying male partner				
	No	108 (20.0)	8(7.4)	0.041
	Yes	432 (80.0)	60 (13.9)	
Had a condom break during anal sex in past month				
	Yes	102 (15.1)	31 (24.1)	<0.001
	No	395 (84.9)	49 (7.7)	
Ever participated in group sex				
	Yes	232 (26.2)	43 (13.0)	0.015
	No	545 (73.8)	53 (6.6)	

HIV prevalence

The weighted prevalence of HIV was 8.3% (95%CI: 6.3-10.9). The prevalence increased linearly with age and was significantly higher among those who had had sex with a woman in the past year (11.1% versus 5.5%, p=0.023), among those who had used a condom with their last non-paying partner (34.2% versus

12.0%, p=0.002), among those who had not used a condom with last paying partner (13.9 versus 7.4%, p=0.041) and among those reporting condom breakage during last anal sex (24.1% versus 7.7%, p<0.0001). Having engaged in group sex was also associated with higher HIV prevalence (13.0% versus 6.6%, p=0.015).

Comparison of HIV prevalence between 2014 and 2017

In 2014, 753 MSM participated in a survey conducted by the same research group that carried out the present study. The mean age in 2014 was 26.5 years (95%CI: 26.1-27.1) while the mean age in 2017 was 26.0 years (95%CI: 25.5-26.5). The age composition of samples therefore did not differ between the two surveys (p<0.0001). No significant statistical differences in other socio-demographic characteristics were observed between the two samples (Table 3). However, the estimated HIV prevalence in 2017 was less than half that of 2014 (8.3% versus 22.3%, p<0.001)

Table 3: Comparison of Socio-Demographic Characteristics of the 2014 and 2017 Survey Samples

Demographic Characteristic	2014 (%)	2017 (%)
Age (years)		
≤ 24	46.3	52.1
25-34	41.2	33.1
≥ 35	12.4	14.8
Level of education		
No formal education	1.1	2.7
Some or completed primary education	42.9	44.8
Some or completed secondary education	52.9	48.4
Post-secondary education	3.1	4.1
Marital status		
Single	83.2	78.9
Married/cohabiting	5.9	10.8
Separated/divorced/widower	6.9	10.3
Current living arrangement		
With family	52.5	50.6
Alone	35.3	39.1
Boyfriend	5.7	6.4
Wife/girlfriend	6.0	3.9
Occupation		

Petty trader	39.8	39.1
Employed	17.9	22.4
Self employed	33.2	42.3
Other	6.5	9.3

Independent risk factors for HIV

The results of bivariate and multivariate logistic regression of independent risk factors for HIV infection are presented in Table 4 and 5. HIV prevalence increased with age, with men aged 25 years and above having 4 times higher risk of infection than those who were between 15 and 19 years. Having had 2 or more receptive non-paying male sexual partners in the last month before the survey was associated with higher odds of HIV infection (AOR=3.0; 95%CI: 1.8-12.0). Having used a condom during last sex with a non-paying partner was also associated with increased risk of testing positive for HIV (AOR=4.1; 95%CI: 1.4-7.8) and those who had ever engaged in group sex had 3 times higher odds of being HIV positive (AOR=3.4; 95%CI: 1.7-13.6). On the other hand, condom use during last anal sex with a paying partner (AOR=0.4, 95%CI: 0.2-0.9) was associated with 60% lower odds of HIV infection.

Table 4: Weighted Logistic Regression Modelling of the Association between Socio-Demographic Factors and HIV among MSM in Dar es Salaam, Tanzania

Variable	Category	OR (95%CI)	AOR (95%CI)$^{\alpha}$	p-value*
Age groups (years)	15-19	1	1	
	20-24	2.3 (0.9;5.4)	2.3 (0.9;5.6)	0.061
	25-29	3.5 (1.5;8.4)	3.9 (1.6;9.5)	0.003
	30-34	3.8 (1.6;9.3)	4.1(1.6;10.4)	0.003
	35+	3.9 (1.6;9.3)	4.0 (1.4;5.3)	0.004
Education level	No formal	1		
	Primary	0.9 (0.3;2.5)		
	Secondary	1.8 (0.3;2.4)		
	Above secondary	1.5 (0.5;5.3)		

Marital Status	Never married	1	1	
	Married/cohabiting	0.5(0.9;1.6)	1.0 (0.5;2.2)	0.990
	Divorced/separated	1.7(1.1;2.9)	1.3 (0.7;2.3)	0.375
Time lived in Dar es salaam	Born and raised	0.4(0.1;1.1)	0.4 (0.1;1.3)	0.117
	1-5 years	0.6(0.2;1.0)	0.6 (0.2;1.3)	0.386
	6 and above years	0.5(0.2;1.6)	0.4 (0.1;1.2)	0.147
Income past month (TZS)	<50,000	1		
	50,000-120,000	1.0(0.5;1.8)		
	121,000-200,000	0.9(0.6;1.6)		
	>200,000	0.8(0.5;1.4)		
Currently living with	Alone	1		
	Family	0.8(0.6;1.5)		
	Boyfriend	1.7(0.9;3.1)		
	Wife/girl friend	1.1(0.4;2.9)		

χ Adjusted for all variables in the table with p-value of ≤0.2 in the bivariate model; * p-value for adjusted OR

Table 5: Weighted Logistic Regression Modelling of Association between Sex-Related Risk Factors and HIV among MSM in Dar es Salaam, Tanzania

Variable	Category	OR (95%CI)	AOR (95%CI)χ	p-value*
Age at sexual debut	≤ 15	1		
	16-18	0.8(0.5;1.2)		
	>18	0.8(0.5;1.3)		
Had sex with a woman past 12 months	No	1	1.	
	Yes	0.5(0.3;0.7)	0.9(0.6;1.2)	0.861
Bought sex past one year	No	1	1	
	Yes	1.1(0.7;1.4)	1.7(0.6;3.0)	0.370
Sold sex past one year	Yes	1		
	No	0.8(0.2;5.1)		
Number of male receptive partners where no payment is involved past month	1	1	1	
	2 and above	1.6(1.1;7.5)	3.0(1.8;12.0)	0.000
Number of non-paying insertive male partners past month	1	1	1	
	2 and above	1.5(0.5;11.2)	1.6(0.4;23.1)	0.531
Used a condom with last receptive non-paying partner	No	1	1	
	Yes	3.1(1.2;7.2)	4.1(1.4;7.8)	0.000

Paid another man for anal sex past month	No Yes	1 1.5(0.5;9.2)	1 1.6(0.6;11.8)	0.142
Used a condom with last paid male partner	Yes No	1 1.1(0.5;2.1)	1 1.5(0.7;3.0)	0.284
Used a condom with last paying male partner	Yes No	1 0.6(0.3;1.0)	1 0.4(0.2;0.9)	0.000
Sold sex to another man past month	No Yes	1 1.3(0.7;2.2)	1 2.5(0.7;8.5)	0.156
Had a condom break during anal sex in past month	No Yes	1.5(1.7;3.6)	1.2(0.7;2.1)	0.431
Ever participated in group sex	No Yes	1 3.1(1.2;15.6)	1 3.4(1.7;13.6)	0.000

χ Adjusted for all variables in the table with p-value of ≤0.2 in the bivariate model; * p-value for adjusted OR

DISCUSSION

This study examined HIV prevalence among MSM in Dar es Salaam after the National guideline for comprehensive package of HIV intervention for key population (CHIP) had been under implementation in Tanzania since 2014. The estimated HIV prevalence was 8.3% (95%CI: 6.3-10.9), as compared to 22.3% (95%CI: 18.7-26.4) in 2013 [4]. This observation suggests that the HIV prevalence in this population has decreased by 62 percent over the past 5 years. The observed decline is substantial and statistically significant. The socio-demographic characteristics of the 2014 and 2017 survey samples did not differ significantly, suggesting that differences in the study population structure may not explain the observed decline. The difference from 2014 would be even greater if our current estimates were compared to another study conducted among MSM in Dar es Salaam that year. That study (albeit based on a sample of only 200 MSM) reported an HIV prevalence of 30.2% among MSM [6].

The present survey is the first study ever to report declining HIV prevalence among MSM in Tanzania. The decline echoes the dynamic of the overall HIV situation in Tanzania, where HIV prevalence in the general population has been steadily decreasing over the past decade, from 7.0% in 2003 to 4.7% in 2016 [2, 3]. Similar trends of decreasing HIV prevalence in key population groups alongside that in the general population have also been reported elsewhere [7, 9, 22].

Despite the reported decrease, the HIV prevalence among MSM is still twice as high as that among men in the general population in Dar es Salaam. For this reason, recent calls for continued efforts to address HIV in high-risk populations made by the authors of a systematic review of the global epidemiology of HIV among MSM [8] is still very relevant also in Dar es Salaam.

Sexual practices associated with HIV risk continue to be common among MSM in Dar es Salaam, and were significantly associated with HIV seropositivity. A substantial proportion of men have multiple sexual partnerships and engage in group sex, as has also been reported earlier both in Tanzania and elsewhere in Sub-Saharan Africa [4, 5, 12, 23, 24].

Men aged 25 and above had higher HIV prevalence than those who were younger in this study, similar to what has been reported earlier in Dar es Salaam and elsewhere in Africa [4, 5, 10, 11]. A higher HIV prevalence among older men may reflect accumulation of risk over time and/or higher survival following ongoing efforts to improve linkage to care for people testing positive for HIV. The most recent AIDS indicator survey in Tanzania reported that 90.9% of persons who were between 15 and 64 years of age and who knew their HIV status indicated that they were on antiretroviral treatment, and 87.7% were virally suppressed [2]. However, HIV testing coverage in the country is still low with only 52.2% of people living with HIV knowing their HIV status (in the 15-64 age bracket) [2].

More than half of our study participants reported to have had sex with more than 2 partners. Moreover, transactional sex was very common in this population, with 64% reporting to have paid for sex during

the past month, and 79% reporting to have sold sex during the last month. However, a striking finding was that condom use was very common among MSM who engaged in commercial sex. Condom use during last commercial sex was reported by a total of 80% of the study participants as compared to 49% in 2014 [4]. A significant increase in condom use among MSM following preventive education has recently been reported in a cohort of MSM in West Africa [22]. We found that condom use with paying partners (commercial sex) was associated with a 60% lower likelihood of HIV infection in this study. This increase in protected commercial sex may partly explain the decreased HIV prevalence observed in this study.

On the other hand, condom use with regular (non-paying) partners was low in this study (9.3%), but comparable to that found in other studies of key populations in Tanzania [25]. Low perceived susceptibility and a sense of trusting a regular partner are factors that have been associated with condom-less sex [26, 27]. Worth noting in this study is the finding that condom use with regular partners was significantly associated with HIV seropositivity. It is possible that this reflects that some HIV positive MSM use condoms when they engage in sex to ensure the safety of their partners. This has also been reported in other studies in Asia and Africa [16, 28, 29].

As was the case in our 2014 study among MSM in Dar es Salaam, nearly one-third of the study participants reported to have engaged in group sex [4], and group sex was associated with HIV infection. This underscores the need for tailored preventive messaging addressing safer group sex in implementing the CHIP [2, 17].

The results of this study should be interpreted in light of the following limitations. Firstly, the cross-sectional nature of the survey limit causal inference of the risk factors for HIV infection identified. However, most of the risk factors reported have also been studied and reported in well-designed longitudinal studies. Secondly, participants were recruited using respondent driven sampling

methodology which is not a random sampling methodology. Despite the fact that we used special statistical software (RDSAT) and controlled for network sizes during analysis, we acknowledge the potential for bias. Thirdly, we collected sensitive sexual behavior data which are subject to desirability bias. The design of the questionnaire, interviewers training, privacy setting of interview venues and establishment of good rapport with participants were put in place to reduce desirability reporting. And fourthly, we have attributed the observed decrease in HIV prevalence to the implementation of the National guideline for comprehensive package of HIV intervention for key population (CHIP) based on the before and after design consideration. We acknowledge that the 2014 and the current survey of 2017 were not designed to assess the effectiveness of CHIP implementation and our conclusion may be confounded by many factors.

On the other hand, this survey was the largest MSM survey in Tanzania and Africa at large and included seeds from various MSM strata (demographic and sexual characteristics) with potentially high external validity of the results presented.

CONCLUSION

The HIV prevalence among MSM in Dar es Salaam has decreased by more than half over the past 5 years, coinciding with the implementation of the CHIP in Tanzania. Despite of the considerable decrease, the HIV prevalence in this population still remains twice as high as that among men in general. More condom protected anal sex could have played a role in the declining HIV prevalence among MSM. Efforts to promote safer sex among men who engage in multiple sexual partnerships and group sex are called for. The roll out of new intervention measures, such as pre-exposure prophylaxis, could significantly contribute in the ongoing efforts to end the epidemic

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Competing interest statement

Authors declare that they have no competing interest.

Authors contributions

AM analyzed data, interpreted results and drafted the manuscript. EJM designed the study, analyzed data and interpreted results. KM, GHL, TL, NM, AR, MTL, DM and BT designed the study and interpreted the results. SL and MM, collected data and interpreted the results. All authors revised and approved the final version of the manuscript.

Data availability

Data are available from the corresponding authors upon reasonable request.

Participants consent

All participants provided written informed consent before interview or blood specimen collection.

Figure 1: Recruitment networks by age groups

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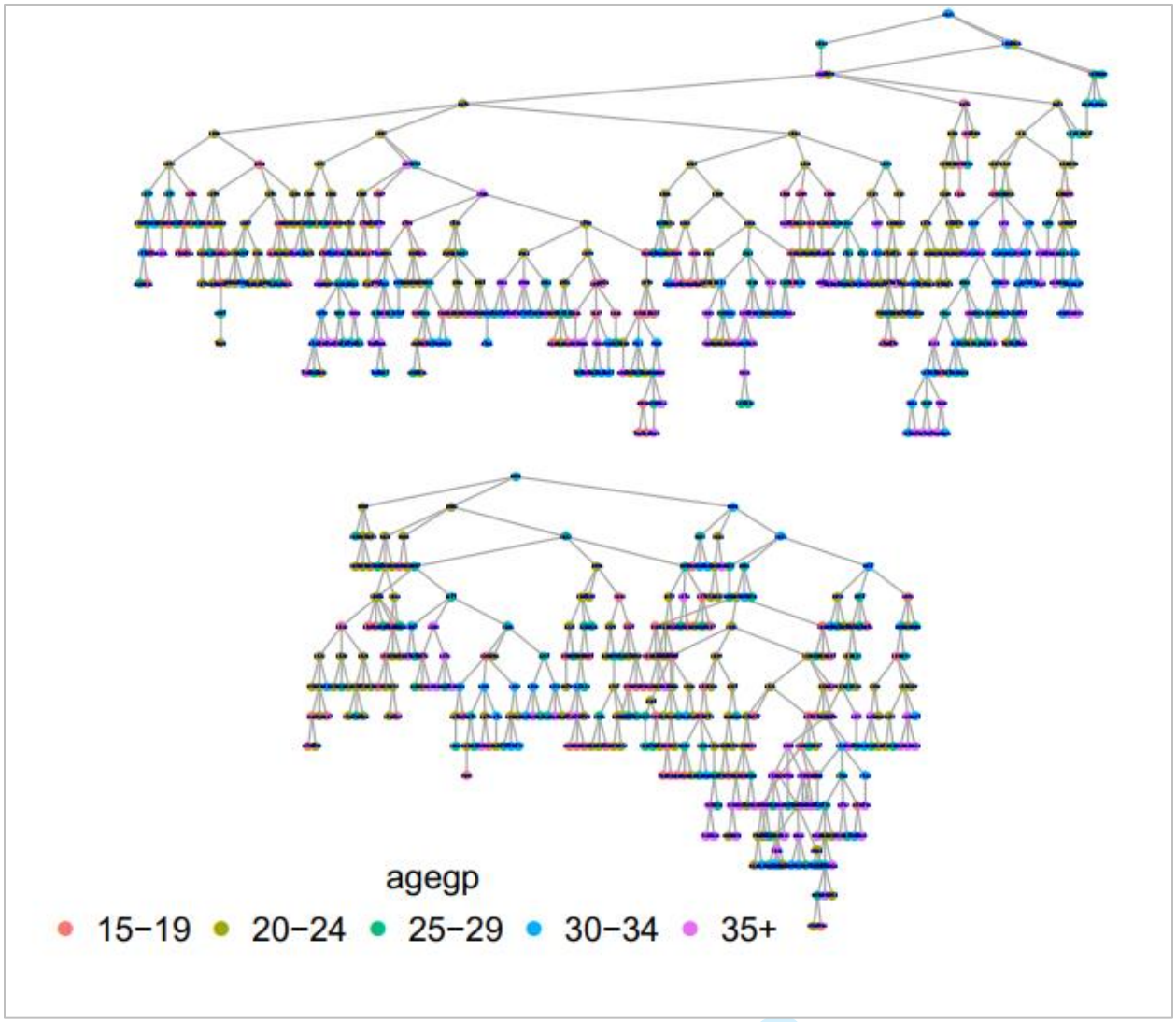

Figure 1: Recruitment networks by age groups

STROBE Statement—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	01
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	02
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	03
Objectives	3	State specific objectives, including any prespecified hypotheses	04
Methods			
Study design	4	Present key elements of study design early in the paper	04
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	04
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	05
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-7
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	*5-7*
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	05
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6-7
		(*b*) Describe any methods used to examine subgroups and interactions	6-7
		(*c*) Explain how missing data were addressed	-
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	6-7
		(*e*) Describe any sensitivity analyses	6-7
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	7
		(b) Give reasons for non-participation at each stage	7-8
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
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 (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	12

		(*b*) Report category boundaries when continuous variables were categorized	12-13
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	12-13
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	14
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	03
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16
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	16

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.