ORIGINAL PAPER

Multi-level Determinants of Clinic Attendance and Antiretroviral Treatment Adherence Among Fishermen Living with HIV/AIDS in Communities on Lake Victoria, Uganda

K. M. Sileo[1,2] · R. K. Wanyenze[3] · W. Kizito[4] · E. Reed[1] · S. K. Brodine[1] · H. Chemusto[4] · W. Musoke[4] · B. Mukasa[4] · S. M. Kiene[1]

Abstract

This cross-sectional study assessed determinants of HIV clinic appointment attendance and antiretroviral treatment (ART) adherence among 300 male fisherfolk on ART in Wakiso District, Uganda. Multi-level factors associated with missed HIV clinic visits included those at the individual (age, AOR = 0.98, 95% CI 0.97–0.99), interpersonal (being single/separated from partner, AOR: 1.25, 95% CI 1.01–1.54), normative (anticipated HIV stigma, AOR: 1.55, 95% CI 1.05–2.29) and physical/built environment-level (travel time to the HIV clinic, AOR: 1.11, 95% CI 1.02–1.20; structural-barriers to ART adherence, AOR: 1.27, 95% CI 1.04–1.56; accessing care on a landing site vs. an island, AOR: 1.35, 95% CI 1.08–1.67). Factors associated with ART non-adherence included those at the individual (age, β: − 0.01, $\eta^2 = 0.03$; monthly income, β: − 0.01, $\eta^2 = 0.02$) and normative levels (anticipated HIV stigma, β: 0.10, $\eta^2 = 0.02$; enacted HIV stigma, β: 0.11, $\eta^2 = 0.02$). Differentiated models of HIV care that integrate stigma reduction and social support, and reduce the number of clinic visits needed, should be explored in this setting to reduce multi-level barriers to accessing HIV care and ART adherence.

Keywords HIV/AIDS · ART adherence · HIV care engagement · Key populations · Fisherfolk · Uganda

Introduction

Ugandan fisherfolk are significantly more likely to be infected with HIV/AIDS than the general adult population, with HIV prevalence estimated between 22 and 40% [1–4] compared to 6.5% [5]. Thus, fisherfolk are a most-at-risk population (MARP) being prioritized for immediate initiation of antiretroviral treatment (ART) upon HIV diagnosis [6, 7]. Immediate ART initiation has significant benefits for individual health and can reduce HIV incidence on a population-level [6, 8]. The success of these guidelines, however,

depends greatly on the ability to engage and retain MARPs across all stages of the HIV care continuum. There is a need to increase engagement among men in sub-Saharan Africa (SSA) in particular, who have worse engagement across all stages of care compared to women [9–11]. Fishermen and other men employed in the fishing industry may face even greater challenges than men generally, given their frequent mobility, the nature of their work, and the structural environment of fishing villages. However, no research to our knowledge has examined HIV care engagement with fisherfolk after linking to care.

Given the unique setting of fishing communities, barriers to HIV care engagement likely occur at multiple levels of the social ecological model (SEM) [12–14]. The SEM is a framework that is commonly used to understand the complex interactions between an individual and factors in the broader environment on health behavior and health outcomes. The SEM recognizes individual factors and factors external to the individual as interacting to influence health behavior/outcomes, including factors at the level of the individual, interpersonal, normative environment, physical/built environment, and policy environment [12–14] (see Fig. 1
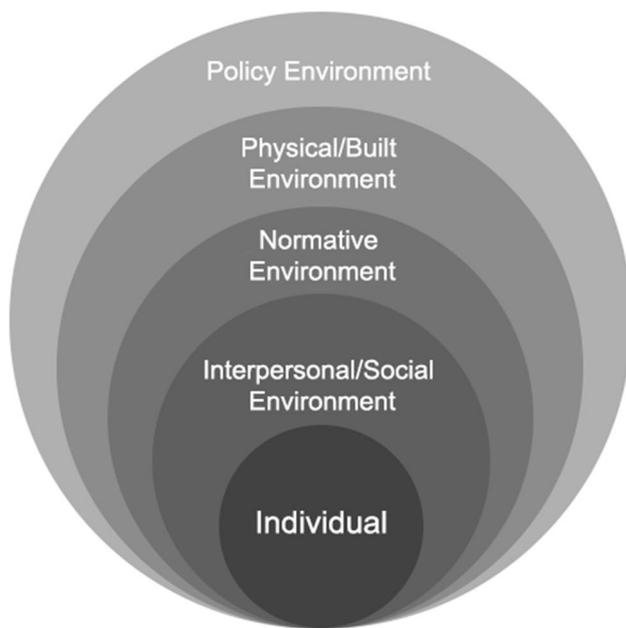
✉ K. M. Sileo
katelyn.sileo@yale.edu; katelyn.sileo@gmail.com

1 Graduate School of Public Health, San Diego State University, San Diego, CA, USA

2 Center for Interdisciplinary Research on AIDS at Yale University, New Haven, CT, USA

3 Makerere School of Public Health, Makerere University, Kampala, Uganda

4 Mildmay Uganda, Kampala, Uganda

Fig. 1 The social ecological model

for a graphic depiction of the SEM). This model has been used to understand HIV behaviors generally [15], including HIV medication adherence and retention in HIV care in various settings [15–18]. Individual-level factors shown to predict better engagement in care in SSA include motivation and knowledge about ART, and socio-demographics such as older age, higher education, being female, and employment [19–28]. In Ugandan fishing villages, the occurrence of heavy alcohol use [2, 29–31] may also be important, as alcohol consumption has been shown in other settings to impede ART adherence [32, 33].

At the interpersonal-level, HIV status disclosure and treatment supporters are associated with greater ART adherence, as well as greater support to get to HIV appointments [34, 35], highlighting social support as a determinant of care engagement. However, men in fishing communities are often single or separated from their families [36–38]. Thus, the networks of support available to them may be more limited than for men generally, or may have a negative influence on health seeking behavior. For example, a qualitative study in Uganda reported engagement in sexual risk behavior and alcohol consumption among fisherfolk was strongly influenced by the broader social environment [49].

At the normative-level, fishing villages have been characterized as having high levels of HIV stigma [36, 39], which has been associated with poor linkage to care and uptake of HIV testing among fisherfolk [40, 41], and poor adherence and retention more broadly in SSA [42, 43]. For example, experiencing prejudice and discrimination first hand from others (i.e., enacted stigma) emerged as a driver of treatment

interruption among ART patients in Malawi [44]. The fear of, or anticipated, HIV stigma and internalized HIV stigma are also associated with poor retention and treatment adherence [45, 46], and may be especially influential for men in SSA [47, 48].

The physical and built environment of fishing villages poses a number of challenges to clinic access. Communities on islands are only accessible by boat [37, 49] and there may be few clinics with ART availability near island outreach testing [40, 41]. The fishing occupation itself includes frequent mobility, irregular work schedules, and an inconsistent cash-based income that varies based on seasonal fish yields [36, 49–51], all of which are likely to affect men's care engagement. Finally, factors within the broader health system (e.g., drug stock out, quality of care, human resource availability and training), and societal-level policies affecting ART eligibility [18, 22, 52–58] have also been shown salient in their impact on access to care in SSA more broadly.

The overall goal of this study is to identify determinants of HIV clinic attendance and ART adherence among male fisherfolk on ART in Wakiso District, Uganda. Using a social ecological perspective, we examine individual, interpersonal, normative, and physical/built environment determinants to understand which factors and levels have the greatest effect, which can inform the development of targeted interventions to improve care engagement. We also explore the role of individual and interpersonal factors in moderating the associations between normative and physical/built environment factors and engagement outcomes.

Methods

This cross-sectional study included male fisherfolk receiving HIV care from one of seven ART clinics in Wakiso District, Uganda. We partnered with Mildmay Uganda, a nonprofit organization that provides free HIV services in several districts in Uganda, to purposively sample participants at HIV clinics between October 2016 and March 2017. Research sites included Mildmay "outreach clinics" (Zzinga, Kachanga, Kasenyi), governmental facilities (Bussi Health Center III [HCIII], Entebbe Hospital, Kigungu HCIII), and a private facility (Rapha Medical Center). The catchment areas of the clinics have a wide range—the smallest estimated to be 500 at Kachanga HCIII and the largest being 300,000 at Entebbe Hospital. Outreach clinics are Mildmay established and operated sites that provide HIV treatment once weekly or biweekly in communities with poor access to services. Three of our sites were on land (Entebbe Hospital, Kasenyi outreach, Kigungu HCIII), and four were on one of three islands on Lake Victoria (Bussi, Kachanga, Zzinga Islands). Each island was accessible only by boat

and required approximately 30–60 minutes of travel time from the landing site.

Men were eligible to participate if they were: at least 18 years of age, fisherfolk by occupation, living with HIV, on ART, and enrolled in HIV care for at least 6 months (to assess ART adherence and retention). On ART clinic days, a male research assistant (RA) reviewed patient records for men presenting to care to pre-screen for eligibility. The RA approached potentially eligible men, confirmed eligibility using a verbal checklist, and obtained written informed consent for men agreeing to participate. To reach men not regularly attending the clinic, we invited men to meet with the RA to learn more about the study during routine reminder calls for clinic appointments, either at their next appointment or an agreed upon location. Of the 322 eligible men invited to participate, 22 declined for the following reasons: did not have time (n = 14), did not want to disclose sensitive information (n = 4), intoxicated (n = 1), hearing impairment (n = 1), wanted more compensation (n = 1), wanted to be interviewed with wife (n = 1). Participants completed an interviewer-administered questionnaire with the RA in a private space in or around the clinic using computer assisted personal interviewing (CAPI) programming in Questionnaire Development Software version 3.0. Men received 10,000 Ugandan Shillings (~ 3 USD) for their participation. Institutional Review Boards at San Diego State University and Makerere School of Public Health approved the study, as did the Uganda National Council for Science and Technology.

Measures

The *individual-level* factors measured and used in the present analysis include: *age* (continuous), *monthly income* (continuous, 1 unit equates to 50,000 shillings, ~ 14 USD), *education* (none vs. primary or secondary level), *occupation* (fishermen vs. other), *months on ART* (continuous, 1 unit equates to 6 months), and *ART dosing* (once daily vs. twice daily dosing). We used the World Health Organization's Alcohol Use Disorders Identification Test (AUDIT) to assess *alcohol risk* [59], shown reliable among people living with HIV (PLHIV) in rural Uganda ($\alpha = 0.71$) [60], using the total AUDIT score as a continuous variable for analysis (α in the present sample = 0.63). *Internalized HIV stigma*, or the endorsement of negative beliefs and feelings associated with HIV about themselves among PLHIV, was measured using Earnshaw's HIV stigma framework measures ($\alpha = 0.79$) (response options: 0–4, "never" to "very often") [61]. We used Chesney's AIDS Clinical Trials Group (ACTG) adherence questionnaire [62] to measure *individual-level barriers to ART adherence*. The scale includes reasons for missed antiretroviral (ARV) doses (response options 0–3, "never to often"). For analysis, we calculated the mean score of all items measuring *individual-level barriers* (e.g., forgot, side effects, lost pills) ($\alpha = 0.69$).

Among *interpersonal-level* factors measured, *relationship status* was dichotomized into living together vs. single or separated (including men who reported being single, divorced, widowed, and married but separated). *Social support* was measured through the Social Support Scale [63], which contains 6 items measuring the participants' access to emotional support (e.g., "You get chances to talk to someone you trust about your personal and family problems" and "You have people who care what happens to you") and 4 items measuring access to instrumental support (e.g., "You get help when you need transportation" and "You get help when you are sick"). This scale ($\alpha = 0.67$) was adapted from the Duke-UNC Functional Social Support Questionnaire [64], and asks participants how much of these types of social support they receive (response options 0–3, "never" to "as much as I would like"). The scale has been validated among PLHIV in rural Rwanda ($\alpha = 0.91$) [65]. A single item assessed *HIV disclosure*, capturing the total number of people the participant disclosed their status to.

At the *normative-level*, we measured two dimensions of HIV stigma using Earnshaw's measures [61], including *enacted HIV stigma* (perceived degree of prejudice and discrimination experienced by PLHIV) and *anticipated HIV stigma* (expectation among PLHIV that they will experience prejudice and discrimination in the future) (α = enacted: 0.65, anticipated: 0.65); response options for both: 0–4, "never" to "very often".

Factors in the physical and built environment included *mobility*, measured with an item asking the participant if they have traveled/slept away in the prior year for work (yes/no), originating from a scale created for fisherfolk in the communities surrounding Lake Victoria in Kenya [51]. We accounted for the differences in the research site (i.e., HIV clinics the men were recruited in) by examining the differences for men accessing a clinic on an island vs. on land (referred to as a "*landing site*"). *Average travel time to the HIV clinic* was measured with one item asking how long in minutes it takes to get to the clinic (continuous, 1 unit equates 30 min). We used Chesney's [62] AIDS Clinical Trials Group (ACTG) adherence questionnaire to measure *structural-barriers to ART adherence* by calculating the mean of items capturing travel and work-related barriers (response options 0–3, "never to often"), as described above ($\alpha = 0.70$).

Our first *outcome*, *missed HIV clinic visits*, was measured using participants' HIV clinic records. The RA extracted the number of clinic appointments scheduled in the prior year from participants' HIV clinic cards, and recorded which of these visits were kept as scheduled vs. missed. We used participant self-report if data were missing or conflicted with participant's clinic records. We

operationalized missed visits as the proportion of HIV clinic visits missed in the prior year.

We use Chesney's [62] AIDS Clinical Trials Group (ACTG) questionnaire to measure our second *outcome*, self-reported adherence. The scale includes items on participants' regimen and number of pills taken per day, which we confirmed using participants' HIV clinic cards. The ACTG asks for the number of doses missed over a 4-day recall period (yesterday, 1 day, 2 days, 3 days ago), and an additional four-items on adherence more broadly (i.e., last missed dose, frequency of missed doses on weekends, difficulty following schedule, and difficulty following special instructions). The ACTG has demonstrated construct validity in Uganda and similar settings [66]. We calculated a *non-adherence index score* which incorporates more items than the 4-day recall period (see data analysis section); the index score has been used in large clinical trials [67, 68] and shown to correlate with plasma HIV RNA more than the 4-day recall period alone [68].

Data Analysis Approach

In SPSS version 24, we used generalized linear modeling with a logit link (events/trial format) for our missed HIV clinic visits, and linear regression modeling non-adherence index score. To create the non-adherence index score, we followed Reynolds et al.'s methodology [68], which includes principle component analysis to approximate a latent variable. The index score was standardized on a scale from 0 to 100, with greater scores equating to worse adherence. For analysis, we used the square root method to transform the variable so that it met the assumptions for normality for linear regression. In preliminary bivariate models, we assessed the unadjusted associations between independent variables with missed clinic visits and non-adherence, respectively. Factors associated with the outcomes ($p < 0.10$) were included in multivariate models for our two outcomes. We also tested hypothesized interactions between independent variables—hypothesizing that older age, greater income, longer time on ART, greater social support, and HIV status disclosure, would mitigate the effects of HIV stigma and physical/built environment factors on our outcomes.

For missed clinic visits, Odds Ratios (OR) and Adjusted Odds Ratios (AOR) from bivariate and multivariate logistic regression analysis with 95% CI are presented. Betas (β) and standard errors (SE) are presented for bivariate and multivariate linear models assessing non-adherence index score. In the linear models, we include the eta squared (η^2) to indicate the variance explained by each individual item, and we report R^2 to indicate the variance explained in adherence by the full model.

Results

Participant Characteristics

On average, men were 36.86 years old (SD = 8.58), and about half were living with a partner (49.00%), while the other half were single, divorced, widowed, or separated. Of the married men, approximately 30% had two or more wives. The average monthly income of men was 226,517 Ugandan Shillings (~62.12 USD, SD = 29.73). Men had been on ART for an average of nearly 2 years (22.90 months, SD = 13.50). The average AUDIT score was 4.45 (SD = 5.13), indicating low-risk drinking overall. The average time men traveled to the HIV clinic was 41.4 minutes (SD = 39.56), and 64.7% of men reported mobility for work. In the prior year, men had missed 39.00% of their scheduled clinic appointments. Men had taken 87.79% (SD = 21.46%) of their ARV doses over the 4-day recall period, making 31.00% "sub-optimally adherent" (<95% of ARVs taken as prescribed). The average score on the non-adherence index score was 41.70 (SD = 79), with greater scores indicating worse adherence (range 0–100). See Table 1 detailed participant characteristics.

Social Ecological Model Predictors of Missed HIV Clinic Visits

Younger age, less time on ART, once-daily dosing, greater AUDIT score, not living with a partner, less social support, less HIV status disclosure, anticipated stigma, mobility, greater travel time to clinic, accessing care on a landing site, and structural barriers to ART adherence were associated with missed clinic visits (see Table 2 for detailed bivariate statistics).

In the final multivariate model, at the *individual-level*, younger men were more likely to miss clinic appointments than older men (AOR = 0.98, 95% CI 0.97–0.99, p = 0.01). At the *interpersonal-level*, men not living with a partner were 1.25 times more likely to report missed clinic visits in the prior year compared to men living with a partner (AOR = 1.25, 95% CI 1.01–1.54, p = 0.03). Anticipated HIV stigma remained positively associated with missed clinic appointments at the *normative-level* (AOR: 1.55, 95% CI 1.05–2.29, p = 0.03). At the *physical/built environment level,* for every 30-minute increase in time spent traveling to the clinic, men were 1.11 times more likely to report missed clinic visits (AOR: 1.11, 95% CI 1.02–1.20, p = 0.02). The odds of missed HIV clinic appointments were 1.35 times greater for men accessing HIV care at a landing site compared to on an island (AOR: 1.35, 95% CI 1.08–1.67, p = 0.008). Greater scores on the structural barriers to ART adherence scale were associated

Table 1 Participant characteristics, N = 300, Uganda 2016–2017

	% (n)/Mean	SD	Range
Individual-level factors			
Age	36.86	8.58	20–70
Education			
No schooling	202 (67.30%)		
Primary level	84 (28.00%)		
Secondary level	14 (4.70%)		
Occupation (other vs. fishermen)			
Fishermen	246 (82.00%)		
Fish seller, cleaner, dryer	35 (11.67%)		
Boat operator, repairer, loader	19 (6.33%)		
Monthly income (in USD)	62.16	29.73	4.14–160.35
Months on ART	22.90	13.50	2–55
Number of pills prescribed per day			
Once daily dosing	260 (86.67%)		
Twice daily dosing	40 (13.33%)		
AUDIT score	4.45	5.13	0.00–20.00
Internalized stigma	0.61	0.53	0.00–2.17
Individual-level barriers to ART adherence	0.35	0.24	0.00–1.42
Interpersonal-level factors			
Marital status			
Never married	30 (10.00%)		
Divorced	78 (26.00%)		
Widowed	16 (5.30%)		
Married and separated most of the time	29 (9.70%)		
Married and living together most of the time	147 (49.00%)		
Social support	1.43	0.44	0.30–3.00
Total number of people disclosed HIV status to	2.04	1.59	0.00–8.00
Interpersonal-level factors			
Anticipated stigma	0.86	0.53	0.00–2.83
Enacted stigma	0.62	0.48	0.00–3.00
Physical and built environment-level factors			
Mobility (traveled/slept out of the community in prior 12 months)			
Yes	194 (64.67%)		
No	106 (35.33%)		
Average travel time to HIV clinic (min)	41.40	39.56	2–180
Structural-level barriers to ART adherence	1.11	0.57	0.00–2.67
Research site			
Island	175 (58.30%)		
Landing site	125 (41.70%)		
HIV care engagement outcomes			
Non-adherence index score (greater score indicating worse ART adherence)	41.79	25.95	0–100%
Proportion of missed clinic appointments (prior year)	39.00%	28.79%	0–100%
ART adherence (% of pills taken over 4 day recall period)	87.79%	21.46%	0–100%

ART antiretroviral therapy

with increased odds of missed visits (AOR = 1.27, 95% CI 1.04–1.56, p = 0.02). Finally, there was a statistically significant interaction between months on ART and anticipated HIV stigma, with anticipated stigma having a greater effect on missed clinic visits for men more recently initiated on ART (AOR = 0.88, 95% CI 0.81–0.98, p = 0.02). See Table 2 for multivariate model statistics, and Fig. 2 for a graphic depiction the observed interaction.

Table 2 Bivariate and multivariate models testing independent variables at each level of the social ecological model and missed HIV clinic visits, Uganda 2016–2017, N = 300

	Bivariate models			Multivariate model		
	OR (95% CI)	χ^2	p	AOR (95% CI)	χ^2	p
Individual-level factors						
Age	0.97 (0.96–0.99)	18.36	**< 0.001**	0.98 (0.97–0.99)	6.00	**0.01**
Monthly income (50,000 UGX/unit)	0.98 (0.94–1.03)	0.57	0.45			
Education (no education vs. any education)						
Any schooling	1.14 (0.92–1.40)	1.46	0.23			
No schooling (reference)						
Occupation (other vs. fishermen)						
Fishermen	1.06 (0.82–1.37)	0.18	0.67			
Other fisherfolk (reference)						
Months on ART (6 month/unit)	0.92 (0.88–0.97)	11.71	**0.001**	1.07 (0.97–1.17)	1.72	0.19
Number of pills prescribed						
Twice daily	0.72 (0.53–0.96)	4.95	**0.03**			
Once daily (reference)						
AUDIT score	1.02 (1.01–1.04)	5.88	**0.02**			
Internalized stigma	1.14 (0.95–1.37)	1.85	0.17			
Individual-level barriers to ART adherence (Scale:0-3)	1.36 (0.89–2.08)	2.01	0.16			
Interpersonal-level factors						
Marital status						
Not married or separated	1.30 (1.06–1.58)	6.61	**0.01**	1.25 (1.01-1.54)	4.30	**0.03**
Married and living together (reference)						
Interpersonal-level factors						
Social support (Scale 0-3)	0.74 (0.58–0.93)	6.60	**0.01**			
Total number of people HIV disclosed status to	0.93 (0.88–0.99)	5.07	**0.02**			
Normative-level factors						
Anticipated stigma (Scale: 0-4)	1.23 (1.02–1.49)	4.71	**0.03**	1.55 (1.05–2.29)	4.83	**0.03**
Enacted stigma (Scale: 0-4)	1.16 (0.95–1.42)	2.00	0.16			
Physical and built environment-level factors						
Mobility (traveled/slept out of the community in prior 12 months)						
Yes	1.27 (1.03-1.57)	5.05	**0.03**			
No (reference)						
Average travel time to HIV clinic (30 min/unit)	1.12 (1.04–1.21)	8.49	**0.004**	1.11 (1.02-1.20)	5.93	**0.02**
Research site						
Landing site	1.74 (1.42–2.13)	29.03	**< 0.001**	1.35 (1.08-1.67)	7.12	**0.008**
Island (ref)						
Structural barriers to ART adherence (Scale: 0-3)	1.42 (1.19–1.71)	14.39	**< 0.001**	1.27 (1.04–1.56)	5.36	**0.02**
Interactions						
Months on ART x anticipated HIV stigma	–	–	**–**	0.89 (0.81–0.98)	5.72	**0.02**
Mobility (traveled/slept out of the community in prior 12 months)						

Bolded text is used to indicate statistically significant associations at the p < 0.05 level

*Used to indicate statistically significant associations at the p < 0.10 level

OR odds ratio, *AOR* adjusted odds ratio, χ^2 Wald Chi square, *AUDIT* the alcohol use disorders identification test, *ART* antiretroviral treatment

Social Ecological Predictors of Non-Adherence Index Score

Younger age, no education, less time on ART, once daily dosing, greater AUDIT score, individual-level barriers to ART adherence, less social support, having disclosed one's status to less people, anticipated and enacted HIV stigma, mobility, structural barriers to ART adherence, and greater proportion of missed clinic visits in the prior
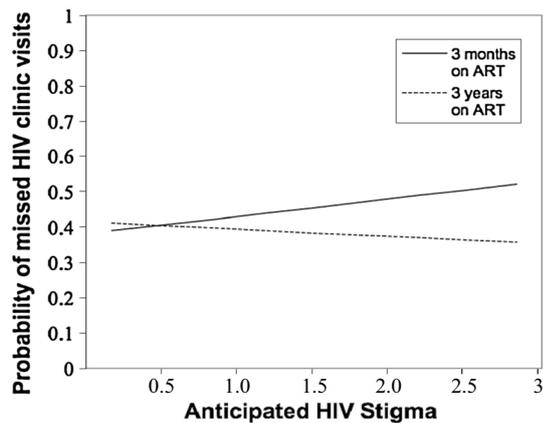
Fig. 2 Interaction between anticipated HIV stigma and months on antiretroviral treatment (ART) on the probability of missed HIV clinic visits in the prior year, controlling for covariates. Men newly initiated on ART are more likely to missed their HIV clinic visits due to anticipated HIV stigma compared to men on ART for a longer time period. The figure displays this difference for men on ART for 3 months compared to men on ART for 3 years

year were associated with greater non-adherence in bivariate models (p < 0.10) (See Table 3 for detailed statistics).

In the multivariate model (Table 3), at the *individual-level*, younger men (β = − 0.01, SE = 0.00, p = 0.002, η^2 = 0.03) and men with lower income (β = − 0.02, SE = 0.01, p = 0.04, η^2 = 0.02) had worse adherence. Greater scores on the individual-level barriers to adherence scale (β = 0.14, SE = 0.09, η^2 = 0.01) were also associated with non-adherence, but only marginally (p = 0.09). The only *interpersonal-level factor* that remained in the model was HIV disclosure (β = − 0.02, SE = 0.01, η^2 = 0.01), though the association was only marginally significant (p = 0.08). Finally, at the *normative-level*, greater scores on the anticipated HIV stigma scale (β = 0.10, SE = 0.04, p = 0.03, η^2 = 0.02) and enacted HIV stigma scale (β = 0.11, SE = 0.05, p = 0.03, η^2 = 0.02) were associated with greater non-adherence. No barriers in the physical and built environment remained in the final model, and no interactions were identified between factors. Taken together, the total model explained 16% of variation in non-adherence (R^2 = 0.16).

Discussion

This study is the first to our knowledge to assess HIV clinic attendance and ART adherence among fishermen on ART [69]. We identified factors at multiple levels of the SEM [12–14] associated with HIV care engagement for men (see Fig. 3 for a graphic depiction of our study's primary findings mapped onto the SEM). Individual, interpersonal, normative, and physical/built environment-level factors were associated with missed clinic visits. For ART adherence,

individual and normative-level factors had the greatest effect. These findings can inform the development of differentiated care models [70] tailored to the needs of fishermen. Our study justifies the need for such efforts by highlighting less than optimal engagement among men; a third of men reported sub-optimal ART adherence (31%), and men missed a significant portion (39%) of their HIV clinic visits over the prior year.

Though HIV stigma was reportedly low in our sample, it was still influential for both clinic attendance and ART adherence for men. Anticipated HIV stigma had the greatest effect compared to any other independent variable on missed visits, and both enacted and anticipated HIV stigma predicted ART non-adherence. We also found anticipated HIV stigma had a greater effect on missed clinic appointments among men more recently initiated on ART (interaction displayed in Fig. 2). This finding supports other research that shows after the initiation of ART, HIV stigma may decrease over time [71]. Thus, strategies for HIV stigma reduction should occur soon after diagnosis and treatment initiation to prevent men from dropping out of care. These findings are in line with that of prior studies that report HIV stigma reduced men's uptake of HIV testing and timely linkage to HIV care in fishing villages [29, 30], and contributes to a large literature in SSA supporting HIV stigma's negative effect on engagement across the care continuum [31–35], which may be particularly true for men in SSA [36–40].

In the broader literature, social support has been shown protective against HIV stigma [72–74], and interventions that enhance patients' support mechanisms report promising effects both on stigma and care engagement [75, 76]. A recent study in Kenyan fishing villages reported improvements in care retention in an evaluation of "microclinic interventions," which included 10 sessions of social support and education, and bolstered social capital and reduced HIV stigma by using patient-defined support networks [75]. While social support did not remain significant in our final models, we did find men living with a partner had better clinic attendance compared to those not living with a partner, perhaps because their partners served as treatment supporters. With half of our sample being unmarried or separated, the integration of a male-to-male peer support program may be beneficial in this setting, and could have the additional benefit of HIV stigma reduction. Community-based ART delivery models, such as community adherence groups (CAGs) and adherence clubs, might also be considered in this context; these service delivery models have been shown to reduce HIV stigma (89, 90) by leveraging or expanding patient's existing support networks (91–93), while reducing structural barriers to care by bringing services closer to the community.

The greatest number of factors associated with clinic attendance fell within the physical/built environment.

Table 3 Bivariate and multivariate models testing independent variables at levels of the social ecological model and ART non-adherence index score, Uganda 2016–2017, N = 300

|	Bivariate models				Multivariate model			
	β	Std. Error	p	η^2	β	Std. Error	p	η^2
Individual-level factors								
Age	− 0.01	0.00	**< 0.001**	0.05	− 0.01	0.00	**0.002**	0.03
Monthly income (50,000 UGX/unit)	− 0.03	0.01	**0.004**	0.03	− 0.01	0.01	**0.04**	0.02
Education (no education vs. any education)								
Any schooling	0.03	0.05	0.62	0.001				
No schooling (reference)								
Occupation (other vs. fishermen)								
Fishermen	0.07	0.06	0.26	0.004				
Other fisherfolk (reference)								
Months on ART (6 month/unit)	− 0.02	0.01	0.08*	0.01				
Number of pills prescribed								
Twice daily	− 0.13	0.07	0.05*	0.01				
Once daily (reference)								
AUDIT score	0.01	0.00	**0.03**	0.02				
Internalized stigma	0.04	0.04	0.32	0.003				
Individual-level barriers to ART adherence	0.23	0.88	**0.009**	0.02	0.14	0.09	0.09*	0.01
Interpersonal-level factors								
Marital status								
Not married or separated	0.03	0.05	0.47	0.002				
Married and living together (reference)								
Social support	− 0.23	0.05	**< 0.001**	0.06				
Total number of people HIV disclosed status to	− 0.38	0.02	**0.009**	0.02	− 0.02	0.01	0.08*	0.01
Community-level factors								
Anticipated stigma	0.17	0.04	**< 0.001**	0.05	0.10	0.04	**0.03**	0.02
Enacted stigma	0.19	0.05	**< 0.001**	0.05	0.11	0.05	**0.03**	0.02
Physical and built environment-level factors								
Mobility (traveled/slept out of the community in prior 12 months)								
Yes	0.15	0.05	**0.002**	0.03				
No (reference)								
Average travel time to HIV clinic (30 min/unit)	0.01	0.02	0.49	0.002				
Research site								
Landing site	0.07	0.05	0.12	0.01				
Island (ref)								
Structural barriers to ART adherence	0.14	0.04	**< 0.001**	0.05				
Proportion of missed clinic appointments (prior year)	0.27	0.08	**0.001**	0.04	0.06	0.07	0.40	0.003

Bolded text is used to indicate statistically significant associations at the p < 0.05 level

B Beta, *Std. error* standard error, *AUDIT* the alcohol use disorders identification test; *ART* antiretroviral treatment

* Used to indicate statistically significant associations at the p < 0.10 level

However, clinic attendance was not associated with ART adherence in the final model and factors in the physical/built environment did not associate with ART adherence. Though research is needed to understand what other negative effects men's poor clinic attendance may have, this finding suggests men may be able to maintain optimal treatment adherence without attending all scheduled clinic appointments. Research to evaluate and optimize strategies that reduce the number of visits men need to maintain optimal adherence would not only benefit men, but would also reduce burden on the overall health system. Though our data cannot speak to this, the use of multi-month refills for patients may be explaining this finding; future research should assess whether multi-month prescriptions are being optimally utilized with fishermen, and whether they can be expanded on to further reduce clinic burden and the time and monetary

Missed Clinic Visits   **ART Non-Adherence**
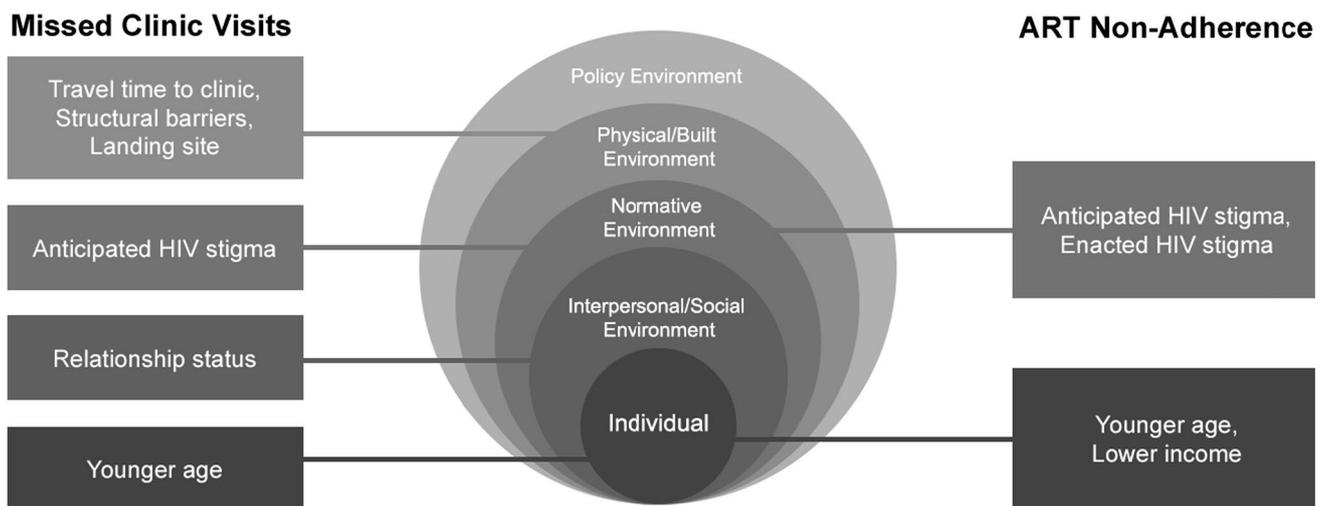
Fig. 3 The study's primary findings by level of the Social Ecological Model. *Note* "Missed Clinic Visits" and "ART Non-Adherence" are the study's primary outcomes; the factors listed below each are the independent variables found to be associated (p < 0.05) with the outcomes in multivariate analysis

costs associated with transportation for stable patients, as has been demonstrated in other studies [77–79].

While our study provides support for the effect of multi-level factors on men's engagement in HIV care, this study provides only a narrow view of the potential factors that affect men's health seeking behavior. The observed effect sizes were small, and some variables shown important for HIV care engagement in this context in qualitative research, such as mobility [49], did not remain in our final models. However, we found men accessing care on a landing site were more mobile than men accessing care on an island, which likely explains why they had worse clinic attendance than those accessing care on an island. Future research is needed to replicate and expand on our findings, and to include policy-environment factors, which were not assessed in this study.

Our clinic attendance measure was collected through clinic records and corroborated by self-report, which may be subject to data entry errors or missing information. Though Chesney's ACTG questionnaire [62] has been shown predictive of viral load [68], our measure of adherence would have been strengthened through objective measures of pill count or viral load samples. We attempted to collect viral load data from patient records, but found the data too incomplete for use. Future research should explore these constructs against biological outcomes, and use longitudinal designs to infer temporality between factors measured. While most of our measures were validated or previously used in East or Southern African settings and piloted for comprehension, they were not formally validated for use with this specific population. The generalizability of our study is limited by use of non-random sampling directly from the clinic, which

may have resulted in the exclusion of men with the greatest barriers to engagement. Future research should focus on engaging men lost-to-follow up, as well as younger men and men of lower income who, consistent with the literature [23–28], had more trouble with engagement. Nevertheless, this study provided insight into multi-level barriers to care for fisherfolk on ART, who struggled with engagement despite being sampled from the clinic.

Conclusion

In line with global HIV guidelines [80, 81], Uganda is moving towards the scale-up of universal antiretroviral treatment (ART) for all [7] making efforts to engage and retain PLHIV along the care continuum a growing priority. Understanding factors influencing engagement in care among most-at-risk populations is especially needed, as achieving population viral load suppression in high prevalence settings would optimize the effectiveness of treatment as prevention [82, 83]. This study begins to fill a gap in the literature on determinants of HIV care engagement among Ugandan fishermen, and highlights the need for multi-level interventions to improve men's care engagement. We recommend future research explore the integration of social support, HIV stigma reduction, and strategies to reduce the number of visits needed for HIV care (e.g., multi-month refills, CAGs) into differentiated models of care for fishermen on ART.

Compliance with Ethical Standards

Conflict of interest We have no conflicts of interest to disclose.

Ethical Approval All procedures performed involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. This article does not contain any studies with animals performed by any of the authors.

Informed Consent Informed consent was obtained from all individual participants included in the study.

References

1. Asiki G, Mpendo J, Abaasa A, Agaba C, Nanvubya A, Nielsen L, et al. HIV and syphilis prevalence and associated risk factors among fishing communities of Lake Victoria, Uganda. Sex Transm Dis. 2011;87(6):511–5.
2. Seeley J, Nakiyingi-Miiro J, Kamali A, Mpendo J, Asiki G, Abaasa A, et al. High HIV incidence and socio-behavioral risk patterns in fishing communities on the shores of Lake Victoria, Uganda. Sex Transm Dis. 2012;39(6):433–9.
3. Opio A, Muyonga M, Mulumba N. HIV sero behavioral survey in fishing communities of the Lake Victoria basin of Uganda. Stockholm: SIDA, MOH, AMREF; 2011.
4. Chang LW, Grabowski MK, Ssekubugu R, Nalugoda F, Kigozi G, Nantume B, et al. Heterogeneity of the HIV epidemic in agrarian, trading, and fishing communities in Rakai, Uganda: an observational epidemiological study. Lancet. 2016;3(3):8.
5. UNAIDS. Country facts: UGANDA 2016. UNAIDS; 2016. http://www.unaids.org/en/regionscountries/countries/uganda.
6. The World Health Organization (WHO). Guidelines on when to start antiretroviral therapy and on pre-exposure prophylaxis for HIV. Geneva: WHO; 2015.
7. Uganda Ministry of Health. Consolidated Guidelines for Prevention and Treatment of HIV in Uganda. Kampala: MOH; 2016.
8. World Health Organization. Consolidated guidelines on the use of antiretroviral drugs for treating and preventing HIV infection. Geneva: WHO; 2013.
9. Shand T, Thomson-de Boor H, van den Berg W, Peacock D, Pascoe L. The HIV blind spot: men and HIV testing, treatment and care in sub-Saharan Africa. IDS Bull. 2014;45(1):53–60.
10. Cornell M, McIntyre J, Myer L. Men and antiretroviral therapy in Africa: our blind spot. Trop Med Int Health. 2011;16(7):828–9.
11. Tromp N, Michels C, Mikkelsen E, Hontelez J, Baltussen R. Equity in utilization of antiretroviral therapy for HIV-infected people in South Africa: a systematic review. Int J Equity Health. 2014;13(1):1–17.

12. Brofenbrenner U. Toward an experimental ecology of human development. Am Psychol. 1977;32:513–31.
13. McLeroy KRBD, Steckler A, Glanz K. A, An ecological perspective on health promotion programs. Health Educ Q. 1988;15(4):351–77.
14. Stokols D. Establishing and maintaining healthy environments: toward a social ecology of health promotion. Am Psychol. 1992;47(1):6–22.
15. Kaufman M, Cornish F, Zimmerman R, Johnson B. Health behavior change models for HIV prevention and AIDS care: practical recommendations for a multi-level approach. J Acquir Immune Defic Syndr. 2014;66:S250–8.
16. Castro EM, Santiago LE, Jiménez JC, Dávila-Vargas D, Rosal MC. A social-ecological view of barriers and facilitators for HIV treatment adherence: interviews with Puerto Rican HIV patients. PLoS ONE. 2015;10(9):e0125582.
17. Berger MB, Sullivan KA, Parnell HE, Keller J, Pollard A, Cox ME, et al. Barriers and facilitators to retaining and reengaging HIV clients in care. J Int Assoc Provid AIDS Care. 2015;15(6):486–93.
18. Hoffmann CJ, Mabuto T, McCarthy K, Maulsby C, Holtgrave DR. A framework to inform strategies to improve the HIV care continuum in low- and middle-income countries. AIDS Educ Prevent. 2016;28(4):351–64.
19. Hornschuh S, Dietrich JJ, Tshabalala C, Laher F. Antiretroviral treatment adherence: knowledge and experiences among adolescents and young adults in Soweto, South Africa. AIDS Res Treat. 2017;5192516. https://doi.org/10.1155/2017/5192516.
20. Marcellin F, Abé C, Loubière S, Boyer S, Blanche J, Koulla-Shiro S, et al. Delayed first consultation after diagnosis of HIV infection in Cameroon. AIDS. 2009;15(23):1015–9.
21. Nyanzi-Wakholi B, Medina Lara A, Munderi P. Gilks C, on behalf of the DTT. The charms and challenges of antiretroviral therapy in Uganda: the DART experience. AIDS Care. 2012;24(2):137–42.
22. Gourlay A, Birdthistle I, Mburu G, Iorpenda K, Wringe A. Barriers and facilitating factors to the uptake of antiretroviral drugs for prevention of mother-to-child transmission of HIV in sub-Saharan Africa: a systematic review. J Int AIDS Soc. 2013;16:18588.
23. Bassett IV, Wang B, Chetty S, Mazibuko M, Bearnot B, Giddy J, et al. Loss to care and death before antiretroviral therapy in Durban, South Africa. J Acquir Immune Defic Syndr. 2009;51(2):135–9.
24. Cornell M, Grimsrud A, Fairall L, Fox MP, van Cutsem G, Giddy J, et al. Temporal changes in programme outcomes among adult patients initiating antiretroviral therapy across South Africa, 2002-2007. AIDS. 2010;24(14):2263–70.
25. Van Cutsem G, Ford N, Hildebrand K, Goemaere E, Mathee S, Abrahams M, et al. Correcting for mortality among patients lost to follow up on antiretroviral therapy in South Africa: a cohort analysis. PLoS ONE. 2011;6(2):e14684.
26. Wang B, Losina E, Stark R, Munro A, Walensky RP, Wilke M, et al. Loss to follow-up in a community clinic in South Africa–roles of gender, pregnancy and CD4 count. S Afr Med J. 2011;101(4):253–7.
27. Charurat M, Oyegunle M, Benjamin R, Habib A, Eze E, Ele P, et al. Patient retention and adherence to antiretrovirals in a large antiretroviral therapy program in Nigeria: a longitudinal analysis for risk factors. PLoS ONE. 2010;5(5):e10584.
28. Cornell M, Myer L, Kaplan R, Bekker LG, Wood R. The impact of gender and income on survival and retention in a South African antiretroviral therapy programme. Trop Med Int Health. 2009;14(7):722–31.
29. Tumwesigye NM, Atuyambe L, Wanyenze RK, Kibira SP, Li Q, Wabwire-Mangen F, et al. Alcohol consumption and risky sexual behaviour in the fishing communities: evidence from two fish

landing sites on Lake Victoria in Uganda. BMC Public Health. 2012;12:12.

30. Smolak A. A meta-analysis and systematic review of HIV risk behavior among fishermen. AIDS Care. 2013;26(3):282–91.

31. Kiwanuka N, Ssetaala A, Nalutaaya A, Mpendo J, Wambuzi M, Nanvubya A, et al. High Incidence of HIV-1 infection in a general population of fishing communities around Lake Victoria, Uganda. PLoS ONE. 2014;9(5):e94932.

32. Sileo KM, Simbayi LC, Abrams A, Cloete A, Kiene SM. The role of alcohol use in antiretroviral adherence among individuals living with HIV in South Africa: event-level findings from a daily diary study. Drug Alcohol Depend. 2016;167:103–11.

33. Hendershot CS, Stoner SA, Pantalone DW, Simoni JM. Alcohol use and antiretroviral adherence: review and meta-analysis. J Acquir Immune Defic Syndr. 2009;52(2):180.

34. Kunutsor S, Walley J, Katabira E, Muchuro S, Balidawa H, Namagala E, et al. Improving clinic attendance and adherence to antiretroviral therapy through a treatment supporter intervention in Uganda: a randomized controlled trial. AIDS Behav. 2011;15(8):1795–802.

35. Nachega JB, Knowlton AR, Deluca A, Schoeman JH, Watkinson L, Efron A, et al. Treatment supporter to improve adherence to antiretroviral therapy in HIV-infected South African adults: a qualitative study. J Acquir Immune Defic Syndr. 2006;43:S127–33.

36. Allison EH, Seeley JA. HIV and AIDS among fisherfolk: a threat to 'responsible fisheries'? Fish Fish. 2004;5(3):215–34.

37. Seeley JA, Allison EH. HIV/AIDS in fishing communities: challenges to delivering antiretroviral therapy to vulnerable groups. AIDS Care. 2005;17(6):688–97.

38. Seeley J, Tumwekwase G, Grosskurth H. Fishing for a living but catching HIV: AIDS and changing patterns of the organization of work in fisheries in Uganda. Anthopol Work Rev. 2009;30(2):66–76.

39. Mack N, Odhiambo J, Wong CM, Agot K. Barriers and facilitators to pre-exposure prophylaxis (PrEP) eligibility screening and ongoing HIV testing among target populations in Bondo and Rarieda, Kenya: results of a consultation with community stakeholders. BMC Health Serv Res. 2014;14:231.

40. Bogart LM, Naigino R, Maistrellis E, Wagner GJ, Musoke W, Mukasa B, et al. Barriers to linkage to HIV care in Ugandan fisherfolk communities: a qualitative analysis. AIDS Behav. 2016;20(10):2464–76.

41. Bogart LM, Wagner GJ, Musoke W, Naigino R, Linnemayr S, Maistrellis E, et al. A comparison of home-based versus outreach event-based community HIV testing in Ugandan fisherfolk communities. AIDS Behav. 2017;21(2):547–60.

42. Katz IT, Ryu AE, Onuegbu AG, Psaros C, Weiser SD, Bangsberg DR, et al. Impact of HIV-related stigma on treatment adherence: systematic review and meta-synthesis. J Int AIDS Soc. 2013;16:18640.

43. Bonnington O, Wamoyi J, Ddaaki W, Bukenya D, Ondenge K, Skovdal M, et al. Changing forms of HIV-related stigma along the HIV care and treatment continuum in sub-Saharan Africa: a temporal analysis. Sex Transm Infect. 2017;93(3):e052975.

44. Tabatabai J, Namakhoma I, Tweya H, Phiri S, Schnitzler P, Neuhann F. Understanding reasons for treatment interruption amongst patients on antiretroviral therapy–a qualitative study at the Lighthouse Clinic, Lilongwe, Malawi. Glob Health Action. 2014;30(2):24795.

45. Lyimo RA, Stutterheim SE, Hospers HJ, de Glee T, van der Ven A, de Bruin M. Stigma, disclosure, coping, and medication adherence among people living with HIV/AIDS in Northern Tanzania. AIDS Patient Care STDs. 2014;28(2):98–105.

46. Treves-Kagan S, Steward WT, Ntswane L, Haller R, Gilvydis JM, Gulati H, et al. Why increasing availability of ART is not enough: a rapid, community-based study on how HIV-related stigma impacts engagement to care in rural South Africa. BMC Public Health. 2016;16(1):87.

47. Wyrod R. Masculinity and the persistence of AIDS stigma. Cult Health Sex. 2011;13(4):443–56.

48. Mburu G, Ram M, Siu G, Bitira D, Skovdal M, Holland P. Intersectionality of HIV stigma and masculinity in eastern Uganda: implications for involving men in HIV programmes. BMC Public Health. 2014;14:1061.

49. Sileo K, Kintu M, Chanes-Mora P, Kiene S. "Such behaviors are not in my home village, I got them here": a qualitative study of the influence of contextual factors on alcohol and HIV risk behaviors in a fishing community on Lake Victoria, Uganda. AIDS Behav. 2016;20(3):537–47.

50. Nunan F. Mobility and fisherfolk livelihoods on Lake Victoria: implications for vulnerability and risk. Geoforum. 2010;41(5):776–85.

51. Kwena ZA, Camlin CS, Shisanya CA, Mwanzo I, Bukusi EA. Short-term mobility and the risk of HIV infection among married couples in the fishing communities along Lake Victoria, Kenya. PLoS ONE. 2013;8(1):e54523.

52. Mills EJ, Nachega JB, Buchan I, et al. Adherence to antiretroviral therapy in sub-saharan africa and north america: a meta-analysis. JAMA. 2006;296(6):679–90.

53. Nachega JB, Mills EJ, Schechter M. Antiretroviral therapy adherence and retention in care in middle-income and low-income countries: current status of knowledge and research priorities. Curr Opin HIV AIDS. 2010;5(1):70–7.

54. Geng EH, Bangsberg DR, Musinguzi N, Emenyonu N, Bwana MB, Yiannoutsos CT, et al. Understanding reasons for and outcomes of patients lost to follow-up in antiretroviral therapy programs in Africa through a sampling-based approach. J Acquir Immune Defic Syndr. 2010;53(3):405–11.

55. Croome N, Ahluwalia M, Hughes LD, Abas M. Patient-reported barriers and facilitators to antiretroviral adherence in sub-Saharan Africa. AIDS (London, England). 2017;31(7):995–1007.

56. Muhamadi L, Nsabagasani X, Tumwesigye MN, Wabwire-Mangen F, Ekström A-M, Peterson S, et al. Inadequate pre-antiretroviral care, stock-out of antiretroviral drugs and stigma: policy challenges/bottlenecks to the new WHO recommendations for earlier initiation of antiretroviral therapy in eastern Uganda. Health Policy. 2010;97(2):187–94.

57. Colvin CJ, Konopka S, Chalker JC, Jonas E, Albertini J, Amzel A, et al. A systematic review of health system barriers and enablers for antiretroviral therapy (ART) for HIV-infected pregnant and postpartum women. PLoS ONE. 2014;9(10):e108150.

58. Dovel KYS, Watkins S, Poulin M. Men's heightened risk of AIDS-related death: the legacy of gendered HIV testing and treatment strategies. AIDS. 2015;29:1123–5.

59. The World Health Organization (WHO). The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care. Geneva: WHO; 2001.

60. Martinez P, Andia I, Emenyonu N, Hahn JA, Hauff E, Pepper L, et al. Alcohol use, depressive symptoms and the receipt of antiretroviral therapy in Southwest Uganda. AIDS Behav. 2008;12(4):605–12.

61. Earnshaw VA, Smith LR, Chaudoir SR, Amico KR, Copenhaver MM. HIV stigma mechanisms and well-being among PLWH: a Test of the hiv stigma framework. AIDS Behav. 2013;17(5):1785–95.

62. Chesney MA, Ickovics JR, Chambers DB, Gifford AL, Neidig J, Zwickl B, et al. Self-reported adherence to antiretroviral medications among participants in HIV clinical trials: the AACTG adherence instruments. AIDS Care. 2000;12(3):255–66.

63. Antelman G, Smith Fawzi MC, Kaaya S, Mbwambo J, Msamanga GI, Hunter DJ, et al. Predictors of HIV-1 serostatus disclosure: a

prospective study among HIV-infected pregnant women in Dar es Salaam, Tanzania. AIDS. 2001;15(14):1865–74.

64. Broadhead WE, Gehlbach SH, Gruy FVD, Berton HK. The duke-unc functional social support questionnaire: measurement of social support in family medicine patients. Med Care. 1988;26(7):709–23.

65. Epino HM, Rich ML, Kaigamba F, Hakizamungu M, Socci AR, Bagiruwigize E, et al. Reliability and construct validity of three health-related self-report scales in HIV-positive adults in rural Rwanda. AIDS Care. 2012;24(12):1576–83.

66. Oyugi JH, Byakika-Tusiime J, Ragland K, Laeyendecker O, Mugerwa R, Kityo C, et al. Treatment interruptions predict resistance in HIV-positive individuals purchasing fixed-dose combination antiretroviral therapy in Kampala, Uganda. AIDS. 2007;21(8):965–71. https://doi.org/10.1097/QAD.0b013e32802e6bfa.

67. Safren SA, Biello KB, Smeaton L, Mimiaga MJ, Walawander A, Lama JR, et al. Psychosocial predictors of non-adherence and treatment failure in a large scale multi-national trial of antiretroviral therapy for HIV: data from the ACTG A5175/PEARLS trial. PLoS ONE. 2014;9(8):e104178.

68. Reynolds NR, Sun J, Nagaraja HN, Gifford AL, Wu AW, Chesney MA. Optimizing measurement of self-reported adherence with the ACTG adherence questionnaire: a cross-protocol analysis. J Acquir Immune Defic Syndr. 2007;46(4):402–9.

69. Uganda MOH. Addendum to the National Antiretroviral Treatment Guidelines. Kampala: Uganda Ministry of Health; 2013.

70. International AIDS Society (IAS). Differentiated care for HIV: a decision framework for antiretroviral. Available from:http://www.differentiatedcare.org/Portals/0/adam/Content/yS6M-GKB5EWs_uTBHk1C1Q/File/DecisionFramework.pdf. 2016.

71. Tsai AC, Bangsberg DR, Bwana M, Haberer JE, Frongillo EA, Muzoora C, et al. How does antiretroviral treatment attenuate the stigma of HIV? evidence from a cohort study in rural Uganda. AIDS Behav. 2013;17(8):2725–31.

72. Stangl AL, Lloyd JK, Brady LA, Holland CE, Baral S. A systematic review of interventions to reduce HIV-related stigma and discrimination from 2002 to 2013: how far have we come? J Int AIDS Soc. 2013;16(2):18734.

73. Tshabalala J, Visser M. Developing a cognitive behavioural therapy model to assist women to deal with HIV and stigma. South Afr J Psychol. 2011;41(1):17–28.

74. Takada S, Weiser SD, Kumbakumba E, Muzoora C, Martin JN, Hunt PW, et al. The dynamic relationship between social support and HIV-related stigma in rural Uganda. Ann Behav Med. 2014;48(1):26–37.

75. Hickey MDSC, Omollo D, Mattah B, Fiorella KJ, Geng EH, Bacchetti P, Blat C, Ouma GB, Zoughbie D, Tessler RA, Salmen MR, Campbell H, Gandhi M, Shade S, Njoroge B, Bukusi EA, Cohen CR. Implementation and operational research: pulling the network together: quasiexperimental trial of a patient-defined support network intervention for promoting engagement in HIV care and medication adherence on Mfangano Island, Kenya. J Acquir Immune Defic Syndr. 2015;69(4):e127–34.

76. O'Laughlin KN, Wyatt MA, Kaaya S, Bangsberg DR, Ware NC. How treatment partners help: social analysis of an African adherence support intervention. AIDS Behav. 2012;16(5):1308–15.

77. Prust ML, Banda CK, Nyirenda R, Chimbwandira F, Kalua T, Jahn A, et al. Multi-month prescriptions, fast-track refills, and community ART groups: results from a process evaluation in Malawi on using differentiated models of care to achieve national HIV treatment goals. J Int AIDS Soc. 2017;20(Supplement 4):21650.

78. McCarthy EA, Subramaniam HL, Prust ML, Prescott MR, Mpasela F, Mwango A, et al. Quality improvement intervention to increase adherence to ART prescription policy at HIV treatment clinics in Lusaka, Zambia: a cluster randomized trial. PLoS ONE. 2017;12(4):e0175534.

79. Ssonko C, Gonzalez L, Mesic A, Silveira de Fonesca M, Achar J, Safar N, et al. Delivering HIV care in challenging operating environments: the MSF experience towards differentiated models of care for settings with multiple basic health care needs. Journal of the International AIDS Society; Vol 20 Supplement 4 (2017). 2017.

80. UNAIDS. 90-90-90: An ambitious treatment target to help end the AIDS epidemic. Geneva: UNAIDS; 2014.

81. World Health Organization. Consolidated Guidelines on the Use of Antiretroviral Drugs for Treating and Preventing HIV Infection: Recommendation for a Public Health Approach. 2nd ed. Geneva: WHO; 2016.

82. Maheu-Giroux M, Vesga JF, Diabaté S, Alary M, Baral S, Diouf D, et al. Population-level impact of an accelerated HIV response plan to reach the UNAIDS 90-90-90 target in Côte d'Ivoire: insights from mathematical modeling. PLOS Med. 2017;14(6):e1002321.

83. Mishra SME, Pickles M, Vickerman P, Shastri S, Gilks C, Dhingra NK, Washington R, Becker ML, Blanchard JF, Alary M, Boily MC. Strategic Epi-ART in India Modelling Team, Exploring the population-level impact of antiretroviral treatment: the influence of baseline intervention context. AIDS. 2014;28(1):S61–72.