Unhealthy Alcohol Use and Syndemic Vulnerability Among HIV-Negative MSM in Kisumu, Kenya: A Longitudinal Analysis of the Anza Mapema Cohort

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Abstract

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Unhealthy alcohol use is common among men who have sex with men (MSM) in Kenya and may contribute to HIV vulnerability through its association with sexual behaviors, violence exposure, substance use, and poor mental health. This secondary analysis used data from 636 HIV-negative MSM enrolled in the Anza Mapema cohort in Kisumu, Kenya. Generalized estimating equations were used to examine longitudinal associations between unhealthy alcohol use (AUDIT ≥8), heavy episodic drinking, and WHO AUDIT risk zones with sexual behaviors, violence and abuse, substance use, and moderate-severe depressive symptoms over 12 months. Unhealthy alcohol use was associated with transactional sex, violence and abuse, substance use, and moderate-severe depressive symptoms. Associations with condomless sex and multiple partnerships were attenuated after adjustment, although participants in the highest AUDIT risk category (Zone IV) remained at elevated risk for both outcomes. Among HIV-negative MSM in Kisumu, unhealthy alcohol use was most consistently associated with violence exposure, transactional sex, substance use, and moderate-severe depressive symptoms. As such, alcohol screening may help identify MSM at elevated risk across multiple HIV-relevant domains.

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Introduction

In Kenya, where same-sex sexual practices remain criminalized, MSM face compounded stigma and structural barriers that shape everyday experiences of social exclusion and vulnerability.[1] The criminalization of same-sex sexual relationships under Kenyan law creates a climate of fear that drives many gay, bisexual, and other men who have sex with men (MSM) to conceal their identities.[2] This criminalization is also associated with discrimination, harassment, and violence from the public.[3] In addition, healthcare providers who stigmatize MSM may directly or indirectly restrict access to essential health services.[4] While many MSM cope with stigma through concealment of sexual identity and avoidance of disclosure while utilizing healthcare facilities,[5] research consistently demonstrates high rates of mental health challenges among MSM populations in Kenya, with studies across regions including Kisumu, Nairobi, and coastal areas reporting clinically significant depressive symptoms in 28%-42% and PTSD symptoms in 52%.[6]

Unfortunately, many Kenyan MSM with stigma and mental health challenges may try to cope with these issues through unhealthy alcohol consumption.[5] Alcohol is not only widely available but socially normalized among Kenyan men, frequently connected to local social constructs of masculinity and coping strategies.[7] Alcohol use is increasingly recognized as a key driver of HIV transmission and poor health outcomes, given its associations with risky sexual behaviors and reduced adherence to prevention strategies.[8] Among MSM in Kenya, alcohol consumption is both a recreational activity and a coping mechanism for stigma, discrimination, depression, and minority stress.[9] In settings where alcohol consumption intersects with sexual networking (such as bars, clubs, or transactional sex venues) drinking influences the circumstances of sexual encounters.[10]

A syndemics framework can be applied to explore how unhealthy alcohol use increases susceptibility to HIV within the social context of Kenya.[11] This approach emphasizes how unhealthy alcohol use is related to sexual behaviors, experiences of trauma and abuse, depression, and non-alcohol substance use challenges — all of which heighten vulnerability to HIV.[12] Studies of MSM in the United States have found that alcohol not only impairs judgment but also increases the likelihood of condomless sex, multiple partners, and transactional sex, all of which elevate HIV risk.[13] For MSM who experience violence or abuse, alcohol may serve as a temporary escape or provide the courage to engage in sexual behavior, while decreasing the use of preventive tools such as condoms.

Prior research has documented a high prevalence of unhealthy alcohol use and its intersection with sexual risk-taking, including transactional sex and multiple commercial sex partners, among MSM in the region.[14,15] While there has been a clear link between sex work and alcohol use,[14] less is known about how alcohol use relates to specific sexual behaviors outside of transactional contexts, such as partner numbers or condom use. Evidence is also limited on how unhealthy alcohol use is associated with experiences of enacted stigma, such as verbal abuse or threats, physical assault, and sexual violence in longitudinal, community-based cohorts. Prior research from a cohort of MSM in coastal Kenya documented high levels of sexual, physical, and verbal violence, alongside evidence linking alcohol use to HIV risk behaviors,[16,17] but the findings were limited by small numbers of participants, a high proportion of whom were involved in transactional sex, and by the single geographic location and research context.

This thesis addresses this gap through a secondary analysis of data from the *Anza Mapema* study, a prospective cohort of 711 MSM in Kisumu, Kenya conducted between 2016 and 2018.[18,19] The parent study primarily sought to measure HIV incidence, identify barriers to

HIV testing and treatment, and evaluate use of HIV prevention strategies available at the time, such as reduction in partner numbers and condom use with sex. Building upon this foundation, the current analysis uses de-identified data to examine associations between unhealthy alcohol use and (1) sexual behaviors, (2) recent (≤3 months) violence and abuse, and (3) depression and non-alcohol substance use among HIV-negative MSM who participated in the *Anza Mapema* study.

Methods

Study Design and Population

This study is a secondary analysis of data from the *Anza Mapema* cohort, a prospective study of MSM in Kisumu, Kenya, conducted between 2016 and 2018.[18,19] The parent study enrolled 711 participants regardless of HIV status, using a combination of community-based recruitment strategies, including peer referral from an existing MSM network and outreach by trained peer educators at known MSM social venues (e.g., bars, discos, and hotels). Participants were followed at quarterly intervals over a 12-month period (baseline and months 3, 6, 9, and 12).

For this analysis, the sample was restricted to those participants who were HIV-negative at baseline (N = 636). Participants who seroconverted during follow-up contributed person-time up to, but not beyond, their first HIV-positive visit. The analytic dataset was structured longitudinally, with repeated observations (person-visits) for each participant across a maximum of 5 study visits (i.e., baseline plus 4 quarterly follow-up visits).

Data Collection

Sociodemographic, behavioral, and psychosocial data were collected using audio computer-assisted self-interview (ACASI) questionnaires administered in English, Kiswahili, or Dholuo to

enhance privacy and reduce social desirability bias when assessing sensitive behaviors and psychosocial experiences. Baseline ACASI questions captured sociodemographic characteristics, alcohol use, sexual behaviors, recent trauma and abuse, moderate-severe depression, and non-alcohol substance use. These data were collected at study clinics in Kisumu, Kenya using ACASI questionnaires administered in English, DhoLuo, and Kiswahili. Study instruments underwent translation and back-translation by certified translators, with final versions established through consensus review by study personnel; research staff were available to answer participant questions in all three languages.

Measures

Primary Exposure

The primary exposure in this analysis is unhealthy alcohol use, measured using the Alcohol Use Disorders Identification Test (AUDIT).[18] Total AUDIT scores (range: 0–40) were calculated by adding responses across ten items scored from 0–4 based on the frequency or severity of alcohol-related behaviors. Participants who reported never consuming alcohol were not administered the remaining AUDIT items and were assigned a total score of 0, consistent with prior studies among MSM in Kenya.[14] Consistent with WHO guidance and prior research among MSM populations, unhealthy drinking was defined as an AUDIT score of ≥8, which optimizes sensitivity for identifying AUDIT scores indicating harmful or hazardous alcohol use (8-15) or alcohol dependence (≥16).[18,20] A secondary exposure examining heavy episodic drinking, defined as consuming ≥6 drinks on a single occasion, was also included to assess whether episodic, high-intensity alcohol use was independently associated with outcomes.[15] A third categorical exposure based on WHO AUDIT risk zones was also examined to assess dose-response relationships across increasing levels of alcohol use severity (Zone I: 0–7, Zone II: 8–

15, Zone III: 16–19, Zone IV: 20–40).[20] Alcohol use exposures derived from the AUDIT questionnaire, including unhealthy alcohol use (AUDIT ≥8), heavy episodic drinking, and WHO AUDIT risk zones were analyzed as time-updated exposures in longitudinal models.

Outcomes

Sexual behavior outcomes included transactional sex in the past 3 months (yes/no), number of male sexual partners in the past 3 months (0, 1, 2, or 3+), condomless sex at last sexual encounter (yes/no), and group sex in the past 3 months (yes/no). Recent violence and abuse outcomes included physical violence, sexual violence, verbal insults, and threats in the past 3 months, measured using items adapted from the USAID Health Policy Initiative (HPI) MSM Trauma Screening Tool,[17] as previously applied in studies of MSM in Kenya.[19,21,22] Each violence outcome was coded dichotomously (yes/no). Non-alcohol substance use was assessed using the Drug Abuse Screening Test 10 (DAST-10) questionnaire, with results coded as a binary outcome (≥1 vs. 0), consistent with prior studies among Kenyan MSM.[14] Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9), with scores ≥15 indicating moderately severe or severe depressive symptoms.[18]

Sexual behavior, recent violence and abuse, depression and non-alcohol substance use outcomes were analyzed as time-updated variables, with assessment schedules varying. Number of male sexual partners and condomless sex at last sexual encounter were assessed at baseline and all quarterly follow-up visits (months 3, 6, 9, and 12). Transactional sex, violence and abuse, depressive symptoms, and non-alcohol substance use were assessed at baseline and months 6 and 12. Group sex was assessed at months 6 and 12 only.

Covariates/Confounders

Covariates were selected *a priori* as potential confounders, based on prior analyses of the *Anza Mapema* cohort by Kunzweiler et al.[19,21,22] Like previous analyses, age was categorized as 18–19, 20–24, 25–29, and 30+ years and education was categorized as 0–8, 9–12, and 13+ years. Age and education were treated as fixed baseline covariates and carried forward across follow-up visits, while study visit was included as a time indicator in longitudinal models.

Missingness

Across variables, responses coded as "don't know," "refuse," or other nonresponse options were treated as missing. Missing data patterns were evaluated prior to analysis, including missed visits and loss to follow-up across study visits. The highest proportion of missingness was observed for number of male partners at baseline (161/636, 25.3%), reflecting a REDCap skip-logic error during early data collection that was corrected at later visits. A moderate proportion of missingness was observed for sexual violence (44/636, 6.9% at baseline), physical violence (40/636, 6.3% at baseline), and verbal insults (32/636, 5.0% at baseline). Missingness for all other variables was minimal and generally below 2%.

Data Analysis

Descriptive statistics were used to characterize the study population at baseline, both overall and by alcohol use category (AUDIT ≥ 8 vs < 8). Missingness for unhealthy alcohol use classification was minimal, 1 participant (0.2%) across study visits. Categorical variables were compared across these categories using Chi-square or Fisher's exact tests, and continuous variables using t-tests or Wilcoxon rank-sum tests, as appropriate. A complete case approach was used for longitudinal analyses, with outcome-specific sample sizes varying due to item nonresponse, missed visits, and visit-specific outcome administration.

For longitudinal analyses, associations between each alcohol use variable and each outcome were examined using generalized estimating equations (GEE). Binary outcomes were modeled using a modified Poisson approach with a log link, robust standard errors, and an exchangeable correlation matrix to account for within-subject correlation across repeated measures. The count outcome for number of male partners was modeled using negative binomial GEE with a log link, robust standard errors, and an exchangeable correlation matrix. Bivariable models were first estimated, followed by multivariable models adjusting for baseline age category, baseline education category, and study visit. For analyses of condomless sex at last sexual encounter and having two or more male sexual partners in the past three months, transactional sex was additionally included as a covariate because of its potential association with both alcohol use and sexual behavior outcomes.

All variable construction, coding, and analyses were conducted in Stata/SE 19.5.

Ethics

The Anza Mapema study was reviewed and approved by Maseno University (protocol MSU/DRPC/MUERC/00104/14), the University of Illinois at Chicago (protocol 2014-0778), and University of Washington (protocol 48148). The current thesis project involves a secondary analysis of de-identified data, which was determined by the University of Washington IRB not to be human subjects research.

Results

Baseline characteristics

Baseline characteristics are presented in Table 1. Among 636 HIV-negative MSM, 319 (50%) reported unhealthy alcohol use (AUDIT ≥8). Participants with unhealthy alcohol use were more

likely to be older compared with those reporting low-risk alcohol use. Heavy episodic drinking (≥6 drinks on a single occasion), the secondary alcohol use measure, was reported by 305 participants (48%) at baseline. At baseline, 50% of participants were classified in WHO AUDIT Zone I (AUDIT 0–7), 22% in Zone II (8–15), 8% in Zone III (16–19), and 20% in Zone IV (20–40).

Table 1. Baseline characteristics of HIV-negative men who have sex with men in the Anza Mapema cohort, Kisumu, Kenya (n=636)

Variable	Total n=636 (%)	Low-risk Alcohol Use (AUDIT <8), n= 317 (%)	Unhealthy Alcohol Use (AUDIT 8 ≥), n= 319 (%)	P Value
Sociodemographic characteristics				
Age, years				< 0.001
18-19	72 (11%)	50 (16%)	22 (7%)	
20-24	297 (47%)	161 (51%)	136 (43%)	
25-29	159 (25%)	69 (22%)	90 (28%)	
30+	108 (17%)	37 (12%)	71 (22%)	
Education, years				0.284
0–8	124 (20%)	58 (18%)	66 (21%)	
9–12	321 (50%)	170 (54%)	151 (47%)	
13+	191 (30%)	89 (28%)	102 (32%)	
Sexual behaviors				
Transactional sex (past 3 months)				0.001
Yes	401 (63%)	173 (55%)	228 (71%)	
No	235 (37%)	144 (45%)	91 (29%)	
Number of male partners (past 3 months)[a]				<0.05
0	21 (4%)	12 (5%)	9 (4%)	
1	194 (41%)	103 (46%)	91 (36%)	
2	127 (27%)	59 (26%)	68 (27%)	

3+	137 (29%)	52 (23%)	85 (34%)	
Condomless sex (participant report)[b]				0.095
Yes	417 (66%)	221 (70%)	196 (62%)	
No	217 (34%)	96 (30%)	121 (38%)	
Condomless sex (partner report)[c]				0.304
Yes	423 (69%)	214 (71%)	209 (67%)	
No	193 (31%)	89 (29%)	104 (33%)	
Group Sex (past 3 months)[d]				0.888
Yes	69 (14%)	45 (14%)	24 (14%)	
No	415 (86%)	267 (86%)	148 (29%)	
Recent violence and abuse (≤3 months)				
Physically abused (past 3 months)[e]				< 0.001
Yes	161 (25%)	57 (18%)	104 (33%)	
No	475 (75%)	260 (82%)	215 (67%)	
Sexual violence (past 3 months)[f]				0.001
Yes	107 (18%)	37 (13%)	70 (23%)	
No	492 (82%)	259 (88%)	233 (77%)	
Verbal Insults (past 3 months)[g]				< 0.001
Yes	308 (50%)	125 (41%)	183 (60%)	
No	303 (50%)	179 (59%)	124 (40%)	
Missing/ N/A	32 (5%)			
Threatened (past 3 months)[h]				0.001
Yes	192 (30%)	65 (21%)	127 (40%)	
No	440 (70%)	250 (79%)	190 (60%)	
Substance use and mental health				
Drug Use (past year)				< 0.001
Yes	265 (42%)	82 (26%)	183 (57%)	

No	371 (58%)	235 (74%)	136 (43%)	
Moderate-Severe depressive symptoms (PHQ-9>=15)				< 0.001
Yes	366 (58%)	146 (46%)	220 (69%)	
No	270 (42%)	171 (54%)	99 (31%)	

a Missing for 161 participants (25%) due to an early ACASI skip-logic error.
b Missing for 2 participants (<1%).
c Missing for 20 participants (3%).
d Group sex was not collected at baseline, therefore the table presents month 6 data (the first time this question was asked) and missing for 4 participants (0.8%).
e Missing for 40 participants (6%).
f Missing for 44 participants (7%).
g Missing for 32 participants (5%).
h Missing for 4 participants (1%).

Participants with unhealthy alcohol use were more likely to report transactional sex and a greater number of male sexual partners in the past three months. Heavy episodic drinking was also more common among participants with unhealthy alcohol use. In addition, unhealthy alcohol use was associated with higher prevalence of drug use (DAST ≥1), severe depressive symptoms (PHQ-9 ≥15),[23] and recent experiences of violence, including physical assault, sexual violence, verbal insults, and threats. Condomless sex and group sex did not significantly differ between alcohol use groups at baseline.

Follow-up Visits

A total of 636 participants were enrolled at baseline, with 504 (79.2%) attending the 3-month visit, 488 (76.7%) attending the 6-month visit, 483 (75.9%) attending the 9-month visit, and 498 (78.3%) attending the 12-month visit.

Sexual behavior outcomes

Transactional sex was reported by 401 participants (63%) at baseline and ranged from 44% to 48% at follow-up visits (Table 2). Unhealthy alcohol use (AUDIT ≥8) and heavy episodic drinking were both significantly associated with transactional sex in unadjusted and adjusted

models. In adjusted analyses, participants with unhealthy alcohol use had 32% higher risk of reporting transactional sex (aRR: 1.32; 95% CI: 1.20–1.47), and those reporting heavy episodic drinking had 33% higher risk (aRR: 1.33; 95% CI: 1.21–1.46). A dose–response relationship was also observed across WHO AUDIT risk zones, with progressively higher risks of transactional sex at increasing levels of alcohol use severity. Participants in the highest risk category (Zone IV) had 50% higher adjusted risk of transactional sex compared with those in Zone I (aRR: 1.50; 95% CI: 1.33–1.69).

Table 2. GEE Results for Associations with Transactional Sex

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**P value**	**Adjusted RR (95% CI)[a]**	**P value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	1.44 (1.30–1.59)	<0.001	1.32 (1.20–1.47)	<0.001	1618	635
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.40 (1.27–1.54)	<0.001	1.33 (1.21–1.46)	<0.001	1619	636
AUDIT risk zones (categorical)						
AUDIT risk zone I	Ref					
AUDIT risk zone II (8–15)	1.31 (1.16–1.47)	<0.001	1.22 (1.08–1.38)	0.001	1618	635
AUDIT risk zone III (16–19)	1.47 (1.26–1.73)	<0.001	1.36 (1.16–1.60)	<0.001	1618	635
AUDIT risk zone IV (20+)	1.66 (1.48–1.86)	<0.001	1.50 (1.33–1.69)	<0.001	1618	635

Notes: Transactional sex was assessed at baseline and at 6 and 12-month follow-up visits and refers to experiences reported in the past 3 months. The outcome was not assessed at months 3 and 9 (structural missingness). Missingness at visits where this outcome was collected was very low: 3/1622 (0.2%). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval
a Results adjusted for baseline age, education, and study visit

At baseline, 84% of participants reported two or more male sexual partners in the past three months. Across follow-up visits, 40% of observations included reports of two or more male sexual partners. Both alcohol use predictors were associated with having two or more male sexual partners in the past three months in unadjusted analyses. However, associations for unhealthy alcohol use and heavy episodic drinking were attenuated and no longer statistically

significant after adjustment for baseline age, education, study visit, and transactional sex. Among AUDIT risk zones, only the highest risk category (Zone IV) remained significantly associated with this outcome after adjustment (aRR: 1.28; 95% CI: 1.10–1.48).

Table 3. GEE Results for 2+ Male Partners

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	1.33 (1.17–1.52)	<0.001	1.09 (0.96–1.24)	0.192	1428	612
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.23 (1.08–1.41)	0.002		0.601	1428	612
AUDIT risk zones (categorical)						
AUDIT risk zone I	Ref					
AUDIT risk zone II (8–15)	1.15 (0.97–1.35)	0.100	1.00 (0.85–1.17)	0.983	1428	612
AUDIT risk zone III (16–19)	1.25 (0.99–1.58)	0.065	1.02 (0.80–1.29)	0.903	1428	612
AUDIT risk zone IV (20+)	1.68 (1.44–1.95)	<0.001	1.28 (1.10–1.48)	0.001	1428	612

Notes: The number of male sexual partners was assessed at baseline and at all quarterly follow-up visits (3, 6, 9, and 12 months) and refers to partners reported in the past 3 months. Missingness was relatively low: 214/2609 (8.2%) (baseline: 161/636; month 3: 9/504; month 6: 13/488; month 9: 12/483; month 12: 19/498). Higher baseline missingness reflects an early structural issue (i.e., incorrect skip rule in the ACASI questionnaire that was subsequently corrected.
Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test.
a Results adjusted for baseline age, education, study visit, and transactional sex

At baseline, 34% of participants reported condomless sex at last sexual encounter. Across follow-up visits, 21% of observations included reports of condomless sex at last sexual encounter. While unhealthy alcohol use and heavy episodic drinking were significantly associated with condomless sex in unadjusted models, these associations were no longer statistically significant after adjustment for baseline age, education, study visit, and transactional sex. However, individuals in the highest AUDIT risk zone (Zone IV) continued to have a higher risk of condomless sex at last sexual encounter (aRR: 1.29; 95% CI: 1.03–1.63).

Table 4. GEE Results for Condomless Sex at Last Sex

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**

Unhealthy alcohol use (AUDIT ≥8)	1.30 (1.09–1.55)	0.003	1.07 (0.90–1.27)	0.462	1607	634
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.24 (1.05–1.47)	0.013	1.08 (0.91–1.27)	0.381	1608	635
AUDIT risk zones (categorical)						
AUDIT risk zone I	Ref					
AUDIT risk zone II (8–15)	1.09 (0.88–1.36)	0.425	0.96 (0.77–1.19)	0.709	1607	634
AUDIT risk zone III (16–19)	1.16 (0.84–1.60)	0.367	0.97 (0.69–1.36)	0.854	1607	634
AUDIT risk zone IV (20+)	1.69 (1.35–2.12)	<0.001			1607	634

Notes: Condomless sex at last sex was assessed at baseline and quarterly follow-up visits (3, 6, 9, and 12 months) and refers to no condom use reported at the participant's most recent sexual encounter. Missingness was low: 21/2609 (0.8%) (baseline: 2/636 [0.3%]; month 3: 2/504 [0.4%]; month 6: 4/488 [0.8%]; month 9: 5/483 [1.0%]; month 12: 8/498 [1.6%]). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test.
a Results adjusted for baseline age, education, study visit, and transactional sex

Group sex was assessed at the Month 6 and Month 12 visits only. At the Month 6 visit, 14% of participants reported group sex in the past three months, compared with 12% at the Month 12 visit. No statistically significant associations were observed between alcohol use and group sex in the past 3 months in either unadjusted or adjusted models.

Table 5. GEE Results for Group Sex

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	1.16 (0.83–1.63)	0.391	1.15 (0.82–1.61)	0.414	977	546
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.08 (0.76–1.53)	0.659	1.06 (0.76–1.47)	0.745	977	546
AUDIT risk zones (categorical)						
AUDIT risk zone I	Ref					
AUDIT risk zone II (8–15)	0.92 (0.59–1.44)	0.723	0.95 (0.61–1.47)	0.804	977	546
AUDIT risk zone III (16–19)	1.57 (0.90–2.74)	0.115	1.46 (0.83–2.58)	0.190	977	546
AUDIT risk zone IV (20+)	1.27 (0.77–2.09)	0.349	1.24 (0.77–2.00)	0.376	977	546

Notes: Group sex was assessed at the 6-month and 12-month study visits and refers to behaviors reported in the past 3 months. Missingness at visits where this outcome was collected was low: 9/986 (0.9%) overall (month 6: 4/488 [0.8%]**;** month 12: 5/498 [1.0%]). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test.
a Results adjusted for baseline age, education, and study visit

Recent violence and abuse outcomes

At baseline, 19% of participants reported physical violence in the past three months. Across follow-up visits where physical violence was assessed, 12% of observations included reports of physical violence in the past three months. For physical violence, unhealthy alcohol use was associated with an 85% higher risk in adjusted models (aRR: 1.85; 95% CI: 1.43–2.38), while heavy episodic drinking was associated with a 58% increased risk (aRR: 1.58; 95% CI: 1.24–2.02). Increasing AUDIT risk zones were associated with progressively higher risks of physical violence.

Table 6. GEE Results for Physical Violence

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	2.07 (1.59–2.68)	<0.001	1.85 (1.43–2.38)	<0.001	1523	625
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.69 (1.31–2.18)	<0.001	1.58 (1.24–2.02)	<0.001	1523	625
AUDIT risk zones (categorical)						
AUDIT risk zone I	Ref					
AUDIT risk zone II (8–15)	1.83 (1.36–2.47)	<0.001	1.67 (1.24–2.24)	0.001	1523	625
AUDIT risk zone III (16–19)	1.88 (1.24–2.85)	0.003	1.60 (1.05–2.43)	0.029	1523	625
AUDIT risk zone IV (20+)	2.50 (1.81–3.46)	<0.001	2.27 (1.65–3.14)	<0.001	1523	625

Notes: Physical violence (past 3 months) was assessed at baseline and at months 6 and 12 and refers to experiences reported in the past 3 months. Months 3 and 9 were not administered for this outcome (structural missingness). Missingness at visits where this outcome was collected was moderate: 99/1622 (6.1%) (baseline: 40/636 [6.3%]; month 6: 32/488 [6.6%]; month 12: 27/498 [5.4%]). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test.
a Results adjusted for baseline age, education, and study visit

At baseline, 16% of participants reported sexual violence in the past three months. Across follow-up visits where sexual violence was assessed, 10% of observations included reports of sexual violence in the past three months. Similar patterns were observed for sexual violence, with unhealthy alcohol use (aRR: 1.78; 95% CI: 1.35–2.35) and heavy episodic drinking (aRR:

1.54; 95% CI: 1.17–2.01) significantly associated with increased risk. A strong dose–response relationship was also observed across AUDIT zones.

Table 7. GEE Results for Sexual Violence

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	2.07 (1.55–2.76)	<0.001	1.78 (1.35–2.35)	<0.001	1515	622
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.69 (1.28–2.25)	<0.001	1.54 (1.17–2.01)	0.002	1515	622
AUDIT risk zones (categorical)						
AUDIT risk zone I	Ref					
AUDIT risk zone II (8–15)	1.82 (1.32–2.51)	<0.001	1.57 (1.13–2.17)	0.007	1515	622
AUDIT risk zone III (16–19)	2.47 (1.72–3.55)	<0.001	1.99 (1.41–2.81)	<0.001	1515	622
AUDIT risk zone IV (20+)	2.27 (1.54–3.35)	<0.001	2.02 (1.38–2.97)	<0.001	1515	622

Notes: Sexual violence was assessed at baseline and at months 6 and 12 and refers to experiences reported in the past 3 months. Missingness at visits where this outcome was collected was moderate: 107/1622 (6.6%) (baseline: 44/636 [6.9%]**;** month 6: 32/488 [6.6%]**;** month 12: 31/498 [6.2%]). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test.
a Results adjusted for baseline age, education, and study visit

At baseline, 47% of participants reported verbal insults in the past three months. During follow-up visits where verbal insults were assessed, 27% of observations included reports of verbal insults in the past three months. At baseline, 30% of participants reported threats in the past three months. During follow-up visits where threats were assessed, 14% of observations included reports of threats in the past three months. Alcohol use was also associated with verbal insults and threats in the past 3 months. Unhealthy alcohol use was associated with increased risk of verbal insults (aRR: 1.46; 95% CI: 1.27–1.68) and threats (aRR: 2.07; 95% CI: 1.66–2.59). Heavy episodic drinking showed similar patterns. For both outcomes, higher AUDIT risk zones were associated with greater risk, with the strongest associations observed in the highest risk category.

Table 8. GEE Results for Verbal Insults

Binary alcohol exposure (modeled separately)	Unadjusted RR (95% CI)	p value	Adjusted RR (95% CI)[a]	p value	N (obs)	N (participants)
Unhealthy alcohol use (AUDIT ≥8)	1.74 (1.50–2.02)	<0.001	1.46 (1.27–1.68)	<0.001	1537	629
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.62 (1.40–1.87)	<0.001	1.42 (1.24–1.64)	<0.001	1537	629
AUDIT risk zones (categorical)						
Audit risk zone 1	Ref					
AUDIT risk zone II (8–15)	1.57 (1.32–1.86)	<0.001	1.37 (1.16–1.61)	<0.001	1537	629
AUDIT risk zone III (16–19)	1.71 (1.37–2.14)	<0.001	1.47 (1.17–1.83)	0.001	1537	629
AUDIT risk zone IV (20+)	2.03 (1.69–2.42)	<0.001	1.63 (1.35–1.96)	<0.001	1537	629

Notes: Verbal insults were assessed at baseline and at months 6 and 12 and refers to experiences reported in the past 3 months. Missingness at visits where this outcome was collected was moderate: 85/1622 (5.2%) (baseline: 32/636 [5.0%]**;** month 6: 26/488 [5.3%]**;** month 12: 27/498 [5.4%]). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test
a Results adjusted for baseline age, education, and study visit

Table 9. GEE Results for Threats

Binary alcohol exposure (modeled separately)	Unadjusted RR (95% CI)	p value	Adjusted RR (95% CI)[a]	p value	N (obs)	N (participants)
Unhealthy alcohol use (AUDIT ≥8)	2.55 (2.06–3.15)	<0.001	2.07 (1.66–2.59)	<0.001	1610	635
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.96 (1.61–2.39)	<0.001	1.68 (1.38–2.04)	<0.001	1611	636
AUDIT risk zones (categorical)						
AUDIT risk zone 1	Ref					
AUDIT risk zone II (8–15)	2.20 (1.71–2.84)	<0.001	1.86 (1.43–2.42)	<0.001	1610	635
AUDIT risk zone III (16–19)	2.20 (1.55–3.14)	<0.001	1.87 (1.31–2.68)	0.001	1610	635
AUDIT risk zone IV (20+)	3.27 (2.58–4.14)	<0.001	2.56 (2.00–3.28)	<0.001	1610	635

Notes: Threats were assessed at baseline and at the 6- and 12-month follow-up visits and refer to experiences reported in the past 3 months. The outcome was not administered at months 3 and 9 (structural missingness). Missingness at visits where this outcome was collected was low: 11/1622 (0.7%) (baseline: 4/636 [0.6%]; month 6: 5/488 [1.0%]; month 12: 2/498 [0.4%]). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test
a Results adjusted for baseline age, education, and study visit

Non-alcohol substance use and depression outcomes

At baseline, 42% of participants reported drug use in the past year. During follow-up visits where drug use was assessed, 32% of observations included reports of drug use in the past year.

Alcohol use was strongly associated with use of substances other than alcohol in the past year. Participants with unhealthy alcohol use had more than twice the risk of reporting non-alcohol substance use compared to those with low-risk alcohol use (aRR: 2.18; 95% CI: 1.86–2.55). Similarly, heavy episodic drinking was associated with increased risk of non-alcohol substance use (aRR: 1.96; 95% CI: 1.69–2.27). A clear dose–response relationship was observed across AUDIT risk zones, with progressively higher risks of non-alcohol substance use at increasing levels of alcohol consumption. Participants in the highest risk category (zone IV) had nearly three times the risk of non-alcohol substance use (aRR: 2.81; 95% CI: 2.36–3.34). Among participants reporting non-alcohol substance, marijuana (54%) and khat (33%) were the most commonly reported substances. Heroin was reported by 4.0% of participants, while cocaine and Rohypnol were each reported by 1.2%.

Table 10. GEE Results for Non-Alcohol Substance Use

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	2.24 (1.92–2.61)	<0.001	2.18 (1.86–2.55)	<0.001	1619	635
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	2.03 (1.75–2.35)	<0.001	1.96 (1.69–2.27)	<0.001	1620	636
AUDIT risk zones (categorical)						
AUDIT risk zone 1	Ref					
AUDIT risk zone II (8–15)	1.84 (1.54–2.20)	<0.001	1.81 (1.51–2.17)	<0.001	1619	635
AUDIT risk zone III (16–19)	2.38 (1.93–2.95)	<0.001	2.36 (1.90–2.93)	<0.001	1619	635
AUDIT risk zone IV (20+)	2.84 (2.40–3.35)	<0.001	2.81 (2.36–3.34)	<0.001	1619	635

Note: Non-alcohol substance use was assessed at baseline and at the 6- and 12-month follow-up visits and refers to substance use reported in the past 12 months. The outcome was not administered at months 3 and 9 (structural missingness). Missingness at visits where this outcome was collected was very low: 2/1,622 (0.1%) (baseline: 0/636 [0.0%]**;** month 6: 1/488 [0.2%]**;** month 12: 1/498 [0.2%])**.** Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test.
a Results adjusted for baseline age, education, and study visit

At baseline, 58% of participants reported moderate-severe depressive symptoms (PHQ-9 ≥15). During follow-up visits where moderate-severe depressive symptoms were assessed, 42% of

observations included reports of moderate-severe depressive symptoms. Alcohol use was significantly associated with moderately severe or severe depressive symptoms (PHQ-9 ≥15). In adjusted models, unhealthy alcohol use was associated with a 56% higher risk of reporting moderately severe or severe depressive symptoms at the same visit (aRR: 1.56; 95% CI: 1.40–1.74), while heavy episodic drinking was associated with a 35% higher risk (aRR: 1.35; 95% CI: 1.22–1.51). A dose–response relationship was observed across AUDIT risk zones, with increasing levels of alcohol use associated with progressively higher risks of moderate-severe depressive symptoms.

Table 11. GEE Results for Moderate-Severe Depressive Symptoms

Binary alcohol exposure (modeled separately)	**Unadjusted RR (95% CI)**	**p value**	**Adjusted RR (95% CI)[a]**	**p value**	**N (obs)**	**N (participants)**
Unhealthy alcohol use (AUDIT ≥8)	1.67 (1.50–1.86)	< 0.001	1.56 (1.40–1.74)	< 0.001	1619	635
Heavy episodic drinking (AUDIT item: ≥6 drinks per occasion)	1.43 (1.28–1.59)	< 0.001	1.35 (1.22–1.51)	< 0.001	1620	636
AUDIT risk zones (categorical)						
Audit risk zone 1	Ref					
AUDIT risk zone II (8–15)	1.42 (1.24–1.63)	< 0.001	1.36 (1.19–1.56)	< 0.001	1619	635
AUDIT risk zone III (16–19)	1.74 (1.49–2.02)	< 0.001	1.62 (1.39–1.89)	< 0.001	1619	635
AUDIT risk zone IV (20+)	2.02 (1.80–2.27)	< 0.001	1.87 (1.65–2.11)	< 0.001	1619	635

Notes: Depressive symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9) at baseline and at the 6- and 12-month visits. Moderate- severe depressive symptoms were defined as a PHQ-9 score ≥15. Missingness at visits where this outcome was collected was very low: 2/1622 (0.1%) (baseline: 0/636, 0%; month 6: 1/488, 0.2%; month 12: 1/498, 0.2%). Models were estimated using generalized estimating equations with robust standard errors and an exchangeable correlation structure.
RR = risk ratio; CI = confidence interval; AUDIT = Alcohol Use Disorders Identification Test
a Results adjusted for baseline age, education, and study visit

Discussion

This study examined the associations between unhealthy alcohol use and a range of behaviors and syndemic conditions among men who have sex with men (MSM) participating in the *Anza Mapema* cohort in Kisumu, Kenya. Across multiple models, unhealthy alcohol use and higher AUDIT risk categories were consistently associated with higher likelihood of several sexual risk

behaviors, recent violence and abuse, co-occurring substance use, and moderate-severe depressive symptoms. Few studies of unhealthy alcohol use have focused specifically on HIV-negative MSM, a group that may particularly benefit from targeted prevention and early intervention.

Sexual Behaviors

With respect to sexual behaviors, unhealthy alcohol use was associated with transactional sex. After adjustment, only the highest level of alcohol use severity (AUDIT Zone IV) remained associated with having multiple male sexual partners and condomless sex in the past three months. These findings are consistent with prior studies among MSM in Kenya demonstrating associations between unhealthy alcohol use, transactional sex, multiple sexual partnerships, and condomless sex.[14,24] Qualitative studies among MSM in Kenya have similarly described alcohol use within sexual contexts as reducing inhibition and shaping decision-making in environments characterized by stigma, transactional sex, and limited negotiating power.[9,25]

Prior research among MSM in Kenya has similarly documented how alcohol-serving and transactional sex environments shape sexual risk networks among MSM populations. Behavioral surveys conducted among MSM in coastal Kenya, including male sex workers, found high levels of multiple sexual partnerships, low awareness of HIV risk associated with unprotected anal sex, and inconsistent condom use with clients. [26] Venue-based research conducted with adults from 2025 in rural Kenya and Uganda mapped 530 alcohol-serving venues and screened 7,744 adults recruited from these settings, finding that 21% were living with HIV, 37% of HIV-negative participants reported elevated HIV risk, and venues with greater numbers of patrons and barmaids were associated with significantly higher odds of identifying individuals reporting

increased HIV risk.[27] Another venue-based study across three sites in Kenya found that the majority of identified venues were nightlife or drinking venues, and that MSM recruited through these venues had substantially elevated HIV prevalence (19.8%), highlighting how identifiable social environments may concentrate overlapping sexual and behavioral vulnerabilities among MSM.[28] These findings suggest that unhealthy alcohol use may serve as a useful marker for identifying MSM with overlapping sexual health vulnerabilities. Screening tools such as the AUDIT may help identify individuals who could benefit from more comprehensive sexual risk assessment and targeted HIV prevention services, particularly among those reporting more severe alcohol-related risk.

Associations with condomless sex at last sex were attenuated after adjustment for covariates including transactional sex and remained evident as an independent risk factor primarily among individuals with the highest levels of alcohol use. This pattern may suggest that severe alcohol use or alcohol dependence, rather than unhealthy alcohol use more broadly, more substantially impairs condom negotiation or planning during sexual encounters outside of transactional sex. In addition, we note that "condomless sex at last sex" reflects an event-level outcome, whereas the AUDIT captures broader drinking patterns over time. Because alcohol use at the time of sexual encounters was not assessed, associations between alcohol use and condomless sex may have been attenuated.[29] Second, condom negotiation may be shaped by partner type, transactional dynamics, economic pressure, and violence risk, such that alcohol may primarily situate individuals within broader sexual risk environments rather than directly impairing decision-making across all sexual encounters.[16, 30] Group sex was not associated with alcohol use in this analysis, but evidence from 509 MSM in Zanzibar suggests it may occur within broader

substance-use contexts, with injection drug use associated with higher odds of group sex (OR 2.5, 95% CI: 1.3–5.0). [31] A systematic review on HIV risk among MSM in East Africa also suggests that group sex may occur within broader overlapping sexual and substance-use risk environments.[32]

Alcohol and recent violence and abuse

In this analysis, alcohol use was strongly associated with recent violence and abuse outcomes, including physical violence, sexual violence, verbal insults, and threats. Unhealthy alcohol use, heavy episodic drinking, and higher WHO AUDIT risk zones were consistently associated with progressively higher risks across violence-related outcomes compared with lower-risk alcohol use categories. Unhealthy alcohol use in the *Anza Mapema* cohort appears to be closely linked to MSM participants' lived exposure to recent violence and abuse — including verbal harassment, threats, physical assault, and sexual violence. Alcohol use may shape the risk of violence and abuse by reducing concealment and increasing visibility in social settings.[5,9] Qualitative research among MSM in Kenya has documented experiences of stigma, verbal harassment, physical assault, and sexual violence occurring within nightlife, transactional sexual, and other socially vulnerable environments.[25]

Intoxication may also impair risk perception and de-escalation in contexts where MSM are targeted for violence under conditions of stigma and limited legal protection.[2,5,29] These dynamics may help explain why alcohol–violence associations appeared stronger than alcohol–sexual behavior associations in the present analysis, as violence may be more directly embedded within alcohol-linked social environments, whereas sexual behaviors, particularly condomless sex, are additionally shaped by partner type, relational dynamics, and transactional sex.[33,9]

Alcohol and non-alcohol substance use and depressive outcomes

Across repeated assessments in the *Anza Mapema* cohort of HIV-negative MSM in Kisumu, unhealthy alcohol use was strongly associated with co-occurring non-alcohol substance use across study visits. Higher WHO AUDIT risk zones were consistently associated with progressively greater non-alcohol substance use, suggesting a dose–response relationship across increasing levels of alcohol use severity. Although prior studies among MSM in Africa have documented use of substances including methamphetamine and heroin, non-alcohol substance use in the present cohort was primarily characterized by marijuana and khat use.[31, 32] Non-alcohol substance use patterns among MSM vary considerably across settings; for example, approximately 60% of MSM in Zanzibar reported non-alcohol drug use in the previous three months, and heroin use among MSM who injected drugs was associated with HIV infection, high-risk sexual behaviors, arrest, and experiences of violence.[31] These findings underscore the importance of considering local substance use contexts when developing prevention and intervention strategies. Importantly, a recent systematic review identified substantial methodological heterogeneity across studies, including inconsistent substance use measures, varying reporting periods, and limited use of validated screening tools.[32] Unlike many prior cross-sectional studies, the present analysis evaluated longitudinal associations between alcohol use severity and non-alcohol substance use using repeated measures and standardized WHO AUDIT risk categories.

In this longitudinal analysis of HIV-negative MSM in Kisumu, unhealthy alcohol use was associated with moderate-severe depressive symptoms across study visits, with evidence of dose–response relationships across increasing WHO AUDIT risk categories. Korhonen et al.'s multi-site cross-sectional study among 1,476 MSM in Kenya similarly documented significant

associations between alcohol use and depressive symptoms, with recent trauma strongly associated with moderate-severe depressive symptoms (aPR 2.43, 95% CI 1.91–3.09).[14] However, the magnitude of these associations has varied across studies, with some attenuation after adjustment for factors such as MSM-related trauma, stigma, depressive symptoms, childhood sexual abuse, and other co-occurring psychosocial stressors.[19] These associations may reflect cyclical and potentially bidirectional pathways, in which sexuality-based stigma and trauma contribute to depressive symptoms and alcohol use as coping responses, while unhealthy alcohol use may further increase exposure to violence, instability, and other psychosocial stressors over time. These findings extend prior cross-sectional research by demonstrating associations between alcohol use and depressive symptoms across repeated assessments.

Qualitative studies among MSM and sex workers in Kenya have similarly documented alcohol and substance use as coping responses to sexuality-based stigma and chronic stress. Lyons et al. conducted in-depth interviews with 60 gay and bisexual men and other MSM in Western Kenya and found that participants frequently described alcohol use as a strategy for coping with discrimination, depression, social isolation, and minority stress within highly stigmatizing environments.[9] Together with the results of the current study, these findings suggest potentially bidirectional relationships between depressive symptoms and alcohol use, shaped by trauma exposure and structural vulnerability. Secor et al.'s cross-sectional study on depression, substance abuse, and stigma among MSM in coastal Kenya also documented high co-occurrence of unhealthy alcohol use, depressive symptoms, and stigma.[17] These relationships are consistent with syndemic frameworks, in which substance use and mental health conditions cluster and interact under conditions of marginalization.[34]

Implications for alcohol use and integrated interventions

Although few alcohol-focused interventions have been specifically evaluated among MSM populations in Kenya, interventions used among East African men and broader MSM populations have included brief alcohol interventions, motivational interviewing, behavioral counseling, peer support approaches, and integration of alcohol screening within HIV and primary care services. [35, 36] In the present analysis, progressively greater burden of sexual risk behaviors, violence and abuse, depressive symptoms, and non-alcohol substance use across WHO AUDIT risk zones suggests that harm reduction and stepped-care approaches may be particularly relevant for MSM in Kenya. These findings indicate that even partial reductions in alcohol use severity may yield meaningful health benefits when abstinence is not immediately achievable.

Behavioral surveys conducted among MSM in Kenya and systematic review evidence from MSM populations across Sub-Saharan Africa have consistently linked unhealthy alcohol use with transactional sex, multiple partnerships, inconsistent condom use, and other HIV-related risk behaviors.[26,32] Existing programs have also incorporated mental health screening, violence screening, and MSM-competent provider training within broader HIV prevention services.

Broader implementation initiatives, including the SHARP program, a regional initiative in Kenya, Tanzania, Uganda, and Zimbabwe focused on MSM-competent provider training and stigma reduction within HIV services, have also emphasized integrated approaches to improving HIV service engagement among sexual minority populations. [35] In a randomized controlled trial among 401 persons with HIV and unhealthy alcohol use in Kenya and Uganda, a brief skills-based alcohol counselling intervention reduced unhealthy alcohol use at 24 weeks compared with

standard care, although no significant effect on viral suppression was observed.[37] These findings reinforce that HIV prevention among MSM requires approaches that address unhealthy alcohol use alongside overlapping psychosocial and structural vulnerabilities.

The observed co-occurrence of polysubstance use and psychosocial vulnerabilities indicates that alcohol-focused interventions alone may be insufficient, as polysubstance use can compound risk through cognitive impairment, reduced capacity for risk negotiation, and disrupted engagement in care.[32] Programmatic responses should prioritize integrated substance use screening within HIV care, with brief interventions or referral depending on severity, harm reduction strategies to reduce the risk of HIV and related infections, and integrated mental health services, supported by community-based and peer-led models.[38,35] However, qualitative research from East Africa highlights that both preventing the development of unhealthy alcohol use and reducing existing unhealthy alcohol use are often constrained by structural, social, and individual-level barriers, underscoring the need for interventions that are both contextually grounded and responsive to patients' lived realities.[36] Framing alcohol solely as an individual behavioral risk may therefore misrecognize the problem. Bazzi et al.'s qualitative study with male and female sex workers in Kisumu found the issue is not simply that individuals drink and make poor decisions; rather, alcohol use appears embedded within conditions where safety, negotiation, power, and access to care are already constrained.[39] However, the extent to which alcohol-focused interventions alone may improve broader psychosocial or behavioral outcomes in this population remains uncertain.

From an HIV prevention perspective, this positions alcohol screening as a high-yield entry point for identifying individuals who may benefit from interventions to reduce alcohol use as well as more intensive, integrated support. MSM-focused services should directly address unhealthy

alcohol use while also responding to the ways mental health symptoms, violence, and sexual risk behaviors co-occur in everyday life, particularly given documented challenges in delivering effective counseling and care for MSM in Kenya. [40] In practice, these findings support direct interventions for unhealthy alcohol use alongside routine screening using tools such as the AUDIT and PHQ-9, brief intervention, stepped referral pathways, and linkage to integrated HIV prevention, mental health, substance use, and post-violence support within MSM-friendly care settings. [1,23,41] Such integrated approaches may also support HIV care engagement, as emerging evidence from Kenya suggests that heavy alcohol use is associated with disruptions across the HIV care continuum.[42]

Strengths and limitations

This study has several notable strengths and limitations. It draws on a relatively large sample of HIV-negative MSM (n=636) within a prospective longitudinal cohort, allowing for analysis of repeated observations over time rather than reliance on cross-sectional data. The use of validated measures, including the AUDIT and PHQ-9,[23,41] and of GEE to estimate population-averaged effects of covariates on outcomes while accounting for correlation between repeated observations within individuals strengthens the robustness of findings.[19] The inclusion of multiple domains, including sexual behaviors, violence exposure, co-occurring substance use, and moderate-severe depressive symptoms, within a single analytic framework further allows for an integrated assessment of how vulnerabilities related to unhealthy alcohol use cluster in this population. Because this is an observational study, causal relationships cannot be established, and the associations observed may reflect bidirectional influences or shared underlying factors. All measures were self-reported and may be subject to recall or social desirability bias. Temporal alignment between alcohol exposure and outcomes is imperfect, which may attenuate event-level

associations and increase uncertainty regarding the causal direction of observed associations. Residual confounding is also possible, particularly from unmeasured structural or contextual factors. In addition, the study did not directly measure the social or environmental contexts in which alcohol use and sexual behaviors occurred, limiting the ability to empirically assess underlying mechanisms. Finally, recruitment through peer networks, which were used to engage a stigmatized and hard-to-reach population, may limit generalizability to MSM not connected to these structures in Kisumu.

Conclusion

This longitudinal analysis of HIV-negative MSM in Kisumu found that unhealthy alcohol use was consistently associated with multiple factors related to HIV vulnerability, including transactional sex, violence exposure, co-occurring substance use, and moderate-severe depressive symptoms. Associations with multiple partnerships and condomless sex were primarily observed among participants in the highest AUDIT risk category. These findings align with a broader literature describing overlapping vulnerabilities among MSM in similar contexts. The observed pattern of associations indicates that unhealthy alcohol use may serve as a useful marker for identifying individuals at elevated risk across several domains relevant to HIV prevention, particularly violence exposure, co-occurring substance use, and moderate-severe depressive symptoms, as well as certain sexual behaviors, particularly transactional sex and, among individuals with the highest levels of alcohol-related risk, multiple partnerships. More importantly, unhealthy alcohol use is a modifiable condition that can be addressed through screening and the use of evidence-based interventions. Future research should evaluate whether alcohol-focused interventions can reduce sexual behaviors, violence exposure, non-alcohol

substance use, and improve mental health, and whether integrating alcohol reduction into HIV prevention strategies enhances their effectiveness for MSM in Kenya.

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