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Mobile phones, sexual behaviors and HIV incidence in Rakai, Uganda from 2010-2018

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Abstract

Background: Sub-Saharan Africa has the highest HIV incidence and prevalence in the world. In the past decade mobile phone ownership has doubled – impacting social and sexual practices. Using longitudinal follow-up data, this study examined if mobile phone ownership was associated with sexual behaviors and HIV incidence for youth and adults.

Methods: The Rakai Community Cohort Study gathers demographic and sexual health information and conducts HIV testing among an open cohort in southcentral Uganda every 12-18 months.

Results: Of the 10,618 participants, 58% owned a mobile phone, 69% lived in rural locations and 77% were sexually active. Analyses were adjusted for time, location, religion and socioeconomic status. Phone ownership was associated with increased odds of ever having had sex for 15-19-year-olds (men AOR 2.12, 95% CI 1.78-2.52; women AOR 3.20, 95% CI 2.45-4.17). Among sexually active participants, owning a phone was associated with increased odds of having 2 or more concurrent sex partners (15-24-year-old men AOR 1.76, 95% CI 1.34-2.32; 25-49-year-old men AOR 1.81, 95% CI 1.54–2.13; 25-49-year-old women AOR 1.81, 95% CI 1.32-2.49).

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For men, phone ownership was associated with increased odds of circumcision (15-24-year-old men AOR 1.24, 95% CI 1.08-1.41; 25-49-year-old men AOR 1.12, 95% CI 1.01-1.24). Phone ownership was not associated with HIV incidence.

Conclusion: Although mobile phone ownership was associated with sexual risk behaviors, it was not associated with increased risk of HIV acquisition. Research should continue exploring how phones can be used for reducing sexual health risk.

Keywords

mobile phones; sexual behaviors; HIV incidence; East Africa

Sub-Saharan Africa (SSA) has the highest rates of HIV infection in the world and young women (15-24 years) are disproportionately at high risk.¹ In the past ten years, mobile phone ownership in East Africa has doubled from 30% to over 70%,² with recent analyses indicating similar trends in the southcentral Ugandan region of focus.³ Mobile phones have dramatically increased social connectedness^{4,5} and this may be impacting sexual behaviors^{3,6-10} and potentially HIV transmission.

Most research examining the link between mobile phones, sexual intimacy, and HIV risk in SSA has been qualitative.⁶⁻⁹ For example, one ethnographic study described how university students in Tanzania used mobile phones to maintain privacy in romantic relationships and to engage in transactional sex.⁷ Another qualitative study among boarding school students in Kenya described how men gifted phones to female classmates expressly to schedule future meetings and engage in sexual relations outside of school.¹¹

Our recent cross-sectional analysis of the Rakai Community Cohort Study (RCCS) identified multiple associations between mobile phone ownership and sexual behaviors as well as an association between phone ownership and HIV prevalence among young women (15-24 years).³ After adjusting for demographic characteristics, we found people who owned mobile phones were more likely to have multiple partners than people who did not own mobile phones and young women who owned mobile phones were less likely to use condoms consistently, more likely to consume alcohol before sex, and more likely to be HIV-positive.³

Although valuable, qualitative and cross-sectional research have several methodological limitations. Qualitative research offers critical insights into the potential processes concerning how mobile phones may increase the risk of HIV infection; however, such findings may not be generalizable. In addition, it is difficult to learn from qualitative research whether mobile phones are increasing the risk of HIV infection at a community or population level. Cross-sectional analyses can identify community and population-level associations between sexual risk behaviors and mobile phone ownership, but they cannot determine if mobile phone ownership may actually increase the risk of HIV infection at the individual level.

The current work addresses these limitations and knowledge gaps by examining HIV incidence as well as additional behaviors (“ever had sex”, concurrent sexual partners, male

circumcision) associated with phone ownership. Specifically, in this follow-up analysis we used longitudinal RCCS data to examine if mobile phone ownership was associated with ever having had sex for adolescents (15-19 years) and sexual behaviors and HIV incidence for youth (15-24 years) and adults (25-49 years).

Methods

Study Design

Data come from the RCCS, which began in 1994 and continues to-date. The RCCS gathers demographic and behavioral data including sexual and reproductive health and conducts biological HIV testing in an open cohort of consenting residents aged 15–49 years in 40 communities in the Rakai District and surrounding areas of south-central Uganda. Estimates of HIV prevalence range from 10% to 25%.¹² The RCCS design and procedures have been described in detail elsewhere.^{13,14} In brief, survey rounds occur every 12-18 months and the current analyses focus on RCCS participants residing in trading and agrarian communities interviewed between 2010 and 2019 (survey rounds 14–18) in which mobile phone ownership was ascertained. Consistent with prior studies of HIV incidence in the region, we restricted all analyses to participants who had at least 2 consecutive observations.¹³

Procedures were approved and registered by Institutional Review Boards (IRBs) in Uganda (The Research and Ethics Committee of the Uganda Virus Research Institute and Uganda National Council for Science and Technology respectively), and IRBs at Johns Hopkins University, Columbia University and Western IRB. Following consent and assent for minors (15-17 years) participants (n ~ 18,000 per study round) completed a face-to-face interview conducted by same-sex interviewers fluent in the local languages (usually Luganda) and were asked to provide biological specimens for HIV and sexually transmitted infection (STI) testing.

Measures

Sociodemographic characteristics included sex, age (15-19, 20-24, 25+ years), time (as measured by survey dates), place of residence, and socioeconomic status (SES) (low, middle, high, very high). In low-and middle-income countries – like Uganda – where income data are not always available, measurement of SES via household income can be problematic. Thus, as an alternative to a household income measure, we used an asset-based measure (ABM) of SES, similar to those used in national surveys such as the Demographic and Health Surveys (DHS).¹⁵⁻¹⁷

In measuring sexual behaviors, participants were asked if they had ever had sexual intercourse (“ever had sex”). Sexually experienced participants were asked how many sexual partners they had in the past 12 months and responses were dichotomized into the outcome variable *Number of sex partners in the past 12 months* (2+ vs 0-1). The interviewer then asked questions about each sexual partnership (up to 4 most recent partners). Alcohol use was classified as “no” if the participant indicated the absence of alcohol before sex in the most recent sexual encounter with each of the reported partners. Condom use was classified

as “inconsistent” if the participant indicated they did not always use condoms with all partners. Concurrent partners were classified as yes if the respondent reported ongoing sexual relationships with 2 or more partners, consistent with previous RCCS analyses.^{3,18,19} Male circumcision was assessed by self-report.

HIV Incidence

As described in detail previously, HIV status was assessed according to Ugandan National HIV guidelines.¹³ HIV incidence was estimated among participants who had at least 2 consecutive observations.

Statistical Methods

First, we examined descriptive statistics detailing participant sociodemographic characteristics and sexual behaviors. We then stratified all subsequent models and analyses by age group (15–24 years or 25+ years) and sex (men and women) based on prior research that indicates youth use mobile phones in distinct ways²⁰ and young women are at higher risk for HIV infection than young men.²¹⁻²⁶

We used logistic regression models with generalized estimating equations and an exchangeable correlation structure to estimate the odds ratios of sexual behaviors associated with mobile phone ownership. Location, SES, time, and religion were included in the model as controlling variables.^{3,5,13,14,18-20,25-28} We conducted the “ever had sex” analysis only for 15-19-year-olds as most participants over 20 years were sexually active. For all subsequent comparisons, participants who had not initiated sex were excluded.

Generalized estimating equations Poisson regression models with an exchangeable correlation structure were used to examine the associations between HIV incidence per person-year and mobile phone ownership. The model included HIV status as the repeated outcome, the duration of time between two consecutive HIV tests as the offset, and mobile phone ownership as the covariate. We again stratified by age and gender and adjusted for time, SES, and location. For each stratum, the effect of mobile phone ownership was estimated from the model and reported as an incident rate ratio.

Results

Descriptive Characteristics

There were 10,618 participants included in the analysis, with participants contributing to a mean of 3.33 survey rounds. Most participants owned a mobile phone (58%), lived in rural locations (69%), and were sexually active (77%). Within the sexually active participants (8,161), 80% had 0-1 sex partners in the past 12 months, 78% did not use alcohol before sex, 78% used condoms inconsistently, and 82% did not have concurrent partners.

Mobile Phone Ownership and Sexual Behaviors

Table 1 includes the adjusted odds ratio (AOR) for each sexual behavior comparing participants who owned a mobile phone to participants who did not own a mobile phone. Mobile phone ownership was associated with increased odds of having had sex for 15-19-

year-old (men AOR 2.12, 95% CI 1.78-2.52; women AOR 3.20, 95% CI 2.45-4.17). The following analyses were restricted to sexually active participants (N=8,161). Owning a mobile phone was associated with increased odds of having 2 or more sexual partners in the past 12 months (15-24-year-old men AOR 1.84, 95% CI 1.54-2.19; 15-24-year-old women AOR 1.40, 95% CI 1.04-1.86; 25-49-year-old men AOR 1.47, 95% CI 1.29-1.67; 25-49-year-old women AOR 1.67, 95% CI 1.33-2.10). Mobile phone ownership was associated with increased odds of using alcohol before sex for 25-49-year-old women (AOR 1.15, 95% CI 1.03-1.29). Mobile phone ownership was associated with increased odds of inconsistent condom use for 15-24-year-old men (AOR 1.21, 95% CI 1.01-1.45) and 25-49-year-old men (AOR 1.69, 95% CI 1.34-2.12) and decreased odds of inconsistent condom use for 25-49-year-old women (AOR 0.75, 95% CI 0.62-0.91). Owning a mobile phone was associated with increased odds of having concurrent sexual partners for 15-24-year-old men (AOR 1.76, 95% CI 1.34-2.32), 25-49-year-old men (AOR 1.81, 95% CI 1.54-2.13), and 25-49-year-old women (AOR 1.81, 95% CI 1.32-2.49). For men, phone ownership was associated with increased odds of circumcision (15-24-year-old men AOR 1.24, 95% CI 1.08-1.41; 25-49-year-old men AOR 1.12, 95% CI 1.01-1.24).

Mobile Phone Ownership and HIV Incidence

We did not find an association between mobile phone ownership and HIV incidence for the crude or adjusted models presented in Table 2.

Discussion

Despite associations between mobile phone ownership and sexual risk behaviors, we found no association between mobile phone ownership and HIV incidence. In this population-based study in Uganda, people who owned a mobile phone engaged in more sexual risk behaviors as compared to people who did not own phones. Prior research in SSA details how owning a mobile phone facilitates wider social and sexual connections.^{3-10,20,27,29} The current work extends the field by identifying associations between having had sex, concurrent partnerships, and mobile phone ownership. Of note, men who owned a phone were more likely to be circumcised.

It is possible that men who own phones have better access to sexual health and HIV prevention initiatives in the region and thus were more likely to be circumcised. Male circumcision has been shown to reduce HIV incidence for men and their partners.³⁰⁻³² Although they were not focused on circumcision, several studies in East Africa suggest mobile phone-based interventions may impact sexual and reproductive health knowledge and practices.³³⁻³⁶ For example, one such intervention provided users with sexual and reproductive health information and referred users to clinics in East Africa through an automated menu-based two-way SMS and interactive voice response (see 4.C.1.3). A randomized controlled trial (RCT) in Kenya (mean age 25 years) showed a 13% improvement in contraceptive knowledge among the intervention group as compared to the control group.⁶³ Another study of the same intervention in Kenya suggested the program prompted AYA to adopt contraception to prevent pregnancy and 20% of AYA reported using the clinic locator function.¹³ There is a need for future work to examine how people in the

region may be using their phones to access sexual health information and HIV prevention resources. In addition, our findings indicate adolescents (15-19 years) who owned a phone were more likely to be sexually active. Thus, mobile phone-based sexual health and HIV prevention interventions tailored to adolescents may present an approach for reaching a high proportion of sexually active adolescents – many of whom move frequently in search of work and are at high risk of HIV infection.^{13,37,38} Further study of mobile phone-based interventions impact on sexual and reproductive health behaviors, HIV prevention, and cost implications appears warranted.

There may be alternative explanations for the directionality of the association between mobile phone ownership and sexual behaviors. People who were already engaging in certain sexual behaviors (e.g., sex with multiple partners, concurrent partners) may be more likely to acquire their own phones. Thus, the behaviors may predate the phone ownership and instead, phone ownership may be a proxy for people who engage in specific sexual behaviors. A strength of this study was that we did account for the order of phone acquisition and HIV infection in the HIV incidence analysis.

Conclusion

The current study suggests that while mobile phone ownership may be associated with increased sexual behaviors, including previously unidentified associations with ever having had sex and concurrent partnerships, mobile phone ownership does not appear to increase HIV incidence. This could be due in part to the impact of HIV combination prevention in the region.^{13,30} Notably, men who owned phones were more likely to be circumcised and circumcision could partly explain why, despite engaging in more risky behaviors, people who owned phones did not appear to be at higher risk of HIV infection. A follow-up study to examine if mobile phones play a role in disseminating combination prevention would be appropriate. For example, might communities with a greater proportion of mobile phones have higher rates of male medical circumcision and could this also extend to other aspects of combination prevention such as antiretroviral adherence? As phone ownership in East Africa increases, future research should continue to explore how mobile phones can be used for improving sexual health and HIV prevention interventions especially among adolescents.

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Table 1: Mobile phone ownership associations with sexual behaviors for RCCS participants stratified by gender and age group, 2010–2018

Outcomes	Odds Ratio (95% CI) §							
	Own mobile Phone vs. No Mobile Phone (reference)			Adjusted for Demographics [‡]				
	Crude		For Men		For Women			
	N [†]	Men	Women	For Men	For Women	For Men	For Women	
Ever Had Sex (Yes vs. No) [‡]								
Ages 15-19 Years	56%	56%	58%	58%	1.94 (1.64-2.29)	2.74 (2.13-3.64)	2.12 (1.78-2.52)	3.20 (2.45-4.17)
Number of Sex Partners in the Past 12 Months (2+ vs 0-1)								
Ages 15-24 Years	43%	43%	10%	10%	1.92 (1.62-2.28)	1.56 (1.18-2.05)	1.84 (1.54-2.19)	1.40 (1.04-1.86)
Ages 25+ Years	56%	56%	10%	10%	1.59 (1.41-1.79)	1.71 (1.37-2.12)	1.47 (1.29-1.67)	1.67 (1.33-2.10)
Alcohol Use Before Sex (Yes vs No)								
Ages 15-24 Years	16%	16%	13%	13%	1.15 (0.93-1.43)	1.27 (1.01-1.60)	1.00 (0.81-1.23)	1.10 (0.86-1.39)
Ages 25+ Years	53%	53%	32%	32%	0.84 (0.75-0.93)	1.26 (1.14-1.39)	0.91 (0.81-1.03)	1.15 (1.03-1.29)
Inconsistent Condom Use (vs Consistent)								
Ages 15-24 Years	79%	79%	90%	90%	1.28 (1.08-1.53)	1.19 (0.96-1.49)	1.21 (1.01-1.45)	1.15 (0.91-1.45)
Ages 25+ Years	97%	97%	98%	98%	1.90 (1.54-2.35)	0.79 (0.65-0.94)	1.69 (1.34-2.12)	0.75 (0.62-0.91)
Concurrent Partners (Yes vs No)								
Ages 15-24 Years	22%	22%	4%	4%	1.81 (1.38-2.37)	1.55 (0.98-2.45)	1.76 (1.34-2.32)	1.47 (0.91-2.38)
Ages 25+ Years	37%	37%	6%	6%	1.91 (1.64-2.22)	1.95 (1.43-2.65)	1.81 (1.54-2.13)	1.81 (1.32-2.49)
Male Medical Circumcision (Yes vs No)								
Ages 15-24 Years	67%	67%	-	-	1.62 (1.44-1.83)	-	1.24 (1.08-1.41)	-
Ages 25+ Years	59%	59%	-	-	1.25 (1.15-1.35)	-	1.12 (1.01-1.24)	-

* Bolded P-value <0.05

[‡] Includes participants regardless of sexual activity. All other analyses include only participants who were sexually active to fit the models for odds ratios.

§ Odds Ratio (OR) greater than 1 indicates that a participant who owns a phone has a greater likelihood of engaging in this behavior as compared to someone who does not own a phone. OR less than 1 indicates that a participant who owns a phone has a lower likelihood of engaging in this behavior as compared to someone who does not own a phone.

[‡]The OR were adjusted for time, SES, location and religion.

HIV incidence among those owning a mobile phone vs. not owning a mobile phone for RCCS participants, stratified by gender and age group, 2010-2018

Table 2:

Outcomes	Incidence Rate Ratio [§] (95% CI)							
	Own Mobile Phone vs. No Mobile Phone (reference)				Adjusted for Demographics [‡]			
	Incidence Rate (per 100py)		Crude		For Men		For Women	
	N [†]	Men	Women	For Men	For Women	For Men	For Women	
HIV Incidence (Yes vs. No)								
Ages 15-24 Years	2507	2446	0.30	0.69	1.24 (0.55, 2.82)	1.44 (0.87, 2.40)	1.30 (0.56, 3.04)	1.44 (0.85, 2.46)
Ages 25+ Years	3289	4029	0.49	0.55	0.70 (0.43, 1.15)	1.23 (0.82, 1.83)	0.79 (0.46, 1.37)	1.07 (0.72, 1.61)

[§]Incidence rate ratio (IRR) greater than 1 indicates that a participant who owns a phone has a greater likelihood of getting infection as compared to someone who does not own a phone. IRR less than 1 indicates that a participant who owns a phone has a lower likelihood of getting infection as compared to someone who does not own a phone.

[†]N are the participants of each stratified group that were used to fit the models for IRR.

[‡]The IRR adjusted for time, SES, religion, and location.