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Cell Phones, Sexual Behaviors and HIV Prevalence in Rakai, Uganda: A Cross Sectional Analysis of Longitudinal Data

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Abstract

Cell phones have increased communication and connection across the globe and particularly in sub-Saharan Africa (SSA) — with potential consequences for the HIV epidemic. We examined the association among ownership of cell phones, sexual behaviors (number of sexual partners, alcohol use before sex, inconsistent condom use), and HIV prevalence. Data were from four rounds (2010–2016) of the Rakai Community Cohort Study (N = 58,275). Sexual behaviors and HIV prevalence were compared between people who *owned* a cell phone to people who *did not own* a cell phone. We stratified analysis by younger (15–24 years) and older (25+ years) age groups and by gender. Using logistic regression and after adjusting for sociodemographic characteristics, we found cell phone ownership was independently associated with increased odds of having two or more sexual partners in the past twelve months across age and gender groups (young men AOR 1.67, 95% CI 1.47–1.90; young women AOR 1.28 95% CI 1.08–1.53; older men AOR 1.54 95%

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Authorship

All authors have read and approved the final manuscript.

F. N., P. K. and J. S. conceptualized the study. S. H., X. Z, and Y. W. created the statistical models. S. H., X. Z, Q. W., and I. C., computed the statistical analyses. P. K. drafted the manuscript. S. G., S, D., K., G. K., T. L., J. K., L. W. C., M. J. W., R. H. G., J. S. S., provided essential comments and revisions. R. S., H. N., S, D., K., G. K., T. L., J. K., L. W. C., M. J. W., and R. H. G., designed the measures and tools.

Conflicts of Interest Statement

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CI 1.41–1.69; older women AOR 1.44 95% CI 1.26–1.65). Interestingly, young men who owned cell phones had decreased odds of using condoms inconsistently (AOR 0.66, 95% CI 0.57–0.75). For young women, cell phone ownership was associated with increased odds of using alcohol before sex (AOR 1.38 95% CI 1.17–1.63) and increased odds of inconsistent condom use (AOR 1.40, 95% 1.17–1.67). After adjusting for sociodemographic characteristics, only young women who owned cell phones had increased odds of being HIV positive (AOR 1.27 95% CI 1.07–1.50). This association was not mediated by sexual behaviors (Adjusted for sociodemographic characteristics and sexual behaviors AOR 1.24, 95% CI 1.05–1.46). While cell phone ownership appears to be associated with increased HIV risk for young women, we also see a potential opportunity for future cell phone-based health interventions.

Keywords

cell phones; sexual behaviors; HIV prevalence; sub-Saharan Africa

Introduction

Cell phones have changed the way people communicate, socialize and engage in intimate relationships, with major implications for youth development[(1,2)]. In sub-Saharan Africa, a confluence of technological, epidemiological and developmental factors contributes to a potentially distinct relationship between cell phones, health, and youth behaviors. Technologically, people in sub-Saharan Africa rely heavily on cell phones, which serve as a primary means for communicating as well as accessing goods, services, and information [3]. In Uganda, where landlines are used by 1% of the population [4], and only 15% of the population has access to the internet [5], owning a cell phone is rapidly becoming essential for acquiring information and resources [3].

Epidemiologically, sub-Saharan Africa has the highest rates of HIV infection in the world, and young women (aged 15–24 years) have disproportionally higher HIV incidence [6]. Developmentally, adolescence and young adulthood is a life period associated with initiation of new health behaviors and a sense of invulnerability, both of which affect sexual behaviors [7,8]. Given the high prevalence of HIV in the region, the transition to adulthood inevitably involves the added risk of HIV infection, particularly for young women [6,9–13]. These technological, epidemiological, and developmental factors motivate our examination of the association between cell phone ownership, sexual behaviors and HIV prevalence in Uganda.

People in sub-Saharan Africa who own cell phones appear to maintain wider social networks [14,15]. The current paper examines if owning a phone may also be associated with a greater number of sexual partners as compared to people who do not own phones. Given the rates of HIV in sub-Saharan Africa, the consequences of unprotected sex or having multiple concurrent partners are substantial [16,17]. For adolescents and young adults negotiating multiple physical, emotional, and social transitions [18,19], the particular ways that cell phone ownership increases the possibility for social and sexual connections may compound risk of HIV infection. For example, a young person with a cell phone would be able to communicate with potential sexual partners who are outside of their immediate community

and geographic location. This could result in planning and maintaining social and sexual relationships that would not be possible without a cell phone.

Further, in part because of their ubiquity, cell phones are a technology that researchers and health workers use to access information [20], and conduct sexual health interventions. These interventions can range from short message service (SMS) targeted to patients to improve adherence to HIV antiretroviral therapy (ART) [21], to mobile applications that health workers can use when conducting behavioral health interventions [22–25]. People who own phones may benefit from the increased exposure to health information as well as the overall increased access to goods and information.

Thus, cell phones provide important ways for people in Uganda - and across sub-Saharan Africa - to communicate and access information and resources. Simultaneously, in the context of the HIV epidemic this connection may also be linked with sexual behaviors and thus with risk of HIV infection. Using survey data from the Rakai Community Cohort Study (RCCS), we explored associations between cell phone ownership and sexual behaviors and HIV prevalence in Rakai, Uganda. Our findings have relevance for behavioral interventions targeted at adolescents and young adults in Uganda and across sub-Saharan Africa.

Methods

Ethical Considerations

Approvals for the current analysis were obtained from the Uganda National Council for Science and Technology (UNCST) and Institutional Review Boards (IRBs) at the Uganda Virus Research Institute, Columbia University, Johns Hopkins University, and Western Institutional Review Board (WIRB)[1] in the United States.

Data Source

The data were drawn from the RCCS. The RCCS, which began in 1994 and continues to-date, gathers demographic information, and sexual and reproductive health responses from an open cohort of residents 15–49 years of age in 40 communities in the Rakai district of southcentral Uganda. The district borders Lake Victoria on the East and Tanzania in the south. For most people agricultural work is the main source of income and the population is approximately 516,000 [26]. Most of the population (57%) is between 0 and 17 years old, 19% are 18 to 30 years old. Estimates of HIV prevalence range from 10–25% depending on the community [27]. The RCCS research design and procedures have been described in detail elsewhere [28–30]. In brief, during survey rounds, which occur every 12–18 months, people aged 15–49 years in the RCCS communities are consented. Minors (ages 15–17) are assented, and parent/guardian consent for participation is obtained. Participants ($n \sim 14{,}000$ per year) then complete a private face-to-face interview conducted by same-sex interviewers fluent in the local languages (usually Luganda), and are asked to provide biological specimens for HIV and sexually transmitted infection (STI) testing. Among all residents in the communities, RCCS achieves over 66% coverage of the *de jure* population (i.e., all

[1]WIRB offers review services for more than 400 institutions around the world (http://wirb.com)

eligible censused persons) and over 90% coverage of the *de facto* population (all eligible persons present in the community at the time of the survey), with 99% of consenting participants responding to the complete questionnaire and over 90% agreeing to specimen collection. In addition, all members of the study communities receive voluntary HIV prevention education, counseling and testing.

The current analyses focus on RCCS participants residing in trading and agrarian communities, interviewed between March 2010 and April 2016 (survey rounds 14–17). Prior to 2010, questions on cell phone ownership were not included.

Description of Measures

Cell phone ownership was considered as both the outcome of sociodemographic characteristics and the predictor of sexual behaviors and HIV status.

Cell phone ownership.—The binary *cell phone* measure was generated from a contact form where participants indicated that they *owned* a cell phone. Participants who reported only having access to a shared phone were included in the no phone category

Sexual behavior and HIV status.—Sexual behaviors were measured using the following indicators: number of sex partners in the past 12 months (categorized as 0–1, or 2+), alcohol consumption prior to sex, and inconsistent / non-use versus consistent use of condoms. These measures were constructed based on detailed questions regarding sexual partnerships in the last year. The RCCS questionnaire assessed an individual's four most recent sexual partners after inquiring if they had ever had "sexual intercourse with any person". Condom use was classified as "consistent" if the participant indicated they always used condoms with all recorded 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. Sexual behavior measures considered in this study were consistent with previous RCCS analyses [31,32]. HIV status was assessed using biological testing.

Sociodemographic measures.—Information on sociodemographic measures including gender, age, place of residence (rural and trading center), marital status (never married, currently married and formerly married), and educational attainment (no formal education, some primary education, some post-primary education), were assessed using single item questions.

Based on the most common responses we collapsed occupation into the following categories: agricultural and housework, administrative and teaching, business, current student, and other. Socioeconomic status (SES) was categorized as low, middle, and high, and based on a series of questions about household possessions such as radios and the use of modern building materials to construct their dwelling.

Statistical Methods

Prevalence of sociodemographic characteristics, including round, place of residence, SES, religion, marital status, educational attainment and occupation, were evaluated over the four

survey rounds using basic descriptive statistics and stratified by gender. These sociodemographic variables have shown to be associated with either cell phone ownership or HIV status in previous research [3, 12, 13, 20, 14, 15, 28–32]. Their bivariate associations with cellphone ownership in the RCCS cohort were evaluated using crude odds ratios and their 95% confidence intervals. To further adjust their correlations and confounding effects, we also investigated their conditional associations using logistic regression with repeated outcomes, in which individual cellphone ownership at each round was included as the outcome, and all the sociodemographic variables are included as covariates. The resulting adjusted odds ratios (AOR) and their 95% confidence interval were reported. In the RCCS cohort, we do have multiple observations for some participants, though the average participant only contributed to 2.4 rounds of data, with the average youth only contributing 1.9 rounds and older adults contributing an average of 2.7 rounds. To account for repeated measures, we used generalized estimating equations (GEE) with exchangeable correlation structure to estimate the logistic models. Given the short longitudinal duration, we selected the exchangeable correlation structure as we did not expect a lot of decay in the correlation of measurements with increasing time. Next, we evaluated the potential impact of cell phone ownership on sexual behaviors using logistic models with GEE and adjusting for survey round and the sociodemographic variables noted above. Since it was reported that young people use cell phones in distinct ways as compared to older generations [14], and young women are widely recognized as an especially high risk group for HIV infection [6,9–13], we stratified our analyses by age groups (15–24 years or 25+ years) and gender, and used a regression model with an interaction term to formally test gender-specific and age-specific interactions.

Finally, we investigated whether owning cell phones was associated with higher HIV prevalence and if such associations were mediated by sexual behaviors. To do so, we constructed two sets of models. First, we built an HIV prevalence model that included cellphone ownership as a key covariate, and sociodemographic factors as controlling variables; logistic regression with repeated measures was used as the HIV prevalence model. Second, we expanded the HIV prevalence model by further including the sexual behaviors as covariates, and compared the coefficients associated with cell phone ownership with and without the inclusion of sexual behaviors. To robustify the results, in these analyses, we bootstrapped subjects to determine the standard errors of the model estimates, which account for the within subject correlations without a pre-specified correlation structure [33]. We performed all these analyses using STATA 14.0 and R 3.4.3.

Results

Sociodemographic Characteristics

Sociodemographic characteristics of the sample are described in Table 1. Overall, we analyzed 58,275 observations from 32,571 individuals. Sixty-seven percent of men owned a cell phone as compared to 49% of women. A greater percentage of observations were drawn from rural (56% men, 53% women) than trading center (44% men, 47% women) communities. The most common occupations for men and women were agriculture and housework (31% men, 45% women) and business (17% men, 21% women). Prevalence of

HIV was 10% for men and 16% for women. In terms of sexual behaviors 15% of men and 10% of women reported never having sex, 32% of men and 6% of women reported having two or more partners in the last 12 months, 36% of men and 19% of women reported consuming alcohol before sex, and 13% of men and 8% of women reported consistent condom use with all sexual partners.

Cell Phone Ownership

Table 2 describes the association between cell phone ownership and sociodemographic variables. A greater proportion of men (67%) than women (49%) owned a cell phone.

Cell phone ownership increased over time, such that fewer people owned phones at round 14 (59% of men, 39% of women) as compared to round 17 (72% of men, 60% of women). Cell phone ownership was higher in trading centers than rural areas (Men AOR 1.13, 95% CI 1.30–1.50; Women: AOR 1.28 95% CI 1.20–1.36).

Cell phone ownership was highest in the highest SES group compared to the lowest SES group (High SES Men 75% AOR 2.08, 95% CI 1.88–2.29; High SES Women AOR 2.25 95% CI 2.05–2.48). Similarly, cell phone ownership increased with educational attainment, and those with post-primary education had the highest proportion of phone ownership (Men 78% AOR 8.51 95% CI 6.91–10.49; Women 63% AOR 7.86 95% CI 6.69–9.24) as compared to those who had no formal schooling.

Cell phone ownership also differed by occupation and administrators and teachers had the highest proportions of cell phone ownership (Men 97%, AOR 4.34, 95% CI 3.20–5.88; Women 90% 3.76 95% CI 3.18–4.44) as compared to agricultural workers (Men 64%; Women 44%). There were significant interactive effects between age and place of residence, SES, marital status and occupation for cell phone ownership, and we present these data in appendix table 2a.

Sexual Behaviors

The following results include the odds of each sexual behavior comparing those who owned a cell phone and those who did not own a cell phone included in Table 3. The associations between cell phone ownership and sexual behaviors differed by gender and age group. When we examined these associations for narrower 10-year age groups, we found the results were similar to the broader age group categories and provide this information in appendix 3a.

Number of sexual partners.—Cell phone ownership was associated with increased odds of having two or more sexual partners in the past year for all age and gender groups (young men AOR 1.67, 95% CI 1.47–1.90; young women AOR 1.28 95% CI 1.08–1.53; older men AOR 1.54 95% CI 1.41–1.69; older women AOR 1.44 95% CI 1.26–1.65).

Alcohol consumption before sex.—Cell phone ownership was associated with increased odds of using alcohol before sex for young women (AOR 1.38, 95% CI 1.17–1.63), and for older women (AOR 1.28, 95% CI 1.18–1.39). However, in men aged 25–49, cell phone ownership was associated with decreased odds of using alcohol before sex (AOR

0.68, 95% CI 0.62–0.75) and the association between phone ownership and alcohol use was not significant for men under 25 years of age.

Consistency of condom usage.—For condom use we compared respondents who always used a condom to respondents who reported inconsistently or never using a condom. Young women who owned a cell phone had increased odds of using condoms inconsistently (AOR 1.40, 95% CI 1.17–1.67). In older women, cell phone ownership was associated with decreased odds of using condoms inconsistently (AOR 0.65, 95% CI 0.57–0.74). Young men who owned cell phones had decreased odds of using condoms inconsistently (AOR 0.66, 95% CI 0.57–0.75) and the association between phone ownership and condom use was not significant for men over 25 years of age.

HIV Prevalence

Table 4 shows that the associations between cell phone ownership and HIV prevalence were moderated by gender. For young women owning a cell phone was significantly associated with increased odds of being HIV positive (Adjusted for sociodemographic characteristics OR 1.27 95% CI 1.07–1.50). Sexual behaviors did not appear to mediate this association (Adjusted for sociodemographic characteristics and sexual behaviors OR 1.24 95% CI 1.05–1.46). The association between cell phone ownership and HIV status was not significant for any other group.

Discussion

To our knowledge, the current study is the first to examine the association between cell phones, sexual behaviors and HIV prevalence using data from a large open community cohort. It is vital to consider the implications of increased connectivity as cell phone use rises globally. In other sub-Saharan contexts researchers have identified how cell phones may be changing the ways that young people form social connections [3, 4, 14, 15]. Our findings suggest that cell phone ownership may also be associated with sexual behaviors in distinct ways for different age groups and genders. Young women in sub-Saharan Africa are at great risk of HIV infection [9,11], and for young women in the Rakai District cell phone ownership was associated with an increased risk of being HIV positive. Further, our analyses suggest that the magnitude of these associations are sufficient to be clinically relevant.

Across age and gender, we found that cell phone ownership was associated with having multiple (2+) sexual partners. It is possible that owning a cell phone facilitates increased social [3, 4, 14, 15] and sexual connections. Beyond number of sexual partners, cell phone ownership had distinct associations within age group and gender in terms of other sexual behaviors. Older men who owned cell phones were less likely to use alcohol before sex, and younger men who owned phones were more likely to use condoms consistently. In contrast, younger and older women who owned cell phones were more likely to use alcohol before sex. Younger women were less likely to use condoms consistently and older women were more likely to use condoms consistently.

Although, younger women who owned cell phones had a greater number of partners, were more likely to use alcohol before sex, and were less likely to use condoms consistently, these

sexual behaviors did not appear to mediate the association between cell phone ownership and HIV prevalence. Additional quantitative and qualitative research is needed to establish whether cell phone ownership influences HIV risk and to determine what came first, the sexual behavior or cell phone ownership. In Rakai further research is needed to examine how cell phone technology may be related to changing social and sexual dynamics.

Existing ethnographic evidence suggests that inexpensive phones are one common gift from older men to younger women, and this gifting practice is so common in South Africa that the cheap phones have been given their own colloquial term *mobile foza orana* named after an invasive species of crayfish [34]. Therefore, owning a cell phone for young women may be the result of engaging in increased sexual activity. While ethnographic reports, as well as the popular media, have emphasized the relationship between cell phones and transactional sex in southern Africa [35,36], the RCCS has not included a question on cell phones and transactional sex and therefore we could not examine this association in our current analyses.

Limitations and Future Directions

There may be alternative explanations for the directionality of the association between cell phone ownership and sexual behaviors and HIV prevalence. Further longitudinal research could determine if the association between cell phones and HIV status is specific to a particular age range or if there is a generational difference between the way younger and older women use phones. Additionally, young women who are already engaging in certain sexual behaviors (e.g. sex with multiple partners, alcohol before sex, condomless sex) could be more likely to acquire their own phones. Thus, the behaviors may predate the phone ownership and instead, phone ownership may in fact be a proxy for youth who engage in specific sexual behaviors. Given the complexity and depth of the RCCS data, and the rapidly increasing rates of cell phone ownership, especially among adolescents and young adults, future research could bolster our theory of directionality by identifying participants and measuring sexual behaviors before and after cell phone ownership. Marginal structural modeling and ethnographic research are two approaches that could be used to examine the direction of this association.

Another limitation is that the current work only considers prevalence, and future research should examine how cell phones and sexual behaviors may be related to HIV incidence. In addition, the sexual behavior estimates were based on self-report measures and thus may be subject to social desirability and recall bias. In addition, it is possible that the sexual behaviors are correlated and thus there may be confounding. Results from this study may be generalizable to other rural and semi-urban settings in East Africa with similar cell phone ownership rates and HIV prevalence.

Conclusion

Technological, epidemiological, and developmental factors in sub-Saharan Africa are changing the dynamics of the HIV epidemic with implications for intervention. Cell phones are critical for connecting people and services in sub-Saharan Africa. Previous research has found that cell-phone based interventions can improve outcomes along the continuum of

HIV Care (CoC) for persons living with HIV [37], while another review found that cell phone-based interventions were feasible and improved both prevention and care of HIV/STIs for hard to reach populations [38]. To determine the best approach for cell phone-based interventions, future research is needed to examine the types of phones that people own in the region as there is wide variety in the functionality and capabilities of smartphones versus flip phones.

We have shown that in the Rakai District, there is an association between cell phone ownership and sexual behaviors across age and gender and that cell phone ownership is associated with HIV prevalence for young women. Therefore, we see an important need, and a potential opportunity, for cell phone-based interventions to disseminate HIV information and provide health resources especially for highly mobile youth in Rakai and other hard to reach areas. Further, exploratory and qualitative work may illuminate the relationship between cell phone ownership and HIV risk and assist in the design of such technology-based health interventions. Although we found an association between cell phones and HIV prevalence for young women, cell phones also present a potential platform for disseminating health-based interventions in Uganda and elsewhere.

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Appendix

Table 2a:

Crude and adjusted associations of cell phone ownership with demographic factors for younger and older RCCS participants, 2010–2016

	Own Personal Cell Phone vs Not Owning Cell Phone							
	Age 15–24 years				Age 25+ years			
Demographics	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR§ (95% CI)**	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR§ (95% CI)**
Number of observations	8737	40%			25226	69%		
Gender (years)								
Men (reference)	5016	50%	1	1	12274	78%	1	1
Women	3721	32%	0.48 (0.45–0.51)***	0.23 (0.21–0.25)***	12952	62%	0.48 (0.45–0.51)***	0.43(0.41–0.46)***
Round Number								
14 (reference)	1699	30%	1	1	5922	58%	1	1
15	2066	42%	1.73 (1.60–1.86)***	1.56 (1.43–1.70)***	5889	71%	1.62 (1.55–1.70)***	1.58 (1.49–1.67)***
16	2264	42%	2.04 (1.89–2.20)***	2.09 (1.92–2.28)***	6262	72%	1.85 (1.76–1.94)***	1.80 (1.70–1.90)***

	Own Personal Cell Phone vs Not Owning Cell Phone							
	Age 15–24 years				Age 25+ years			
Demographics	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR§ (95% CI)**	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR§ (95% CI)**
17	2708	48%	2.71 (2.51–2.92)***	3.01 (2.76–3.28)***	7153	76%	2.24 (2.14–2.35)***	2.14 (2.02–2.27)***
Place of Residence								
Rural (reference)	4288	36%	1	1	12919	65%	1	1
Trading center	4449	45%	1.48 (1.40–1.58)***	1.20 (1.12–1.29)***	12307	74%	1.61 (1.52–1.70)***	1.24 (1.16–1.32)***
Socioeconomic Status								
Low (reference)	657	27%	1	1	1954	44%	1	1
Middle	1842	31%	1.25 (1.12–2.60)***	1.13 (1.01–1.28)*	5793	57%	1.63 (1.52–1.75)***	1.38 (1.28–1.49)***
High	6238	46%	2.35 (2.13–1.39)***	1.69 (1.51–1.90)***	17479	80%	3.70 (3.45–3.98)***	2.47 (2.28–2.67)***
Educational Attainment								
None (reference)	43	19%	1	1	676	35%	1	1
Primary	4264	35%	2.09 (1.47–2.96)***	3.00 (2.05–4.40)***	14222	63%	3.37 (2.99–3.80)***	2.91 (2.56–3.30)***
Post-Primary	4430	48%	3.83 (2.70–5.44)***	8.53(5.80–12.55)***	10328	85%	11.79(10.34–13.44)***	7.12 (6.19–8.18)***
Current Marital Status								
Never Married (reference)	5318	37%	1	1	2146	70%	1	1
Currently Married	2976	45%	1.48 (1.39–1.58)***	1.57 (1.44–1.72)***	18581	70%	0.97 (0.89–1.06)	1.28 (1.16–1.41)***
Separated/ Widowed	443	59%	2.49 (2.15–2.89)***	2.65 (2.23–3.16)***	4499	64%	0.82 (0.74–0.90)***	1.23 (1.10–1.37)***
Primary Occupation								
Agriculture	1754	34%	1	1	9759	56%	1	1
Admin/ Teaching	514	86%	11.8 (9.24–15.03)***	6.56 (5.07–8.49)***	2898	94%	7.90 (6.80–9.18)***	3.46 (2.92–4.10)***
Student	2305	27%	0.67 (0.62–0.72)***	0.34 (0.31–0.38)***	705	85%	3.51 (2.94–4.19)***	1.61 (1.32–1.97)***
Business	1922	63%	3.18 (2.89–3.50)***	2.54 (2.28–2.83)***	6499	80%	2.29 (2.16–2.43)***	1.86 (1.74–1.98)***
Other	2242	54%	2.19 (2.00–2.38)***	1.59 (1.44–1.75)***	5365	75%	1.90 (1.79–2.02)***	1.32 (1.23–1.41)***

Abbreviations: OR: odds ratio; CI: confidence interval.

*
P-value <0.05,

**
<0.01, and

***
<0.001.

† The percentages are given as row percent representing the proportions of owning a personal cell phone among all the observations within each characteristic category.

§ Odds ratio (OR) greater than 1 indicates a greater likelihood of owning a phone. OR less than 1 indicates a lower likelihood of owning a phone.

§ The OR ratios were adjusted for visit rounds, place of residence, SES, religion, education, current marital status, and occupation.

Table 3a:

The association between cell phone ownership and sexual behaviors for sexually active RCCS participants stratified by gender, and 5-year age groups, from 2010–2016

	N†		Adjusted Odds Ratio § (95% CI) Own Personal Cell Phone vs. No cell phone (reference)	
Outcomes	**Men**	**Women**	**For men**	**For women**
Number of sex partners in the past 12 months (0–1 vs 2+)				
Ages 15–24 years	6222	8491	1.67(1.47–1.90) ***	1.28(1.08–1.53) **
Ages 25–34 years	7872	11372	1.42(1.26–1.61) ***	1.64(1.39–1.93) ***
Ages 35+ years	7767	9240	1.64(1.44–1.88) ***	1.27(0.99–1.62)
Alcohol used before sex (yes vs. no)				
Ages 15–24 years	5750	8287	0.85(0.71–1.03)	1.38(1.17–1.63) ***
Ages 25–34 years	7721	11134	0.68(0.60–0.78) ***	1.31(1.17–1.46) ***
Ages 35+ years	7465	7937	0.69(0.60–0.80) ***	1.23(1.09–1.39) ***
Inconsistent condom use				
Ages 15–24 years	6222	8491	0.66(0.57–0.75) ***	1.40(1.17–1.67) ***
Ages 25–34 years	7872	11372	0.88(0.69–1.12)	0.71(0.57–0.88) **
Ages 35+ years	7767	9240	0.92(0.73–1.15)	0.67(0.56–0.80) ***

* P-value <0.05,
** <0.01, and
*** <0.001.

† N are the person-rounds of each stratified group that were used 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 visit rounds, location, SES, religion, education, current marital status, and occupation.

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Table 1:

Characteristics of Rakai participants (non-fishing villages), Rakai Community Cohort Study (RCCS), 2010–2016

	Observations (%)	
Characteristics of participants	**Men**	**Women**
Number of Unique Persons	14520	18051
Number of Observations	25868 (100%)	32407 (100%)
Cellphone Status		
Owning a cellphone	17290 (67%)	16673 (49%)
Do not own a cellphone	8578 (33%)	15734 (51%)
Age (years)		
15–24	10041 (39%)	11675 (36%)
25+	15827 (61%)	20732 (64%)
Round Number		
14	7039 (27%)	8882 (27%)
15	5885 (23%)	7357 (23%)
16	6244 (24%)	7804 (24%)
17	6700 (26%)	8364 (26%)
Place of Residence		
Rural	14499 (56%)	17294 (53%)
Trading Center	11369 (44%)	15113 (47%)
Socioeconomic Status		
Low	3317 (13%)	3532 (11%)
Middle	7476 (29%)	8538 (26%)
High	15075 (58%)	20337 (63%)
Religion		
Catholic	16429 (64%)	20260 (63%)
Protestant	4464 (18%)	5756 (18%)
Muslim	3531 (17%)	4641 (14%)
Other	1244 (5%)	1750 (5%)
Marital Status		
Never Married	10076 (39%)	7369 (23%)
Currently Married	13721 (53%)	19303 (60%)
Separated/Widowed	2071 (8%)	5735 (18%)
Highest Level of Schooling		
None	700 (3%)	1462 (5%)
Primary	16142 (62%)	18689 (58%)
Post-Primary	9026 (35%)	12256 (38%)
Primary Occupation		
Agriculture/housework	8040 (31%)	14548 (45%)
Admin /Teaching	1576 (6%)	2102 (6%)
Student	5325 (20%)	4174 (13%)

Characteristics of participants	Observations (%) Men	Women
Business	4305 (17%)	6836 (21%)
Other	6622 (26%)	4747 (15%)
HIV Status		
Negative	23310 (90%)	27183 (84%)
Positive	2558 (10%)	5224 (16%)
Ever had sex		
Yes	21861 (85%)	29103 (90%)
No	4007 (15%)	3304 (10%)
Number of Sex Partners in the Past 12 months[†]		
0–1	13551 (62%)	27076 (93%)
2+	8310 (38%)	2027 (7%)
Alcohol used before sex[†]		
Yes	7589 (36%)	5127 (19%)
No	13347 (64%)	22231 (81%)
Condoms used[†]		
Inconsistent	19027 (87%)	26709 (92%)
Consistent with all partners	2834 (13%)	2394 (8%)

[†]Included observations who reported ever having sex in number of sexual partners, alcohol use and inconsistent condom use analyses.

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Table 2:

Crude and adjusted associations of cell phone ownership with demographic factors, RCCS, 2010–2016

	Own Personal Cell Phone vs Not Owning Cell Phone							
	Men				Women			
Demographics	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR § (95% CI)**	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR § (95% CI)**
Number of observations	17290	67%			16673	49%		
Age (years)								
15–19	1784	31%	0.13 (0.11–0.14)***	0.22 (0.19–0.25)***	909	15%	0.13 (0.12–0.15)***	0.13 (0.11–0.15)***
20–24	3232	75%	0.78 (0.71–0.86)***	0.98 (0.88–1.10)	2812	49%	0.66 (0.61–0.70)***	0.58 (0.53–0.63)***
25–29 (reference)	3279	79%	1	1	3493	59%	1	1
30–35	3032	79%	1.04 (0.93–1.13)	1.04 (0.93–1.16)	3467	62%	1.15 (1.07–1.23)***	1.36(1.25–1.79)***
35–39	2702	78%	0.94 (0.84–1.04)	0.91 (0.80–1.03)	3000	66%	1.32 (1.22–1.43)***	1.61(1.47–2.15)***
40+	3261	75%	0.84 (0.75–0.94)**	0.80 (0.70–0.90)***	2992	63%	1.27 (1.16–1.38)***	1.64(1.48–2.71)***
Round Number								
14 (reference)	4164	59%	1	1	3457	39%	1	1
15	4031	68%	1.47 (1.39–1.56)***	1.50 (1.40–1.62)***	3924	53%	1.68 (1.60–1.77)***	1.68 (1.58– 1.79)***
16	4258	68%	1.62 (1.53–1.72)***	1.74 (1.61–1.87)***	4268	55%	2.03 (1.93–2.13)***	2.02 (1.89– 2.15)***
17	4837	72%	2.07 (1.95–2.20)***	2.29 (2.12–2.47)***	5024	60%	2.56 (2.44–2.69)***	2.54 (2.38– 2.71)***
Place of Residence								
Rural (reference)	9280	64%	1	1	7927	46%	1	1
Trading Centers	8010	79%	1.41 (1.30–1.50)***	1.13 (1.05–1.22)**	8746	58%	1.68 (1.59–1.77)***	1.28 (1.20– 1.36)***
Socioeconomic Status								
Low (reference)	1587	48%	1	1	1024	29%	1	1
Middle	4406	59%	1.45 (1.34–1.57)***	1.29 (1.17–1.42)***	3229	38%	1.53 (1.41–1.67)***	1.30 (1.18– 1.43)***
High	11297	75%	2.69 (2.48–2.92)***	2.08 (1.88–2.29)***	12420	61%	3.27 (3.01–3.55)***	2.25 (2.05– 2.48)***
Educational Attainment								
None (reference)	298	43%	1	1	421	29%	1	1
Primary	9980	62%	2.12 (1.76–2.55)***	3.27 (2.69–3.98)***	8506	46%	2.05 (1.77–2.36)***	3.08 (2.64– 3.58)***

	Own Personal Cell Phone vs Not Owning Cell Phone							
	Men				Women			
Demographics	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR § (95% CI)**	**N**	**%†**	**Crude OR (95% CI)**	**Adjusted OR § (95% CI)**
Post-Primary	7012	78%	4.51 (3.73–5.45) ***	8.51(6.91–10.49) ***	7746	63%	4.19 (3.63–4.85) ***	7.86 (6.69– 9.24) ***
Current Marital Status								
Never Married (reference)	4929	49%	1	1	2535	34%	1	1
Currently Married	11225	82%	4.14 (3.88–4.41) ***	1.86 (1.67–2.07) ***	10332	54%	2.11 (1.97–2.25) ***	0.78 (0.71– 0.86) ***
Separated/Widowed	1136	55%	1.57 (1.42–1.73) ***	0.72 (0.63–0.83) ***	3806	66%	3.48 (3.21–3.76) ***	1.18 (1.06– 1.33) **
Primary Occupation								
Agriculture	5131	64%	1	1	6382	44%	1	1
Admin/Teaching	1529	97%	10.8 (8.34–13.98) ***	4.34 (3.20–5.88) ***	1883	90%	7.99 (6.92–9.23) ***	3.76 (3.18– 4.44) ***
Student	2189	41%	0.42 (0.39–0.45) ***	0.59 (0.53–0.66) ***	821	20%	0.34 (0.31–0.37) ***	0.60 (0.53– 0.68) ***
Business	3645	85%	2.40 (2.19–2.62) ***	2.04 (1.84–2.26) ***	4776	70%	2.40 (2.26–2.56) ***	2.02 (1.87– 2.17) ***
Other	4796	72%	1.41 (1.31–1.52) ***	1.47 (1.35–1.60) ***	2811	59%	1.66 (1.56–1.78) ***	1.49 (1.37– 1.62) ***

Abbreviations: OR: odds ratio; CI: confidence interval.

*P-value <0.05,

**<0.01, and

***<0.001.

†The percentages are given as row percent representing the proportions of owning a personal cell phone among all the observations within each characteristic category.

§Odds ratio (OR) greater than 1 indicates a greater likelihood of owning a phone. OR less than 1 indicates a lower likelihood of owning a phone.

§The OR ratios were adjusted for age group, visit rounds, place of residence, SES, religion, education, current marital status, and occupation.

Table 3:

The association between cell phone ownership and sexual behaviors for sexually active RCCS participants stratified by gender, and age group, from 2010–2016

	N[†]		Adjusted Odds Ratio [§] (95% CI) Own Personal Cell Phone vs. No cell phone (reference)	
Outcomes	**Men**	**Women**	**For men**	**For women**
Number of sex partners in the past 12 months (0–1 vs 2+)				
Ages 15–24 years	6222	8491	1.67(1.47–1.90)*	1.28(1.08–1.53)*
Ages 25+ years	15639	20612	1.54(1.41–1.69)*	1.44(1.26–1.65)*
Alcohol used before sex (yes vs. no)				
Ages 15–24 years	5750	8287	0.85(0.71–1.03)	1.38(1.17–1.63)***
Ages 25+ years	15186	19071	0.68(0.62–0.75)***	1.28(1.18–1.39)***
Inconsistent condom use				
Ages 15–24 years	6222	8491	0.66(0.57–0.75)***	1.40(1.17–1.67)***
Ages 25+ years	15639	20612	0.87(0.74–1.03)	0.65(0.57–0.74)***

*P-value <0.05,

**<0.01, and

***<0.001.

[†]N are the person-rounds of each stratified group that were used 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 visit rounds, location, SES, religion, education, current marital status, and occupation.

Table 4:

HIV prevalence among those owning a cell phone vs. not owning a cell phone for sexually active RCCS participants between stratified by round, gender, and age group from 2010–2016

			Odds Ratio [§] (95% CI) Own Personal Cell Phone vs. No cell phone (reference)					
	N[†]		Crude		Adjusted for demographics[‡]		Adjusted for both demographics and sexual behaviors [§]	
Outcomes	**Men**	**Women**	**For men**	**For women**	**For men**	**For women**	**For men**	**For women**
HIV prevalence overall N=58275								
Ages 15–24 years	6222	8491	1.09(0.78–1.52)	1.19(1.03–1.39)*	0.89(0.63–1.27)	1.27(1.07–1.50)**	0.89(0.62–1.27)	1.24(1.05–1.46)*
Ages 25+ years	15639	20612	0.72(0.65–0.80)***	1.09(1.02–1.17)*	0.98(0.87–1.09)	1.07(0.99–1.15)	0.98(0.87–1.10)	1.02(0.94–1.10)

[§]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.

[†]N are the person-rounds of each stratified group that were used to fit the models for odds ratios.

[‡]The OR were adjusted for visit rounds, location, SES, religion, education, current marital status, and occupation.

[§]The OR were adjusted for number of sexual partners, alcohol use before sex, and inconsistent condom use.