



# Is It the Timing? Short-Term Mobility and Coital Frequency in Agbogbloshie, Ghana

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## Abstract

Short-term mobility is often associated with increased sexual risk behavior. Mobile individuals often have higher rates of sexual risk behavior compared to non-mobile individuals, but the reasons why are not clear. Using monthly retrospective panel data from 202 men and 282 women in Agbogbloshie, Ghana, we tested whether short-term mobility was associated with changes in coital frequency, and whether the association was due to the act of travel in the given month (e.g., enabling higher risk behavior), the reason for travel, or an individual's travel propensity at other times in the year. Overnight travel specifically to visit family or friends, or for education, health, or other reasons, was associated with increased coital frequency for men. However, men with higher travel propensities had lower overall coital frequency and the act of traveling enabled more sex only for the most frequent male travelers. Men who seldom traveled had much higher coital frequency, but the act of traveling was not associated with additional sex acts. For women, travel for education, health, or other reasons increased coital frequency. Occasional female travelers had slightly more sex acts compared to non-mobile women, and the act of traveling for these women was associated with slight increases in coital frequency, supporting the enabling hypothesis. Highly mobile women had fewer sex acts per month on average. Our findings suggest that mobility characteristics measured on a broad temporal scale, as well as the reason for mobility, are important to understand the relationship between short-term mobility and sexual behavior.

**Keywords** Circular migration · Health · Sexual risk behavior · Ghana · Temporal scale

## Introduction

Short-term mobility is often associated with changes in individual risk behavior for HIV and other sexually transmitted infections (STI). In the field of migration and HIV, a number of studies have shown positive associations between mobility and sexual risk behavior conducive to HIV compared to non-mobile individuals, such as substance abuse, inconsistent condom use, and paying for sex (Abdullah, Ebrahim, Fielding, & Morisky, 2004), especially in sub-Saharan Africa (Brockhoff

& Biddlecom, 1999; Kishamawe et al., 2006; Kwena, Camlin, Shisanya, Mwanzo, & Bukusi, 2013; Lurie et al., 2003). Even though mobile people often appear to behave differently compared to non-mobile people, the reasons why they behave differently is not clear. Additionally, changes in sexual behavior while traveling may not always mark additional health risk. Mobile individuals could exhibit higher sexual risk behavior while they are away from home due to a different social or physical environment or because of the freedom from being geographically separated from family. On the other hand, a mobile individual reuniting with an ongoing sexual partner, and then returning home and having fewer sex acts, would result in a positive association between mobility and increased sexual behavior but not necessarily signify increased risk. The association likely depends on broader travel characteristics of the individual, such as how common travel is for the individual (Camlin & Charlebois, 2019; Deane, Parkhurst, & Johnston, 2010; Greif & Nii-Amoo Dodoo, 2011).

The intrinsic risk theory states that mobile individuals are at higher risk of HIV/STI infection compared to non-mobile individuals because either they are selected on risky behavior

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tendencies or that the act of migration enables risk behavior by creating opportunities for it (Cassels, Jenness, & Khanna, 2014b). Support for this theory was found in early HIV studies among truck drivers in East Africa: psychosocial properties (e.g., a risk profile) and demographic characteristics (e.g., ethnicity) influenced both labor migration and high-risk sexual relations such as sex with commercial sex workers (Quinn, 1994), and truck drivers had higher levels of HIV infection (Mbugua et al., 1995). In many more recent studies, mobile individuals have been shown to have higher rates of HIV (Camlin et al., 2019; Dobra, Barnighausen, Vandormael, & Tanser, 2017; Nunn, Wagner, Kamali, Kengeya-Kayondo, & Mulder, 1995) or more risky sexual behavior (Brockerhoff & Biddlecom, 1999; Coffee et al., 2005; Magis-Rodriguez et al., 2004; Sanchez et al., 2012; Zuma et al., 2005) compared to non-migrants. Additionally, the reasons, contexts, and behavioral consequences of mobility are highly gendered (Camlin et al., 2019; Kwena et al., 2013). Lastly, it is important to note that while sexual risk behaviors such as substance abuse (Weine & Kashuba, 2012), multiple and concurrent partnerships (Cassels, Manhart, Jenness, & Morris, 2013; Gandhi et al., 2015), inconsistent condom use (Brockerhoff & Biddlecom, 1999), and paying for sex (Camlin, Kwena, Dworkin, Cohen, & Bukusi, 2014) have been associated with migration, coital frequency may not be associated with sexual risk behavior.

Mobility may have a broad influence on risk over time as well, wherein people who have higher travel propensities, or higher rates of overall travel, may be selected on certain socioeconomic or other characteristics that are associated with opportunities for sexual risk behavior. Additionally, the association between mobility and risk behavior likely depends on competing priorities, reason for travel, and time constraints. In this sense, sexual behavior during travel that potentially involves leisure time might be fundamentally different from travel that is not typically associated with leisure time such as travel with strict time constraints.

In this article, we use monthly retrospective panel data to investigate whether short-term mobility and reason for travel are associated with changes in total monthly sex acts. Second, we examine whether there are differences in rates of monthly sex acts across individuals with different travel propensities. Lastly, we examine whether the relationship between short-term mobility and changes in monthly sex acts vary by travel propensity. If the intrinsic theory holds true, we expect to see that at an individual level, overnight travel would be associated with increased sex acts (enabling) and that frequent travelers also have more sex acts compared to infrequent travelers (enabling and selection). If the time constraints/competing priorities theory hold true, then we expect that social travel would have a positive association with coital frequency, but not work travel. Secondly, we would expect that frequent travelers would have fewer overall sex acts compared to seldom travelers.

## Method

### Participants

This analysis used data from the Migration and HIV in Ghana (MHG) study, a retrospective panel study of sexually active adults in Agbogbloshie, Ghana (2012) (Cassels, Jenness, Biney, Ampofo, & Dodoo, 2014a). Agbogbloshie is an urban resource-poor area in the capital city of Accra, selected for this study based on its hypothesized high levels of migration and short-term mobility and high rates of HIV infection. In 2012, the population of Agbogbloshie was estimated at 8305 (54% female and 46% male), of whom 5466 were aged 15–49 years (same gender distribution) (Ghana Statistical Service, 2012). A wide range of ethnicities is represented in Agbogbloshie, as it attracts seasonal migrants partly because it is home to Ghana's largest commercial fresh produce market (Oberhauser & Yeboah, 2011). Thus, a large proportion of residents are migrants (Awumbila & Ardayfio-Schandorf, 2008; Oberhauser & Yeboah, 2011), and the individuals living in Agbogbloshie are quite mobile as well.

The MHG used a 2-stage cluster randomized sampling scheme to obtain a probability sample of the population. Eligibility criteria to participate were current residence in the selected household, age 18–49 years, and lifetime history of consensual sexual intercourse. Respondents were recruited in the months of July and August. Among households selected for recruitment in our study, 70% completed the survey. Most non-recruitment was due to ineligibility and inability to locate the subject. Among households contacted, 1.9% refused to participate. The sample size for this analysis was 484 individuals, representing 5808 person-months. The sampling scheme, survey methods, weighting scheme, and details about completion and response rates have been described in detail elsewhere (Cassels et al., 2014a).

The survey focused on demographics, migration and short-term mobility, and sexual behavior. For sexual behavior, summary data were collected on the number of lifetime sexual partners, past-year partners, and past-year partners with whom condoms were not always used. We used an event history calendar to collect detailed partnership data for partners in the past year (up to 3), with responses for each month during that period. For each partner, data included the duration of the partnership and monthly information on the number of total and unprotected sexual acts. A series of structured questions captured lifetime and recent migration and short-term mobility patterns, including the place of birth, length of time living in Agbogbloshie, number of residences within Accra, and summary measures of number of overnight trips and reasons for that travel. Short-term mobility data included month-by-month information on each overnight episode, destination (city

and region), duration of mobility episode, and reason for travel.

## Measures

The main outcome variable in our analyses was coital frequency or the total number of sex acts in a given month. We limited our outcome variable to total sex acts as opposed to total number of condomless sex acts for two reasons. First, > 90% of all sex acts in our study were reported to be condomless. Second, we ran all the analyses with both outcomes, and the results did not differ in any meaningful ways. The main predictor variable was short-term mobility in a given month. Short-term mobility was measured as any overnight travel  $\geq 10$  km away from Agbogbloshie regardless of duration or distance in a given month (see Fig. 1 for map of all travel destinations, by gender). International travel, although rare, was included. A night away from home but within 10 km of Agbogbloshie, such as a night spent at a place of work or partner's house, was not counted as a mobility episode.

Additional migration variables included reason for travel in a given month and travel propensity over the past year. Respondents were asked, "For each of these trips, what was your main reason to travel?" Similar response categories were combined into four categories: work/money, farming; visit family, friends, partner; funerals, holidays/celebration/festivals; education, health, other. Travel propensity was measured as the proportion of 12 months with any overnight travel, then categorized into 0 months (no travel), 1 month/year, two months/year, 3 to 4 months/year, or > 4 months/year with any travel.

A number of additional time-varying co-variates were considered. Marital status was categorized as never married (reference), cohabiting, married, and widowed/separated/divorced (and not currently married or cohabiting). Other controls included age (continuous), income quartiles, and pregnancy trimester and postpartum, as coital frequency varies by stage of pregnancy (Cassels, Jenness, & Biney, 2019). We included month of observation to address trends in recall bias or specific timing effects as well. All models were run separately by gender. We did not include sexual partnership concurrency in our models, as acquiring additional partnerships while traveling is a direct determinant of increased coital frequency (Jenness, Biney, Ampofo, Nii-Amoo Dodoo, & Cassels, 2015) and we aimed to measure changes in coital frequency for any reason.

## Statistical Analysis

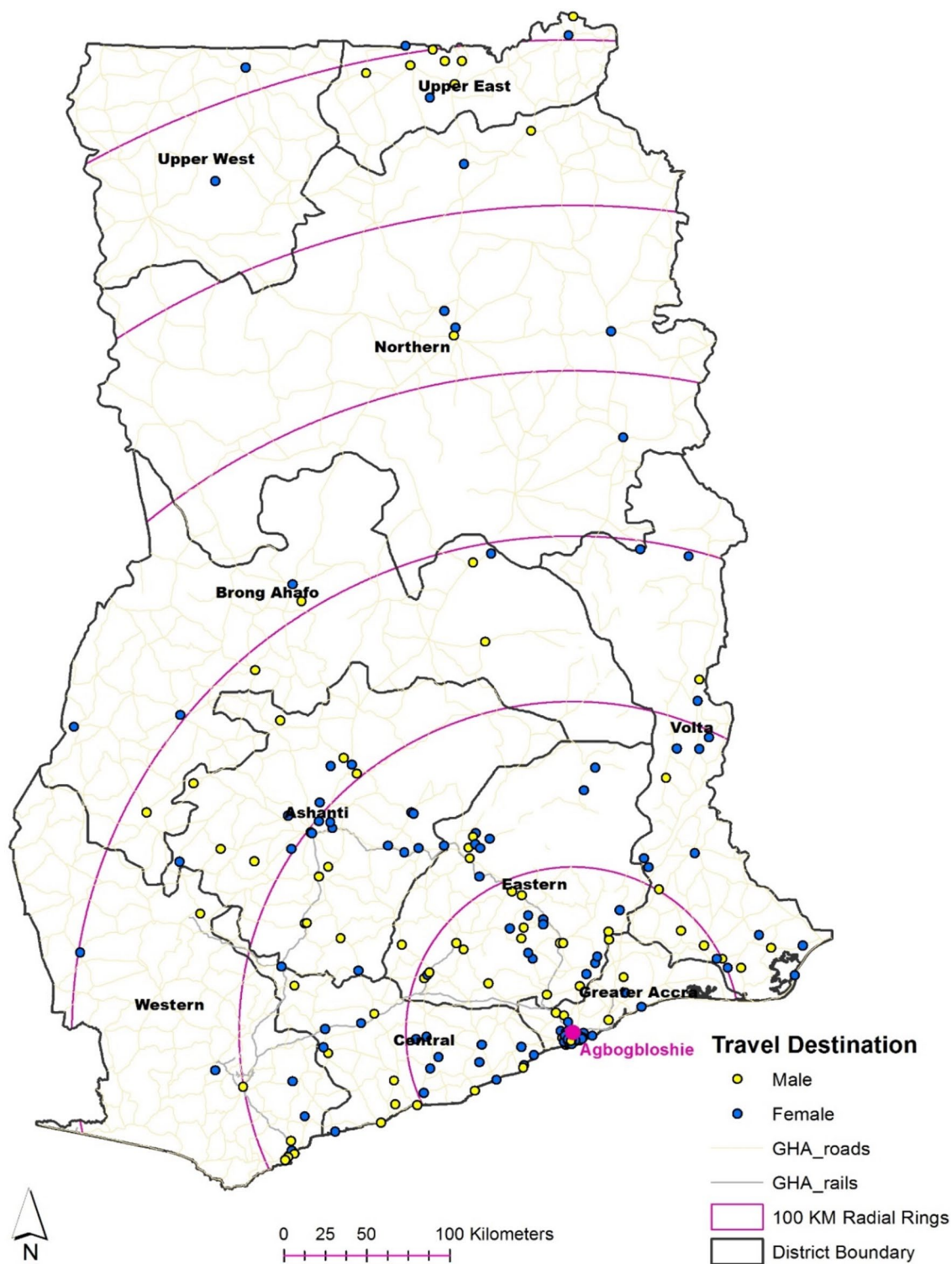
Our first question regarded whether overnight travel in a given month was associated with changes in coital frequency. We also examined whether reason for travel explained

changes in coital frequency within individuals. To answer these questions, we estimated regression models with person fixed effects. These models compared respondents with themselves at other months in the year, and thus account for fixed, unmeasured confounders; therefore, there was no need to include time-invariant co-variates in the model. Since our outcome variable was coital frequency, which was over-dispersed, we estimated our models with a negative binomial regression. All of the models were stratified by gender, since we hypothesized that the relationship between mobility and coital frequency substantially differs by gender. Lastly, by estimating our model with fixed effects, we necessarily excluded individuals from the model whose coital frequency never varied over the 12-month retrospective period. Therefore, our coefficients represent within-individual differences in coital frequency in months when they were mobile and when they were not mobile.

In order to examine whether coital frequency differed between individuals with different travel propensities, we estimated negative binomial regressions models with random effects. The random effects modeling framework allowed monthly predictor and outcome data to be nested within individuals. These models reveal between-group differences since individuals whose coital frequency never changed are retained. They also facilitate a comparison of the magnitude of changes in coital frequency between individuals never-and ever-mobile. In the random-effects model, we controlled for additional variables that a priori were associated with number of sex acts and mobility, including age, marital status, income quantiles, and pregnancy trimester for women. Lastly, to examine whether the association between short-term mobility and coital frequency varied by travel propensity, we re-estimated our fixed-effects models fully stratified by travel propensity.

## Results

We recruited 484 study subjects, comprised of 202 men and 282 women, which yielded 5808 person-months of data. However, some individuals moved to our study site within the 12 months prior to the interview. We therefore dropped 175 person-months prior to their move to Agbogbloshie since we could not ascertain which mobility episodes were away from "home." These person-months were contributed by 30 individuals (minimum 1 month per person, maximum 11 months per person, mean 5 months living in Agbogbloshie). Since respondents were recruited at different times during the month, the number of exposure days in the final month (month = 12) varied, and some responses were censored, namely coital frequency and overnight mobility. Thus, we dropped all responses from month 12, the month



**Fig. 1** Travel destinations of adults in Agbogbloshie in Accra, Ghana, in 2012 by gender ( $n=484$ )

of the interview. The final sample size for the analysis was 4665 person months: 202 men contributed 1899 person-months and 282 women contributed 2766 person-months.

Table 1 shows the sociodemographic and behavioral characteristics of Agbogbloshie, using weighted statistics since our sample was representative of the population.

Slightly more than half of adults in Agbogbloshie were female (57.3%) and below the age of 30 years (55.8%) in 2012. Men reported a higher number of sexual partners (1.9 vs. 1.2) per year and many more men engaged in concurrent partnerships (30% vs. 5.5%) compared to women. Average monthly coital frequency was also higher for men. However, men and women in Agbogbloshie had similarly high levels of short-term mobility and travel propensity. Around 80% of adults traveled in the prior year, and about 2.5 out of 12 months included some overnight mobility. Destinations included all ten districts in Ghana (see Fig. 1).

At a cross-sectional view, total monthly sex acts did not vary by travel for men or women (Table 2). Travel propensity,

however, was associated with more monthly sex acts for men. Men who reported travel during only one month of the prior year had 6.47 (95% CI 4.2–8.7) average monthly sex acts compared to men who never traveled (2.80 acts; 95% CI 1.9–3.7). Men with a moderate amount of travel reported more sex acts compared to men who never traveled. Reason for travel was also associated with the amount of monthly sex acts. Men who traveled for work reported fewer sex acts during that month of travel compared to men who did not travel in that month (2.82 acts; 95% CI 1.7–4.0 vs. 4.47 acts; 95% CI 3.6–5.4). Average monthly sex acts declined with age, although this pattern was not statistically significant. Women who were cohabiting or married reported more sex

**Table 1** Sociodemographic and behavioral characteristics of adults in Agbogbloshie, Accra, Ghana, 2012 ( $n = 484$  individuals)

	Total		Men		Women	
	%/M	95% CI	%/M	95% CI	%/M	95% CI
Sociodemographic characteristics						
Sex						
Male	42.6	36.9–48.5				
Female	57.3	51.6–63.1				
Age						
18–29	55.8	49.9–61.6	50.5	41.8–59.2	59.8	52.0–67.2
30–39	29.1	24.2–34.6	33	25.2–41.8	26.3	20.3–33.3
40–49	15.0	11.3–19.6	16.5	10.9–24.2	13.9	9.5–20.1
Marital status						
Never married	40.6	34.9–46.6	39.4	31.4–48.0	41.6	33.8–49.8
Cohabiting	21.5	16.7–27.2	19.9	13.5–28.4	22.6	16.2–30.7
Married	31.4	26.2–37.0	34.1	26.1–43.0	29.4	23.0–36.7
Widowed/separated/divorced	6.5	4.4–9.5	6.6	3.7–11.4	6.4	3.8–10.8
Income						
Mean (in Ghana Cedi)	2039	1812–2265	2655	2246–3063	1572	1349–1795
Median (Ghana Cedi)	1580		1920		1200	
Pregnancy status						
Ever pregnant (self or current partner)*			18.8	12.6–27.1	24.9	18.9–31.9
Sexual behavior and health characteristics						
Sexual history						
Total partners <sup>a</sup>	1.48	1.33–1.63	1.9	1.57–2.22	1.17	1.09–1.25
Any concurrent sexual partnership <sup>b</sup>						
Yes	15.7	12.2–20.1	30.0	23.0–38.2	5.5	3.2–9.6
Coital frequency						
Acts per month, total	4.8	4.27–5.28	5.5	4.59–6.45	4.2	3.69–4.75
Acts per month, unprotected	4.3	3.89–4.80	4.8	3.96–5.54	4.1	3.52–4.57
HIV-1 Infection						
Infected	4.4	1.8–7.0	2.7	0.0–5.4	5.6	1.6–9.7
Migration and mobility						
Short-term mobility						
Any overnight trip > 10 km from home	79.4	74.6–83.4	77.3	69.4–83.7	80.8	74.7–85.7
Number of overnight trips (mean)	7.3	4.1–10.5	6.1	2.1–10.1	8.1	3.5–12.8
Proportion of months with any travel	19.4	18.8–20.0	19.3	18.3–20.2	19.5	18.7–20.3

<sup>a</sup>How many sexual partners, including spouse, in last 12 months

<sup>b</sup>In in last 12 months

**Table 2** Monthly total sex acts by mobility and sociodemographic characteristics among adults in Agbogbloshie, Accra, Ghana, 2012

	Total		Men		Women	
	<i>M</i>	95% CI	<i>M</i>	95% CI	<i>M</i>	95% CI
Short-term mobility characteristics						
Current month travel						
No (reference)	3.78	3.3–4.3	4.44	3.5–5.3	3.29	2.8–3.8
Yes	3.72	3.1–4.3	4.32	3.2–5.8	3.27	2.6–3.9
Number (proportion) of months with travel within year						
No travel (reference)	3.15	2.5–3.8	2.80	1.9–3.7	3.38	2.4–4.4
1 month (< 10%)	4.65	3.5–5.8	6.47	4.2–8.7	3.10	2.3–3.9
2 months (10–20%)	3.48	2.6–4.3	3.79	2.6–5.0	3.26	2.1–4.4
3–4 months (20–40%)	4.16	3.2–5.1	4.86	3.2–6.5	3.58	2.5–4.7
> 4 months (> 40%)	3.11	2.3–4.0	3.07	2.0–4.1	3.14	1.9–4.3
Main reason for travel						
No travel (reference)	3.71	3.2–4.2	4.47	3.6–5.4	3.13	2.6–3.6
Work, farming	2.98	2.0–3.9	2.82	1.7–4.0	3.46	1.7–5.2
Visit family, friends, partner	4.18	3.1–5.2	5.33	3.1–7.6	3.50	2.5–4.5
Funeral, holiday	3.87	3.1–4.7	4.29	3.1–5.1	3.62	2.6–4.6
Education, health, other	4.13	2.9–5.4	4.12	1.8–6.5	4.13	2.7–5.6
Sociodemographic characteristics						
Age						
18–29 (reference)	3.99	3.3–4.7	4.65	3.2–6.1	3.52	2.9–4.2
30–39	3.79	3.2–4.2	4.37	3.4–5.3	3.33	2.5–4.2
40–49	3.11	2.3–3.9	3.88	2.5–5.3	2.54	1.6–3.5
Marital status						
Never married (reference)	3.58	2.8–4.4	4.55	3.0–6.1	2.79	2.1–3.5
Cohabiting	4.38	3.5–5.2	4.32	3.1–5.6	4.42	3.2–5.6
Married	4.28	3.6–5.0	4.51	3.5–5.6	4.11	3.2–5.0
Widowed/separated/divorced	2.39	1.5–3.3	3.65	2.1–5.2	1.83	0.7–2.9
Income						
First (GHS: 0–720) (reference)	3.30	2.5–4.1	3.07	1.5–4.7	3.38	2.4–4.4
Second (720–1499)	3.75	2.9–4.6	5.10	3.1–7.1	3.06	2.3–3.8
Third (1500–2480)	4.47	3.4–5.5	5.54	3.7–7.4	3.28	2.4–4.2
Fourth (> 2480)	3.69	2.9–4.5	3.59	2.5–4.7	3.84	2.6–5.1
Pregnancy status						
Not pregnant or postpartum (reference)					3.45	2.9–4.0
First trimester					4.51	2.7–6.3
Second trimester					2.33	1.3–3.3
Third trimester					0.90	0.4–1.4
0–3 months postpartum					0.32	0.0–0.7
Total number of monthly sex acts	3.77		4.42		3.29	

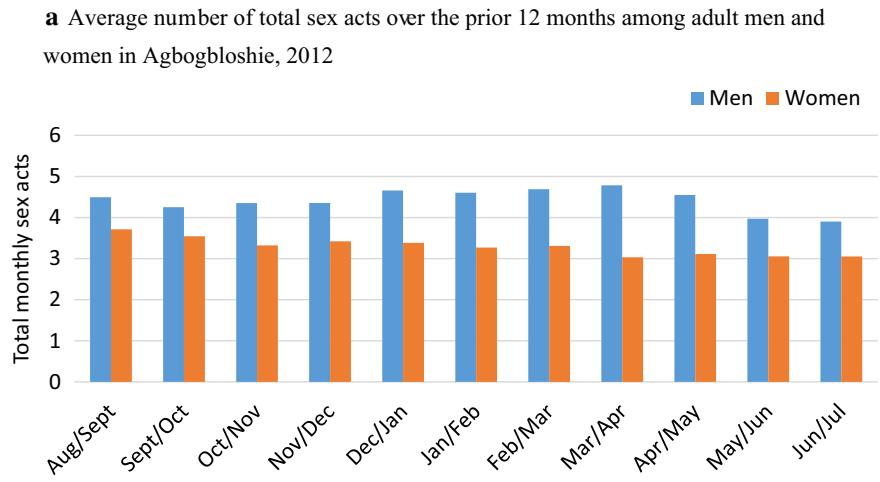
Standard errors and confidence intervals adjusted for clustering

acts compared to never married or divorced women. Lastly, coital frequency significantly declined in the later stages of pregnancy and postpartum.

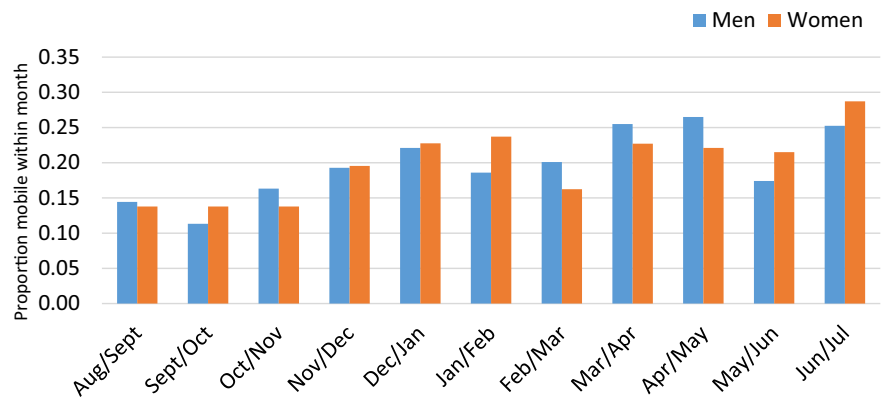
Coital frequency and mobility varied over time (see Figs. 2a and 2b). Note that the peak rainy season is in May and June, and data were collected in July and August. For men, coital frequency was slightly higher during the months of December through April, but this trend was not significant.

For women, reported coital frequency declined over the course of the year, with most recent months having the fewest sex acts. Rates of mobility appeared to follow a bimodal distribution for men and women, with rates highest around December and April/May. Reported rates were also low in the first few months of the prior year and high in the month prior to the interview. This could be due to recall bias, whereas respondents may have underreported trips earlier in the year.

**Fig. 2 a** Average number of total sex acts over the prior 12 months among adult men and women in Agboglobshie, 2012. **b** Proportion of adult men and women mobile within a month, over the prior 12 months, in Agboglobshie, 2012



**b** Proportion of adult men and women mobile within a month, over the prior 12 months, in Agboglobshie, 2012



Slightly different results emerged when we examined the association between short-term mobility and coital frequency within individuals using fixed-effects models (Table 3),

compared to cross-sectional analyses. By definition, individuals without variation in coital frequency were not included, which left 175 men and 225 women in the models. Among

**Table 3** Fixed-effects negative binomial model predicting total sex acts per month

	Men				Women			
	Model 1		Model 2		Model 1		Model 2	
	Coef	p value	Coef	p-value	Coef	p-value	Coef	p-value
Any overnight travel	0.078	.131			0.036	.369		
Main reason for travel								
No travel (reference)								
Work, farming			-0.033	.803			-0.096	.473
Visit family, friends, partner			0.2902	<.001			0.007	.898
Funeral, holiday			-0.121	.172			0.025	.670
Education, health, other			0.3085	.035			0.232	<.001
Month	-0.01	.119	-0.009	.092	-0.02	<.001	-0.02	<.001
Number of observations	1905		1905		2391		2391	
Number of groups	175		175		225		225	

those with variation, the mean number of months with mobility were 2.5 (range, 1–10) and 2.7 (range, 1–10), for men and women respectively. Results in Table 3 suggest that men did not have additional sex acts during months that they traveled compared to months in which they did not travel. However, specifying the reason for travel differentiated the results. Men who traveled to visit family or for education or health reasons had around 0.3 additional sex acts compared to months without travel. For women, any overnight travel was also not statistically associated with an increase in coital frequency. However, women who traveled specifically for education or health reasons had 0.23 additional sex acts compared to months without travel.

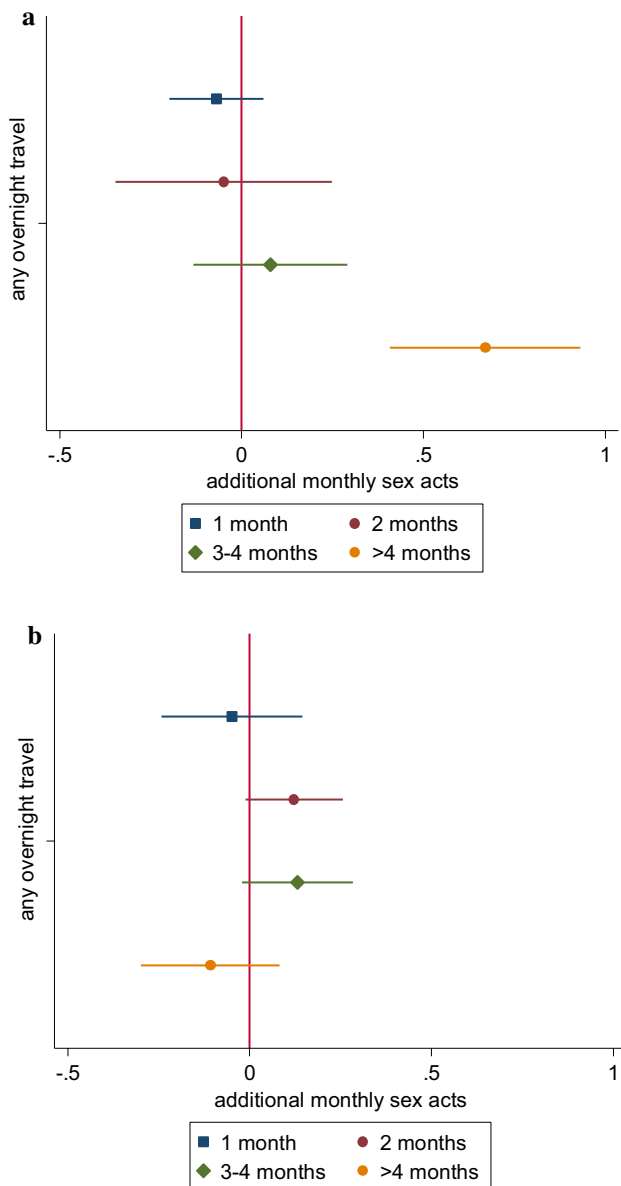
Using negative binomial random effects models, accounting for variation within individuals, we examined whether travel propensity was associated with differences in monthly coital frequency (Table 4). Men and women with high travel propensity (3 months or more containing travel in the past year) generally had fewer monthly sex acts compared to those who did not travel during the year. Men with low travel

propensity (only one month containing travel during the year) had significantly more monthly sex acts compared to non-travelers (1.14 additional acts,  $p < .001$ ). Interestingly, only women with moderate travel propensity (2 months/year containing travel) had significantly more sex acts compared to non-travelers (0.88 additional acts,  $p < .001$ ). When accounting for other co-variates, travel propensity continued to be highly predictive of coital frequency for men, but the magnitude of the coefficients and significance levels vary for women. Similar to the fixed-effects models, visiting family or friends and travel for education or health was significantly associated with coital frequency, for men and women respectively.

Lastly, we ran fully stratified fixed-effects models to test whether the association between short-term mobility and coital frequency varied by travel propensity (see Fig. 3). Due to small sample sizes, we were unable to run these models with reason for travel as the primary outcome variable. Recall men with low travel propensity had the highest levels of coital frequency in a given month. Among these men, travel in a given

**Table 4** Random effects negative binomial models to test the association between travel propensity and total monthly sex acts

	Men				Women			
	Model 1		Model 2		Model 3		Model 4	
	Coef	<i>p</i> -value	Coef	<i>p</i> -value	Coef	<i>p</i> -value	Coef	<i>p</i> -value
Travel propensity								
No travel	(reference)				(reference)			
1 month/year	1.143	< .001	1.306	< .001	-0.214	.313	-0.672	.002
2 months/year	-1.153	< .001	-0.961	< .001	0.875	< .001	0.410	.137
3–4 months/year	-1.003	< .001	-0.652	.008	-0.421	.068	-0.210	.394
> 4 months/year	-0.334	.186	-0.065	.823	-0.451	.087	-1.114	< .001
Main reason for travel								
No travel (reference)								
Work, farming			-0.043	.729			-0.255	.139
Visit family, friends, partner			0.134	.050			-0.004	.950
Funeral, holiday			-0.065	.398			-0.001	.990
Education, health, other			0.182	.173			0.369	< .001
Age (continuous)			.043	< .001			0.012	.412
Marital Status								
Never married (reference)								
Cohabiting			1.985	< .001			1.508	< .001
Married			0.599	.010			1.253	< .001
Widowed/separated/divorced			-0.602	.025			0.088	.761
Income (quartiles)								
First ((reference)								
Second			0.760	.006			0.087	.680
Third			0.654	.011			-0.340	.110
Forth			0.897	< .001			0.421	.095
Pregnancy trimester (1–4)								
Month			-0.009	.057			-0.014	< .001



**Fig. 3** **a** Fixed-effects negative binomial model predicting total sex acts per month given any travel in a month, stratified by travel propensity, for men. Bars represent model coefficients and 95% confidence intervals for additional sex acts in a given month in which the man traveled, by overall level of travel propensity in the year. **b** Fixed-effects negative binomial model predicting total sex acts per month given any travel in a month, stratified by travel propensity, for men. Bars represent model coefficients and 95% confidence intervals for additional sex acts in a given month in which the woman traveled, by overall level of travel propensity in the year

month was not significantly associated with changes in coital frequency in those months. In fact, travel in a given month was only associated with increased sex acts in that month for men with high travel propensities. Men who reported travel within more than four months in the last year were the only ones that exhibited higher rates of coital frequency during

active travel months (fixed effects suggest 0.67 additional acts, 95% CI 0.41–0.93). Again, recall that men with high travel propensities typically had fewer sex acts in a given month throughout the year. These findings together suggest that men who seldom travel are not engaging in additional sex acts while they are traveling. Additionally, men who travel frequently might be having additional sex acts while traveling, and not while at home.

Recall that women with moderate travel propensity had the highest rates of coital frequency, but any overnight travel was only marginally associated with increased coital frequency among the full sample of women. Evidence from the stratified model suggested that women with a moderate amount of travel in a year (2–4 months containing travel) engaged in slightly more sex acts in months with active travel: 2 months with travel associated with 0.12 additional acts (95% CI – 0.01–0.25), and 3–4 months with travel associated with 0.13 additional acts (95% CI – 0.02–0.28). Women with a high propensity of travel (> 4 months containing travel), and women who seldom traveled, did not have more sex acts in months in which they actively traveled.

## Discussion

Travel propensity throughout the year was significantly associated with sexual behavior, more so than actual travel in a given month. Simultaneously considering mobility in a given month and travel propensity throughout the year revealed interesting patterns. Our findings suggest that the act of traveling did not enable additional risky sexual behavior for men, but did enable small increases in risk for some women.

For men, some types of short-term mobility appeared to be associated with increased coital frequency, but the act of traveling did not necessarily enable additional risk for men. Overall, men did not have more sex acts in months in which they were mobile, but the reason for travel mattered. Men who traveled for social reasons such as visiting family or for education, as opposed to work, holiday, or funerals, had higher rates of coital frequency. However, the relationship between mobility and sexual behavior was more nuanced when approached from a broader temporal lens. Men who traveled frequently throughout the year were having more sex acts when they were actively away from home, but had lower rates of coital frequency overall compared to men with low travel propensity or men who did not travel. Thus, the additional coital acts may not represent additional risk, as they had fewer acts overall. Interestingly, men who seldom traveled had much higher coital frequency compared to men who never traveled during the year, but the act of traveling was not associated with additional sex acts. These men could be

selected on some other attribute, such as social status, which could concurrently explain higher levels of coital frequency.

Our results support the enabling hypothesis for women. Among women, we found evidence of a small association between short-term mobility and coital frequency, stemming from women who traveled for education, health, or other reasons. Travel propensity throughout the year was associated with differences in coital frequency. Women who traveled occasionally (travel in 2 months of the year) had more monthly sex acts on average compared to women who did not travel, and they had an increase in coital frequency during months with active travel as well.

Interestingly, we did not see evidence to support the enabling hypothesis for occasional female travelers, which might suggest a type of threshold effect. Our other published work found similar results. Mobile women engaged in additional concurrent partnerships if their travel was sufficiently far from home (but not too far), suggesting the context and type of mobility matters (Cassels, Jenness, Biney, & Dodoo, 2017). Additionally, the effect sizes for females were small but significant. Men exhibited higher sexual risk behavior across the board, regardless of mobility status. Similar to these findings, the association between travel and increased coital frequency is likely a function of gendered cultural norms, in which women may feel the need to conceal additional sex acts in places other than home (Carter et al., 2007; Mulawa et al., 2016).

Relationship status might be an important driver of the link between short-term mobility and coital frequency. For example, the finding in which frequent male travelers have lower overall coital frequency, but increases in rates during months with active travel, could be explained if their spouse resided in the destination of travel. Rates of coital frequency would be lower if the couple was separated when the male was living in Agbogbloshie. Indeed, post hoc analyses suggest that men with high travel propensities were more likely to have an ongoing spouse, and less likely to have a casual or one-time partner, compared to a non-traveler. Interestingly, women not in an active spouse or cohabiting relationship exhibited significant increases in coital frequency in mobile months. Women with medium travel propensities, the ones who exhibited higher coital frequency during active travel months, were much more likely to have casual and one-time partnerships, and less likely to have a spouse or cohabiting partner, compared to the other groups. Relationship status and the gendered social context of sexuality is likely driving these divergent findings between men and women.

Acquiring additional, concurrent partnerships is associated with increased coital frequency (Jenness et al., 2015); therefore, we would expect to see an increase in coital frequency if individuals were engaging in concurrent partnerships while away from home. Our past work has shown that overnight travel is associated with increased sexual partnership concurrency for

women, but not men. Nonetheless, we reran the models controlling for changes in partnership degree. Partnership degree was highly correlated with coital frequency, but changes in degree did not account much of the variation in coital frequency due to short-term mobility, reason for travel, or travel propensity. All of these predictors remained significant, and the magnitude of the effects did not vary much.

Our findings have some implications for policy and further research. In many contexts, migrants are considered key populations who play a significant role in driving epidemics of HIV and other sexually transmitted infections (UNAIDS & World Health Organization, 2018), due to increased risk, vulnerability, and burden of HIV infection due to biological, social, and structural factors (Dzomba, Tomita, Govennder, & Tanser, 2019). New efforts are underway to identify populations that are at high risk of acquiring and passing on HIV, with the goal to better target interventions in geographic space (Cuadros et al., 2019; Meyer-Rath et al., 2018). However, many of these studies do not include short-term mobility or travel in their definition of migration, which could underestimate the role of human mobility in ongoing transmission of HIV. Research on migration and HIV should incorporate a broader definition of human mobility. Second, prioritizing mobile men for HIV interventions may not be effective in reducing HIV transmission. In many places, women are equally as mobile as men, but the context and implications around mobility may infer higher risk for women. Thus, prioritizing mobile women may be a more effective intervention strategy.

## Limitations

Since our study relied on self-reported behavior, the data are prone to recall bias and social desirability bias. We designed the survey and trained interviewers with the goal to reduce these errors. For example, we populated the event history calendar with well-known landmarks to anchor the past 12 months in time, but interviewers also worked with respondents to add additional personal markers, such as a birth or marriage, to help correctly recall time. Secondly, interviewers were trained to establish rapport with respondents and engage in conversation about relationships. Monthly reports of coital frequency were not necessarily filled in linearly, but rather a conversation about typical or atypical months ensued and responses were filled in organically. Questions and responses were addressed interactively with the subject, with the events over the year entered into the survey tool in order of recall related to key milestones (e.g., childbirth and holidays). Responses were also cross-checked with other information in the survey, such as changes in relationship status or holidays. Social desirability bias may have led to underreported coital frequency as well. However, overall monthly coital frequency was remarkably similar for

men and women once adjusted for partnership degree. Lastly, our analytical approach examined changes within individuals over time. Therefore, over- or underreporting levels of coital frequency would not bias our results if they were consistently over- or underreported over time.

## Conclusions

Our findings suggest that associations between short-term mobility and sexual behavior could imply very different risk for men and women. Additionally, the underlying process that influences the relationship is gendered. Our results highlight how travel to a different place may be sufficient to enable additional sex acts for women, who may feel the need to conceal certain types of sexual behavior. Whereas for men, different contexts may not enable behavior since cultural standards do not require concealment. Lastly, the reason and broader temporal context of mobility are necessary to understand in order to reveal whether changes in sexual behavior represent additional risk.

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## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Ethical Approval** The Institutional Review Boards of the University of Washington and University of Ghana approved all procedures. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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

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