The Relationship Between Cell Phone Use and Family Planning: A Multi-Country Longitudinal Study

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Abstract

Cell phones may have a transformative impact on a range of health and development outcomes in low- and middle-income settings, yet little is known about the effect of cell phone ownership on these outcomes- such as those related to fertility and family planning. This is primarily due to limitations of study designs: the existing studies are nearly all cross-sectional, and many have small sample sizes and limited geographic scope. In this research, we use longitudinal panel data from eight countries to identify the effect of cell phone use on fertility and family planning outcomes. These data permit us to address some of the prominent limitation of previous studies: by using representative data (national and/or subnational), we expand on the scope of many previous studies; and the longitudinal panel design permits us to adjust for the way in which women who own phones may be different from those who don't in unobserved characteristics. We also conduct this study in a variety of settings that differ in fertility and family planning profiles to examine whether and how the impact of cell phones may be context specific.

Background

Cell phones may have a transformative impact on a range of health and development outcomes, yet little is known about the effect of cell phone ownership on these outcomes- such as those related to fertility and family planning. Nonetheless, there is substantial investment in promoting use of cell phones: donor agencies like the Bill & Melinda Gates Foundation seek to expand access to various digital services (BMGF 2023), and researchers have touted mobile phones as a vehicle for sustainable development (Rotondi et al. 2020). MHealth already plays a prominent role in health programs and is frequently used for health promotion, facilitating knowledge sharing and behavior change; and to link users to essential sexual and reproductive health (SRH) services such as family planning counseling and services, medical abortion and post-abortion care, and HIV care and treatment (Hampshire et al. 2015; Ippoliti & L'Engle 2017).

In theory, the promise of cell phone use for impacting SRH is well-justified. There are several reasons why one might expect that owning a cell phone could impact women's fertility and family planning outcomes in sub-Saharan Africa (as described in Billari et al. 2020). First, phone ownership facilitates exposure to information from a range of sources, thereby potentially connecting women to information about family planning resources broadly and in her community (social learning) (Fjeldsoe et al. 2009; Walakira et al. 2013). Second, digital technology can connect women to social networking sites like facebook, whatsapp, etc…, and their exposure to family planning and fertility-related behaviors of other women can influence that of their own (i.e., through social influence). Third, the influence could be indirect, in which the phone facilitates access to economic resources, which then in turn impact fertility and family planning outcomes. Finally, ownership of a phone could permit greater flexibility with relationships, both facilitating connections with new partners and allowing regular communication with a partner who is living remotely, both of which could impact fertility and family planning outcomes.

Yet the evidence does not yet support this promise, and the impact of cell phone use on family planning and fertility-related outcomes is not established, for several reasons. First, the effectiveness of programs using cell phones for promoting contraceptive uptake and continuation is mixed; few have shown a sustained impact (Bastawrous et al. 2013), and the challenges in implementing cell phone-based programs have been noted (Babalola et al. 2017). Many of the existing studies have important limitations; many are pilot studies with small sample sizes (Colaci et al. 2016). Among studies that have examined the impact of cell phone use, most have come from a developed context like the United

States, where cell phone ownership is nearly universal, while ownership among women remains low in some settings like rural sub-Saharan Africa (L'Engle et al. 2013). Programs are typically targeted at women who already have cell phones, and these women are different than those who don't in characteristics that are likely related to fertility and family planning outcomes (Babalola et al. 2017). Some have noted the prominent research gaps in the literature on the impact of cell phone use on health and development outcomes (Sonne 2020). So while there appears to be a connection between cell phone ownership and family planning, the relationship does not persist for all features of the cell phone or in all settings, and it's not possible to draw conclusions about the impact of cell phone use on SRH outcomes in low- and middle-income (LMIC) settings.

In this research, we use longitudinal panel data from seven countries in Sub-Saharan Africa (Kenya, the Democratic Republic of Congo, Burkina Faso, Nigeria, Cote d'Ivoire, Uganda, and Niger) to identify the effect of cell phone use on fertility and family planning outcomes. These data permit us to address some of the prominent limitation of previous studies: by using representative data (national and/or subnational), we expand on the scope of many previous studies; and the longitudinal panel design permits us to adjust for the way in which women who own phones may be different from those who don't in unobserved characteristics. We also conduct this study in a variety of settings that differ in fertility and family planning profiles to examine whether and how the impact of cell phones may be context specific.

Methods

Data

We used data from the Performance Monitoring for Action Project (PMA). Since 2013, PMA (known from 2013 to 2019 as "PMA2020") has collected representative data on family planning and contraceptive use in eleven geographies in Africa and Asia. To do so, PMA used multi-stage stratified cluster design to draw a probability sample of households and women of childbearing age. Datasets can be obtained. and a description of the study design and other features are available at the PMA website: www.pmadata.org.

Data collection begins with mapping and listing of all households and health facilities in selected enumeration areas (EAs), after which approximately 35 households are randomly selected. For selected households, the interviewers (which PMA calls "Resident Enumerators", or REs) first administers a

household survey that measures household assets, followed by a survey to all women aged 15–49 within the household that captures family planning-related behaviors. Data are collected on smartphones using Open Data Kit (ODK) as the program for data collection. After the interview is completed, the RE submits the data to a cloud server; these data are aggregated and downloaded by the PMA data management team for regular checks of data quality. Survey instruments are available on the PMA website (at https://www.pmadata.org/data/survey-methodology).

PMA weighted the data to be representative of each geography. The weighting procedures started with adjusting for sampling and non-response in the baseline phase 1 survey. Then, to account for differences in sample composition for women who participate in follow-up surveys and those who don't, PMA used inverse probability weights. PMA also weighted to adjust for the likelihood of responding to the phone survey. More details on these weighting procedures are available on the PMA website.

Starting in 2019, PMA started a new phase of the project that involved a change in study design from repeated cross-sectional to a longitudinal panel. PMA initiated data collection under this phase in the fall of 2019, starting with baseline data collection in Kenya (nationally-representative), Burkina Faso (nationally-representative), the Democratic Republic of Congo (Kinshasa and Kongo Central provinces), and Nigeria (Kano and Lagos states); followed by baseline data collection in Uganda, Cote d'Ivoire, Rajasthan province), and Niger in the fall of 2020. In this analysis, we focus on countries in Sub-Saharan Africa and do not use data from India, due to substantial differences between the cell phone environment in India compared to the other geographies. In addition to information on family planning and contraceptive dynamics, the baseline survey instrument also asked women to consent to follow-up interviews and, if they did, asked for their phone number to facilitate relocation and re-interviews.

Since the baseline survey, PMA has conducted two follow up surveys in each geography, which took place in 2021, 2022, and 2023. PMA has experienced exceptionally low attrition, obtaining over 70 percent of the baseline sample in all geographies (as documented in Anglewicz et al. 2023). PMA also had high response rates to the baseline survey, with less than 2% refusing the survey in each geography.

The countries included in our study vary in key family planning and fertility characteristics: the mCPR ranges from 8.1 percent to 44.2 percent, and long-acting contraceptive method prevalence ranges from 2.6 percent to 31.0 percent (PMA 2023).

Measures

Our primary independent measure of interest is phone ownership among women aged 15 to 49 years old in the PMA survey. This question is phrased as "do you own a phone?" in the survey instrument and is asked in all three phases of PMA data collection.

Our outcome measures include several related to fertility and family planning. The first set capture fertility preferences, including (1) "Now I have some questions about the future. Would you like to have a/another child or would you prefer not to have any / any more children?", with response options of "Have a/another child", "No more/prefer no children", and "Undecided / Don't know", and a follow-up question that asks about the timing of their fertility preferences for those who want more children; and (2) "If you got pregnant now, how would you feel?", with response options ranging from "very happy" to "very unhappy". Our longitudinal design allows us to measure whether their fertility preferences were fulfilled, or their feeling about future pregnancies with pregnancy outcomes. Next, we measure contraceptive use, asked as "Are you or your partner currently doing something or using any method to delay or avoid getting pregnant?" in the PMA survey.

We also include measures to adjust for socioeconomic characteristics that may differ between women who own a phone compared with those who don't, including age (15–24 years; 25–34 years; 35+ years), parity (0 children; 1–2 children; 3–4 children; 5+ children), highest schooling level (none/primary; secondary +), household wealth tertile (lowest; middle; highest), rural/urban residence, and type of partnership (currently married/living with partner or not married but with a partner/boyfriend; not married, no partner/boyfriend).

Analytic Methods

We conduct this analysis in several steps. First, we present the weighted percentages of women owning phones in each context over time, for the three phases of PMA data to date, which will show the extent of change over time in phone ownership. We expect that these percentages will be gradually increasing over time, as cell phones become more widely accessible for women throughout sub-Saharan Africa in particular.

Second, we conduct multivariable regressions in which the dependent variables are the measures of fertility and family planning listed above, and the main independent variable is cell phone ownership. We begin with simple logistic regressions that are cross-sectional, using baseline data from PMA, to establish the association between cell phone ownership and fertility/family planning characteristics.

In settings where cell phone ownership is lower than higher-income settings, ownership is not random but instead is selective based on socioeconomic characteristics like economic status, urban residence, and other characteristics. In Burkina Faso, for example, cell phone owners were wealthier, better-educated, urban residents, and younger (Greenleaf et al. 2019). As a result, any studies looking at the impact of phone ownership on various outcomes would need to account for the selection of particular women into cell phone ownership from the impact of the cell phone. Previously this has been done with statistical techniques that control for characteristics that differ between phone owners and non-owners. But this approach is flawed because women who own phones differ systematically from those who don't in many commonly unobserved characteristics that are associated with fertility and family planning outcomes, like aspirations and ambitions, etc… (Billari et al. 2020). So attempts to statistically reduce bias are likely flawed.

To address this possibility, we use individual level fixed effects regression. The purpose of this step is to account for unmeasured characteristics that are related to both phone ownership and fertility/family planning, since phone ownership likely selects women with specific characteristics. Our covariates represent some of the important factors that affect this relationship but there are likely several sources of unobserved characteristics that we cannot control for, such as genetic composition, risk-taking propensity, charisma, intelligence, or other traits that may affect why some individuals may engage in transfers or migrate. For example, personality characteristics like introversion can be associated with the degree of involvement in social exchange networks (Kawachi and Berkman 2001). To address the possibility of unobserved characteristics that may affect phone ownership and fertility/family planning, we combine all three phases of PMA's longitudinal panel data in each country and use fixed effects models to control for unobserved time-invariant characteristics that could otherwise bias our results.[1]

[1] We also considered random effects models to examine the relationship between shocks and health; and used Hausman tests to compare the fixed and random effects models. Since Hausman tests indicated that random effects would be inappropriate for most models and fixed effects models are less affected by unobservable biases (Allison, 2005), we relied on results of the fixed effects regressions and show only these results.

We include the controls above that are time-varying independent variables. Our complete model can be expressed in the following form:

$$F_{it} = X_{it}\,\beta_1 + P_{it}\,\beta_2 + \alpha_i + \varepsilon_{it},$$

where F_{it} is the fertility and family planning measure of individual *i* at time *t*, X_{it} represents a set of time-varying background characteristics (e.g., marital status, wealth, etc…), α_i is an intercept for each individual, and ε_{it} is the error term. We focus on P_{it}, which represents phone ownership. In this research, we use unbalanced panel data from PMA. We use all three phases of PMA data and include women who were interviewed at least twice between these three phases (so some women were interviewed twice, others three times).

Results

Figure 1 shows the percentages of women owning phones over time in each setting, which reveals several patterns. First, there is substantial variation across settings, ranging from a high of approximately 93% of women in Kenya owning phones in 2022, to a low of 22.3% in Kongo Central in 2019. Second, these percentages change over time, in some cases substantially: there is a particularly large increase between phase 1 and phase 2 in Niger (30.0% to 56.1%). But overall, there are generally consistent increases over time in the percentages of women owning phones.

Table 1a and 1b show multivariable regression results in which the dependent variable is modern contraceptive use, the main independent variable of interest is ownership of a phone (results shaded in grey), with other control variables as age, marital status, number of children, level of education, and rural residence (compared with urban). Results overall show strong and consistent associations between phone ownership and modern contraceptive use in nearly all settings. For example, women who own a phone have 1.95 greater odds of using modern contraception in Kenya, 2.12 greater odds in Cote d'Ivoire, and 1.75 greater odds in DRC- Kongo Central.

However, results from simple cross-sectional analysis is not sufficient to establish a causal relationship between cell phone ownership and contraceptive use. For this, we turn to our fixed effects regressions. But we first conduct random effects regressions, which we compare with the fixed effects results. In Table 2, we show results for Hausman tests, which overall justify our use of fixed effects, as the chi squared tests are statistically significant in all settings except Kano, Nigeria. Still, we justify our use of

fixed effects from a conceptual perspective as well, in that we feel that it's important to a priori adjust for unobserved time-invariant characteristics.

Turning to our fixed and random effects results, we first present regression results for (1) modern contraceptive use, and (2) overall contraceptive use (i.e., including both modern and traditional contraception). We show results in forest plots, with odds ratios and 95% confidence intervals. We show these results for both the unadjusted relationship between cell phone ownership and contraceptive use, and the adjusted relationships that include age, education, marital status, wealth tertile, urban/rural residence, and number of children.

First, for modern contraception, in our random effects regression we find a statistically significant association between cell phone ownership and contraceptive use in seven settings in the adjusted analysis; only in DRC-Kinshasa and Burkina Faso do we not find a significant association. However, in the fixed effects regressions, we find that the relationship is not statistically significant in DRC-Kinshasa and Burkina Faso, as with the random effects; but also in DRC Kongo Central and Niger, there is no significant association. In the other geographies, we find that phone ownership is significantly linked to higher odds of modern contraceptive use.

Unsurprisingly, our results for overall contraceptive use are similar to modern contraception. The random effects results are statistically significant in all geographies except DRC Kinshasa (including Burkina Faso this time), but adjusted fixed effects are significant in Cote d'Ivoire, DRC Kongo Central, Kenya, Nigeria-Kano, and Uganda.

Discussion and Next Steps

These results reinforce previous research that there is indeed an association between fertility/family planning and phone ownership in a range of settings. However, it comes with the caveat that this is merely an association between these items and does not account for the selection of women with different characteristics into phone ownership. As a result, our fixed effects regression results are the natural next step in this research. The data are available for us to conduct these regressions, which will be done in the next few weeks- and for the full set of fertility and family planning related outcomes.

Figures & Tables

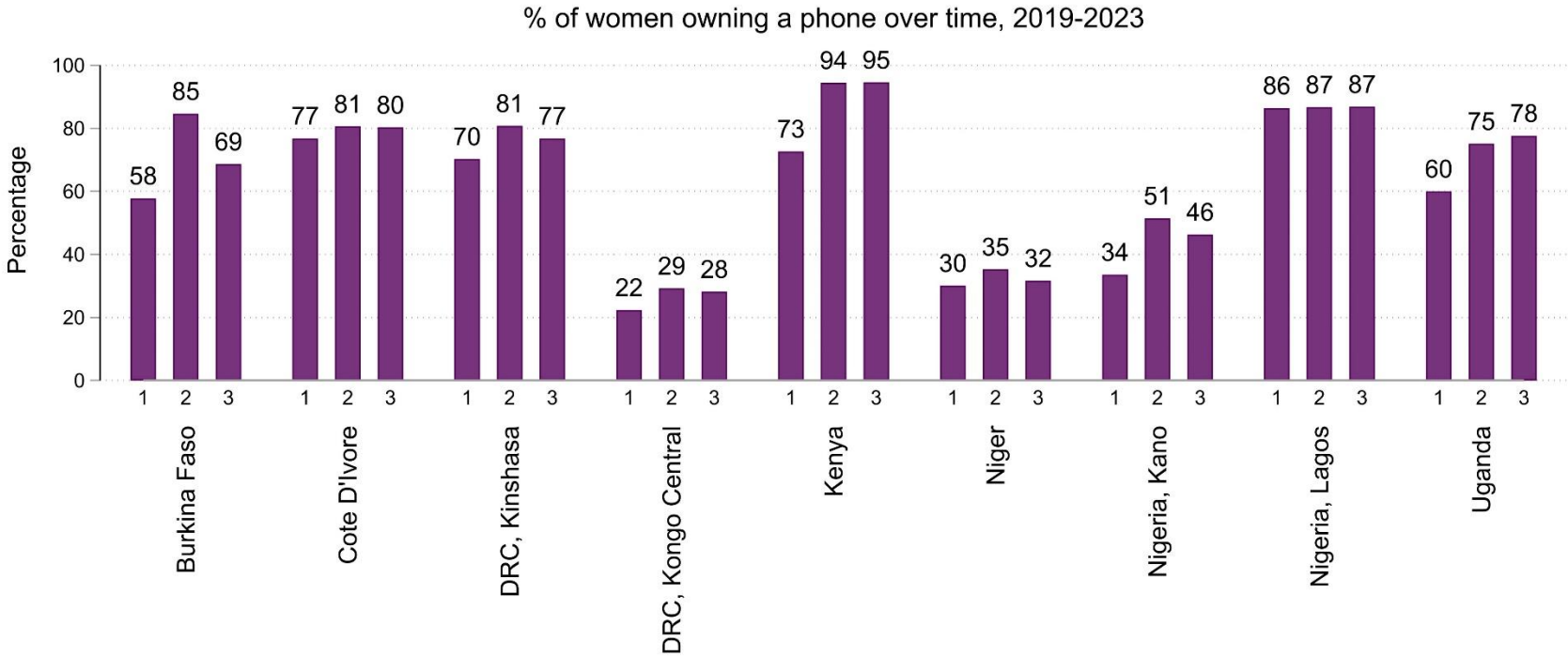


Table 1a: Cross-sectional multivariable regression results for the association between phone ownership and modern contraceptive use, PMA data

	Kenya			Nigeria- Kano			Nigeria- Lagos			DRC- Kinshasa			DRC- Kongo Central		
	OR	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**	
Age															
15-19 (ref)															
20-24	**1.72**	**1.39**	**2.11**	6.48	0.79	53.08	**6.32**	**3.21**	**12.42**	**2.44**	**1.73**	**3.44**	1.11	0.75	1.65
25-29	1.25	0.99	1.57	5.27	0.62	44.62	**3.26**	**1.56**	**6.82**	**2.50**	**1.69**	**3.69**	1.26	0.82	1.95
30-34	1.10	0.86	1.40	6.61	0.75	58.18	**4.51**	**2.09**	**9.73**	**1.77**	**1.15**	**2.73**	0.83	0.51	1.35
35-39	0.84	0.64	1.08	6.14	0.69	55.04	**4.72**	**2.16**	**10.34**	1.09	0.67	1.77	0.78	0.47	1.32
40-44	*0.73*	*0.56*	*0.96*	6.68	0.72	62.29	**3.88**	**1.72**	**8.76**	0.69	0.41	1.15	*0.53*	*0.30*	*0.95*
45-49	**0.35**	**0.26**	**0.47**	1.64	0.15	18.30	1.67	0.68	4.08	**0.36**	**0.19**	**0.67**	*0.26*	*0.13*	*0.51*
Marital status															
Currently married (ref)															
Divorced/widowed	**0.60**	**0.51**	**0.70**				0.90	0.53	1.52	0.81	0.53	1.23	0.84	0.58	1.21
Never married	**0.66**	**0.56**	**0.77**	0.20	0.01	3.39	*1.98*	*1.11*	*3.53*	1.24	0.94	1.64	1.26	0.90	1.77
Number of children															
None (ref)															
1-2	**6.19**	**5.09**	**7.52**	5.46	0.67	44.19	*1.88*	*1.06*	*3.31*	**2.18**	**1.62**	**2.93**	**2.64**	**1.79**	**3.90**
3-5	**10.42**	**8.20**	**13.24**	*9.45*	*1.19*	*74.88*	**4.20**	**2.26**	**7.83**	**3.72**	**2.52**	**5.49**	**2.77**	**1.68**	**4.55**
6+	**10.98**	**8.42**	**14.32**	16.84	2.08	136.29	**4.36**	**2.06**	**9.20**	**5.09**	**3.18**	**8.14**	**4.53**	**2.61**	**7.88**
Level of education															
None (ref)															
Primary	**3.47**	**2.70**	**4.45**	1.27	0.65	2.50	3.98	0.87	18.27	1.08	0.24	4.83	1.37	0.86	2.19
Secondary or higher	**3.60**	**2.77**	**4.68**	**3.21**	**1.67**	**6.19**	*5.11*	*1.17*	*22.39*	0.72	0.16	3.11	**2.18**	**1.39**	**3.42**
Rural residence	**0.85**	**0.77**	**0.94**	**0.30**	**0.18**	**0.51**									
Owns a phone	**1.95**	**1.71**	**2.23**	*1.56*	*0.93*	*2.60*	*1.76*	*1.10*	*2.82*	*1.25*	*1.00*	*1.56*	**1.75**	**1.38**	**2.22**

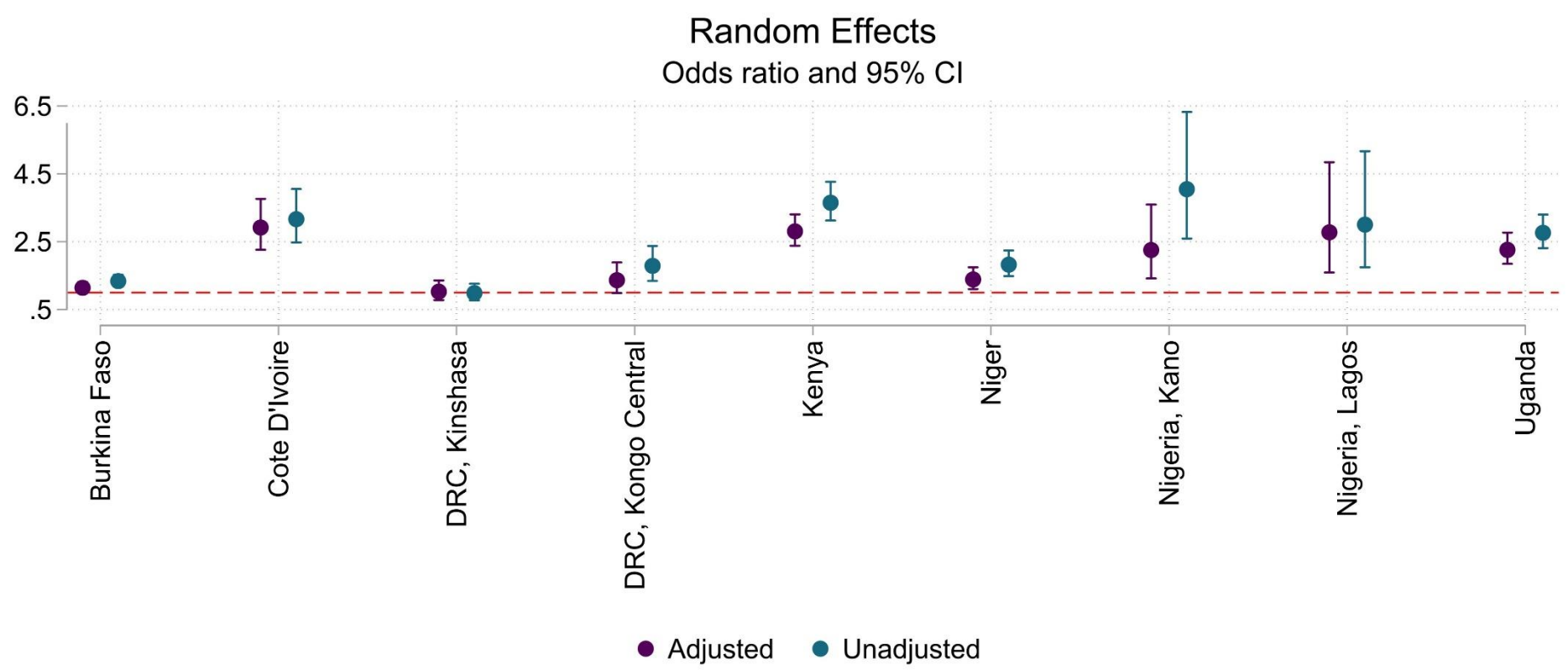
Notes: numbers in bold font are statistically significant at p<0.01; italicized is p<0.05.

Table 1b: Cross-sectional multivariable regression results for the association between phone ownership and modern contraceptive use, PMA data

	Burkina Faso			Niger			Cote d'Ivoire			India- Rajasthan			Uganda		
	OR	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**		**OR**	**95% CI**	
Age															
15-19 (ref)															
20-24	**1.80**	**1.45**	**2.23**	0.78	0.46	1.31	**1.67**	**1.26**	**2.22**	0.95	0.58	1.55	1.14	0.85	1.53
25-29	**1.64**	**1.29**	**2.10**	0.79	0.46	1.35	*1.37*	*1.00*	*1.88*	*1.67*	*1.02*	*2.72*	0.95	0.69	1.33
30-34	**1.43**	**1.10**	**1.86**	0.73	0.41	1.27	0.94	0.66	1.32	**2.85**	**1.73**	**4.70**	*0.66*	*0.46*	*0.96*
35-39	1.01	0.76	1.35	0.60	0.33	1.09	0.92	0.63	1.33	**4.56**	**2.74**	**7.60**	**0.57**	**0.38**	**0.85**
40-44	0.76	0.55	1.03	**0.29**	**0.15**	**0.55**	*0.59*	*0.39*	*0.90*	**3.72**	**2.22**	**6.24**	*0.63*	*0.41*	*0.97*
45-49	*0.66*	*0.47*	*0.93*	**0.18**	**0.08**	**0.41**	**0.30**	**0.18**	**0.51**	**4.16**	**2.44**	**7.11**	**0.39**	**0.25**	**0.63**
Marital status															
Currently married (ref)															
Divorced/widowed	0.78	0.59	1.01	**0.22**	**0.12**	**0.42**	0.94	0.65	1.35	**0.26**	**0.17**	**0.38**	*0.76*	*0.62*	*0.94*
Never married	**1.83**	**1.43**	**2.34**	0.54	0.15	1.92	**1.75**	**1.38**	**2.22**	**0.02**	**0.01**	**0.07**	*0.70*	*0.51*	*0.97*
Number of children															
None (ref)															
1-2	**5.66**	**4.38**	**7.32**	**6.92**	**2.61**	**27.60**	**2.10**	**1.61**	**2.74**	**6.03**	**4.39**	**8.29**	**3.69**	**2.65**	**5.13**
3-5	**9.54**	**7.00**	**13.00**	**13.00**	**2.38**	**54.27**	**4.08**	**2.90**	**5.75**	**8.10**	**5.75**	**11.42**	**5.77**	**3.89**	**8.55**
6+	**12.07**	**8.56**	**17.01**	**12.67**	**1.46**	**53.18**	**6.70**	**4.55**	**9.87**	**6.18**	**4.09**	**9.33**	**6.41**	**4.16**	**9.88**
Level of education															
None (ref)															
Primary	**1.40**	**1.20**	**1.64**	**1.53**	**1.15**	**2.04**	**1.34**	**1.09**	**1.64**	*1.24*	*1.03*	*1.49*	**2.03**	**1.46**	**2.83**
Secondary or higher	**2.17**	**1.84**	**2.56**	**2.13**	**1.60**	**2.84**	**2.26**	**1.82**	**2.80**	**1.42**	**1.18**	**1.71**	**2.20**	**1.54**	**3.14**
Rural residence	**0.70**	**0.61**	**0.80**	**0.39**	**0.30**	**0.50**	*0.83*	*0.70*	*0.99*	*1.21*	*1.04*	*1.41*	**0.77**	**0.66**	**0.91**
Owns a phone	**1.32**	**1.14**	**1.53**	**1.46**	**1.13**	**1.89**	**2.12**	**1.70**	**2.65**	0.96	0.83	1.11	**1.79**	**1.51**	**2.13**

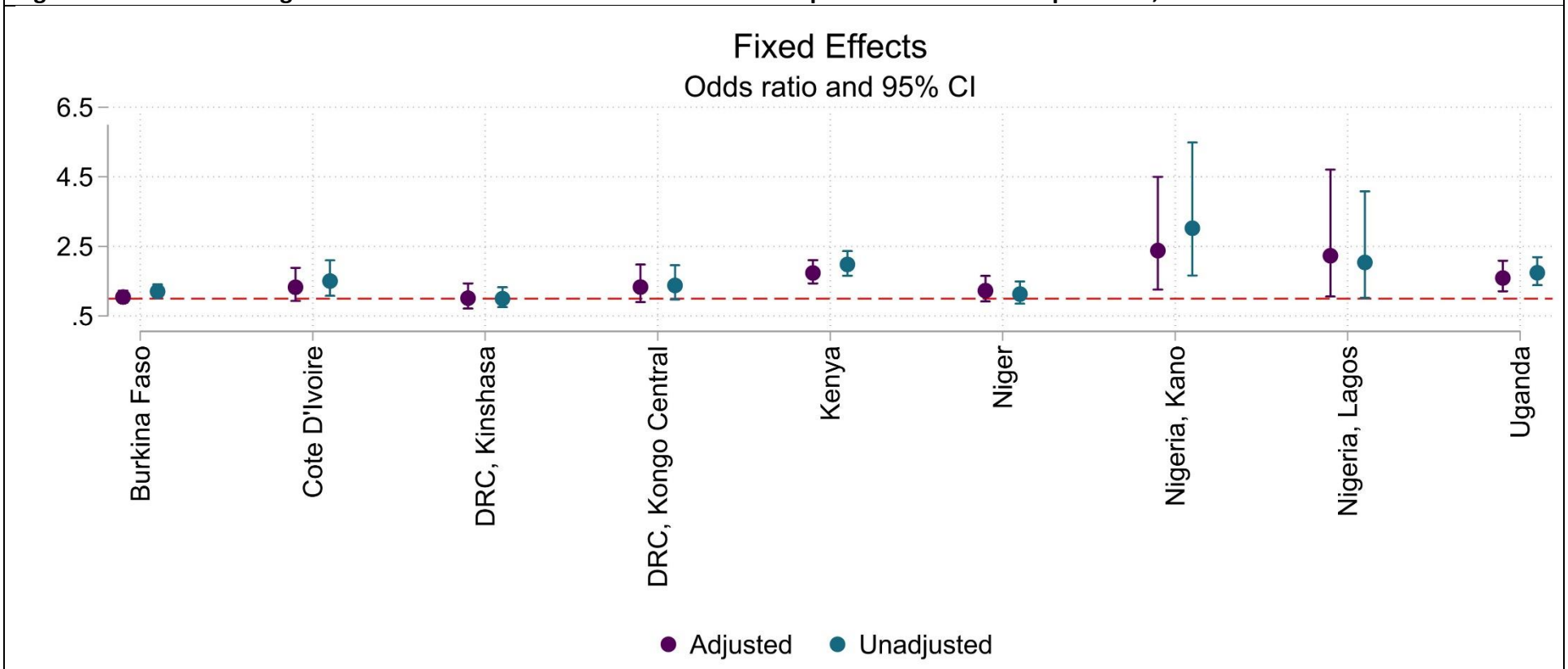
Notes: numbers in bold font are statistically significant at p<0.01; italicized is p<0.05.

Figure 1: Random Effects Regression Results for the Effect of Phone Ownership on Modern Contraceptive Use, PMA 2019-2023



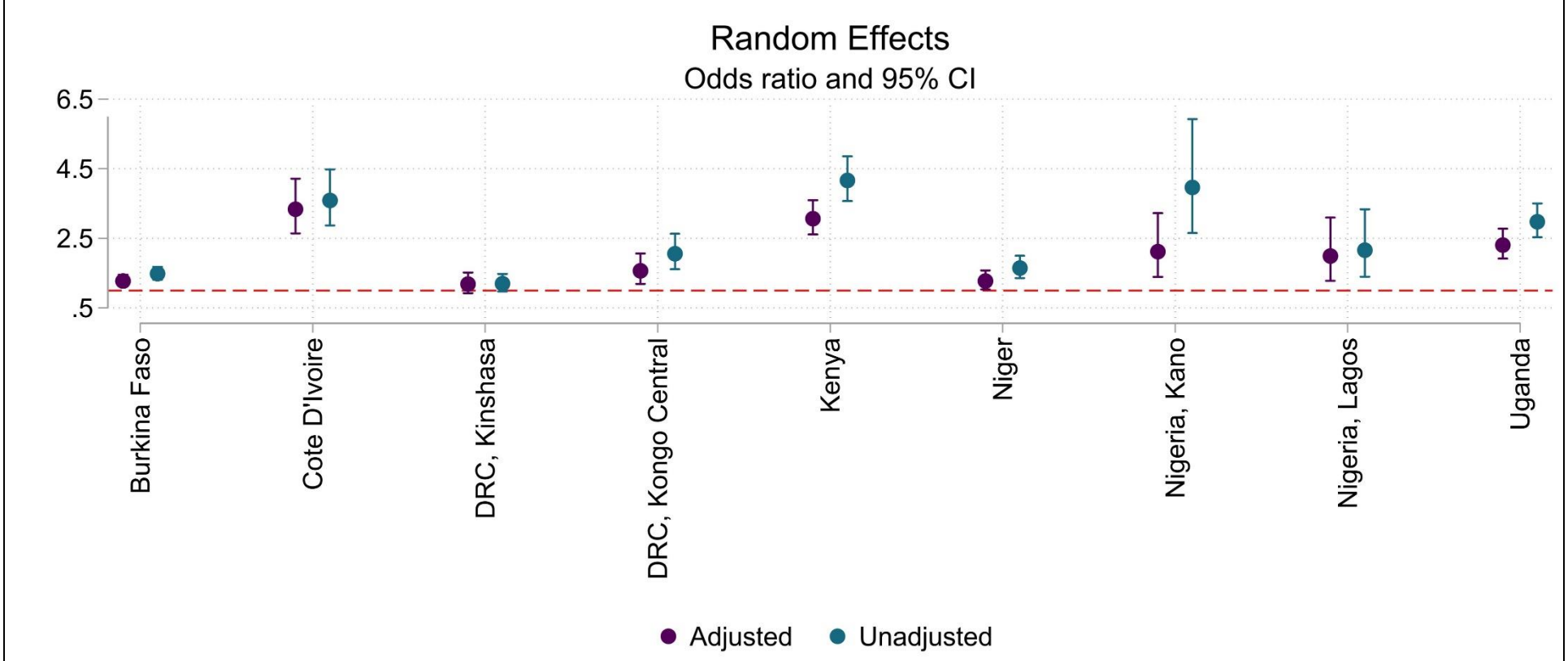
Notes: Estimates are weighted for the complex survey design and lost to follow-up. Adjusted regressions control for age, marital status, number of children, household wealth, and level of education.

Figure 2: Fixed Effects Regression Results for the Effect of Phone Ownership on Modern Contraceptive Use, PMA 2019-2023



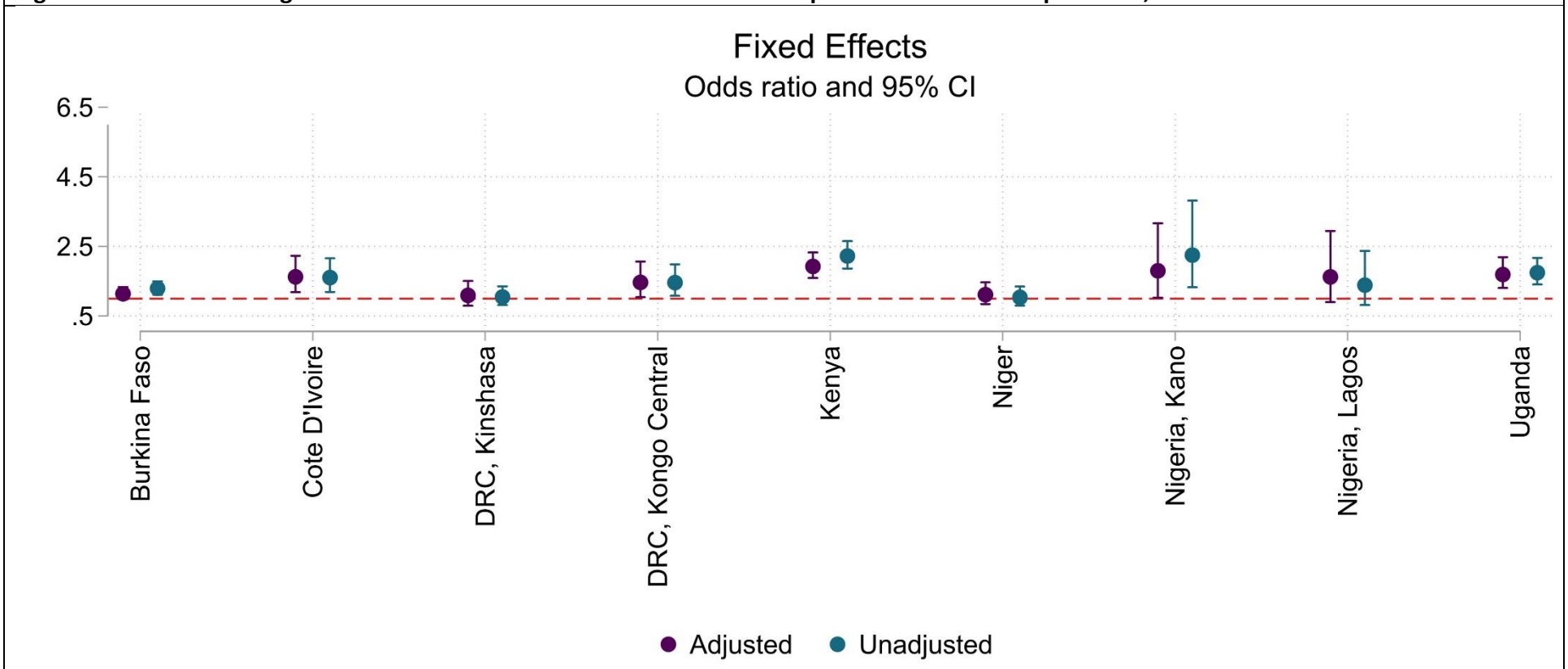
Notes: Estimates are weighted for the complex survey design and lost to follow-up. Adjusted regressions control for age, marital status, number of children, household wealth, and level of education.

Figure 3: Random Effects Regression Results for the Effect of Phone Ownership on Overall Contraceptive Use, PMA 2019-2023



Notes: Estimates are weighted for the complex survey design and lost to follow-up. Adjusted regressions control for age, marital status, number of children, household wealth, and level of education.

Figure 4: Fixed Effects Regression Results for the Effect of Phone Ownership on Overall Contraceptive Use, PMA 2019-2023



Notes: Estimates are weighted for the complex survey design and lost to follow-up. Adjusted regressions control for age, marital status, number of children, household wealth, and level of education.

Table 2: Hausman Test Results for Difference Between Fixed and Random Effects

Geographies	Contraceptive Use		Modern Contraceptive Use	
	P-value	Chi2	P-value	Chi2
Burkina Faso	0.000	50.9	0.000	49.9
Cote D'Ivoire	0.000	124.1	0.000	100.2
DRC, Kinshasa	0.000	37.3	0.000	34.2
DRC, Kongo Central	0.000	44.8	0.000	33.2
Kenya	0.000	198.3	0.000	209.1
Niger	0.000	53.0	0.000	42.8
Nigeria, Kano	0.794	4.7	0.830	4.3
Nigeria, Lagos	0.000	30.7	0.002	24.3
Uganda	0.000	39.5	0.000	65.0

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