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RESEARCH ARTICLE

Timing between age at first sexual intercourse and age at first use of contraception among adolescents and young adults in Niger: What role do education and place of residence play? [version 1; peer review: 2 approved, 1 approved with reservations, 1 not approved]

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Abstract

Background: Low contraceptive use among women in Niger is one of main causes of early childbearing and unwanted pregnancies, which affect maternal and child health. Education and place of residence have been cited as factors affecting modern contraceptive use.

Methods: We investigated the separate and joint effects of the place of residence and education on the time to modern contraceptive uptake among women aged 15-24 in Niger. The study used data from the second round of the 2016 Niger Performance Monitoring and Accountability 2020 (PMA2020) project. Survival analysis was applied for 830 women.

Results: Nelson-Aalen curves show that urban women had higher hazards of (and shorter delays in) modern contraceptive uptake as compared to their rural counterparts. Also, the higher the level of education, the higher the hazards of (and the shorter the delays in) modern contraceptive uptake. Findings from the multivariate (survival) analysis confirms these figures and provides the net effect of the place of residence on modern contraceptive uptake. Whether living in urban or rural areas of Niger, what matters more is the level of education.

Conclusions: Family planning programmes concerning adolescent and young women should focus more on women with no education and those that are illiterate.

Keywords

Education, First sexual intercourse, Niger, place of residence, survival analysis, uptake of modern contraceptive, women aged 15-24

Open Peer Review

Reviewer Status ? ✔ ✔ ✘

	Invited Reviewers			
	1	**2**	**3**	**4**
version 1 published 10 May 2019	? report	✔ report	✔ report	✘ report

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This article is included in the International Conference on Family Planning gateway.

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Author roles: Olakunle AA: Methodology, Writing – Original Draft Preparation; **Banougnin BH**: Conceptualization, Formal Analysis, Methodology

How to cite this article: Olakunle AA and Banougnin BH. **Timing between age at first sexual intercourse and age at first use of contraception among adolescents and young adults in Niger: What role do education and place of residence play? [version 1; peer review: 2 approved, 1 approved with reservations, 1 not approved]** Gates Open Research 2019, **3**:1463 (https://doi.org/10.12688/gatesopenres.12972.1)

First published: 10 May 2019, **3**:1463 (https://doi.org/10.12688/gatesopenres.12972.1)

Introduction

Niger presents worrying characteristics for youth sexual reproductive health. The country has the highest fertility rate as well as the lowest age for marriage and childbearing in Africa and the world (Barroy *et al.*, 2015). With a total fertility rate of 7.6 children per women and a population growth rate of 3.9%, Niger's population has increased from 7,292,000 in 1989 to 21,311,000 in 2018 (United Nations, 2019). Early marriage and, especially, childbearing are the main causes driving the high population growth and fertility in Niger (Nouhou, 2016). In general, early marriage and childbearing is also associated with increased risk of maternal death and new-born death (Gibbs *et al.*, 2012). The 2018 Niger Performance Monitoring and Accountability 2020 (PMA2020) family planning brief reports that more than 70.9% of women aged 18–24 were married by age 18 (INS - Niger, 2018). The brief also reports that one-third of Niger women aged 18–24 had their first birth by age 18. Moreover, estimates from UNICEF (2008) show that a woman's lifetime risk of dying due to complications caused by pregnancy or childbirth was one in seven. This represents 14,000 deaths among Nigerien mothers from pregnancy-related causes. The maternal mortality rate in Niger was 553 per 100,000 live births in 2015 (Roser & Ritchie, 2019b) and the under-five mortality rate was 84.5 deaths per 1,000 live births in 2017 (Roser, 2019a). These figures reflect the poor health of both mother and child in Niger.

One of the major causes of maternal and childhood mortality remains the early age at first birth which typically depends on the age at first sexual intercourse. Evidence has shown that there is an inverse association between age at first sexual intercourse and early childbearing (Gebreselassie & Govindasamy, 2013; Khatiwada *et al.*, 2013; Meekers, 1993; Westoff, 2003). Data from the 2012 Niger Multiple Indicator Cluster Survey (MICS) and Demographic and Health Survey (DHS) show that 28% of women had already had their first sexual intercourse by age 15, and 45% had given birth by age 18 (INS - Niger *et al.*, 2013). These figures are among the highest in sub-Saharan Africa (ICF International, 2018). This is an age at which adolescents are most susceptible to sexually transmitted infections, including HIV/AIDS and human papillomavirus and other health complications (Fagbamigbe *et al.*, 2015). The modern contraceptive is one of the means of promoting good reproductive health, especially among adolescents and young women.

Sub-Saharan Africa has one of the highest rates of teenage pregnancy (Yakubu & Salisu, 2018) and the lowest contraceptive prevalence rates (Radovich *et al.*, 2018) in the world. The low contraceptive use among Niger adolescents (4%) and youths (14%) (ICF International, 2018) is one of the main causes of early childbearing and unwanted pregnancies, which have many consequences including unsafe abortion, high maternal and child mortality and reduced earning potential and educational achievements. This calls for an increasing interest in expanding contraceptive use among adolescents and youths as advocated by the Family Planning 2020 global partnership (Family Planning 2020, 2015).

The research literature has shown that the sooner the use of contraceptive methods, especially modern methods (pill, intrauterine device, injectables, female condom, male condom, female sterilization, male sterilization, implants and lactational amenorrhea), the higher the odds of preventing early childbirth (Abma & Martinez, 2017; Guleria *et al.*, 2017; Shu *et al.*, 2016). Many factors affecting the use of contraceptive methods in the sub-Sahara African context have been observed. Many of them repeatedly cited women's level of education and place of residence as major determinants of contraceptive use (Fawole & Adeoye, 2015; Nair & Devi, 2017; Ochako *et al.*, 2017). Most of these studies have examined the separated effect of the place of residence and education on contraceptive use. Likewise, few studies have been carried out on factors affecting the timing between first sexual intercourse and first use of contraceptive methods. Furthermore, the third target of Sustainable Development Goals (SDGs) aims to reduce maternal mortality and under-five mortality to less than 70 deaths per 100,000 live births and 25 deaths per 1,000 live births (Gostin & Friedman, 2015). There is an expectation that through the use of modern contraceptive methods (from the very first sexual initiation), there will be an improvement in maternal and child health in Niger. This study aims to investigate both separated and joint effects of the place of residence and education on the timing between first sexual intercourse and first use of modern methods of contraception.

Methods
Data
The study draws on data from the Performance Monitoring and Accountability 2020 (PMA2020) project. PMA2020 supports low-cost, rapid-turnaround survey monitoring key indicators for family planning, water, sanitation and hygiene, and other health and development indicators in 11 low to middle income countries (for more details concerning the methods and objectives of PMA2020, see Johns Hopkins University, 2013). The PMA2020 project received approval to collect data from Institutional Review Boards at Johns Hopkins Bloomberg School of Public Health and the Niger Institute of Statistics.

We use data from the second round of Niger PMA2020 survey conducted from February to April 2016 (Performance Monitoring and Accountability 2020 Project, 2016). The 2016 Niger PMA2020 survey used a two-stage cluster sample design with Niamey (the capital city of Niger), urban areas outside of Niamey, and rural areas as strata. This sample design enabled national and sub-national estimates to be produced. The study selected 84 enumeration areas (EAs) based on the 2012 Niger census' sample frame, and randomly selected 35 households within each EA. Then, all resident women of reproductive ages within the sampled households were interviewed. The final dataset included 2,785 households (96.2%) and 3,048 women of reproductive ages (95.5%).

Our study population consisted of 1,238 women aged 15–24 at the time of the survey. Several studies in the areas of sexual and reproductive health have defined young women as those falling within the ages of 15–24 years (Ali & Cleland, 2005; Dellar *et al.*, 2015; Gouws *et al.*, 2008; Lauby & Stark, 1988). Furthermore, young women undergo significant transitions in lifestyle, maturity, and legal rights between these ages; which places them at different vulnerabilities at different time points (Dellar *et al.*, 2015). Of the 1,238 women aged 15–24, 749 (60.5%) had already had their first sexual intercourse. Among these 749 women, we

excluded 31 who reported having their first sexual intercourse before age 4, 26 who did not know when they first had sex, and 18 missing values. This resulted in a sample of 674 young women. From these, 671 were able to provide information on whether and, if so, when they have used a modern method of contraception for the first time. The corresponding weighted number of women aged 15–24 who had ever had sex is 830[1] (69.6% of women aged 15–24). None of the remaining 567 women (who had never had sex or did not give any consistent answer about the experience of the first sexual intercourse) use contraception.

Measures

The 2016 Niger PMA2020 survey questionnaire was extensive and included sections on reproduction, pregnancy and fertility preferences, contraception, sexual activity, menstrual hygiene, and location. In particular, the questionnaire provided data on family planning use, of the type gathered in the Demographic and Health Surveys. Throughout this study, pill, intrauterine device, injectables, female condom, male condom, female sterilization, male sterilization, implants and lactational amenorrhea are referred as modern methods of contraception. The survey also collected information on the respondent's socioeconomic characteristics, including educational attainment, marital status, and location.

The dependent variable of the study is the time to uptake of a modern contraceptive use since the first sexual intercourse. The time to uptake of a modern contraceptive use is calculated in years and is equal to the age at first modern contraceptive use minus the age at first sexual intercourse for modern contraceptive users. For non-users, the time to uptake of a modern contraceptive use is equal to the current age minus the age at first sexual intercourse. PMA2020 survey asks four questions to determine the time to uptake of a modern use: "How old were you when you first had sexual intercourse?", "Have you ever done anything or tried in any way to delay or avoid getting pregnant?", "How old were you when you first used a method to delay or avoid getting pregnant?", and "Which method did you first use to delay or avoid getting pregnant?".

The main independent variables are the place of residence and education. During the 2016 Niger PMA2020 survey, women were asked the following question about their educational attainment: "What is the highest level of school you attended?". The possible response categories to this question were: 'Never attended', 'Primary', 'Secondary', and 'Higher'. Only a very small proportion (0.4%) of young women had a higher level of education. To prevent non-accurate p-value for the test analysis, we combined the 'Secondary' and 'Higher education' categories into one ('Secondary or higher'). The place of residence is divided into two categories: urban and rural areas. As mentioned above, the odds of modern contraceptive use usually depend

(non-exhaustively) on the availability by location (urban/rural residence) and knowledge (education) (Kandala *et al.*, 2015; Kravdal, 2002; Rutenberg *et al.*, 1991). In addition to education and place of residence, other variables (of control) such as age and household wealth tertile. Empirical data point out wealth as affordability factor, and age as confidence-to-buy factor affecting differences in modern contraceptive use across social groups (O'Regan & Thompson, 2017; Wambui *et al.*, 2009).

Analytic methods

We used survival analysis since the main outcome of this study (time to modern contraceptive uptake) is a form of time to event. The survival time is assumed to begin when a woman has her first sexual intercourse until when she starts using modern contraceptives. Young women who have never used any modern contraceptive at the time of interview are right censored as of the date of the survey. Let T be a non-negative random variable representing the duration from first sexual intercourse to modern contraceptive uptake. The subjects at risk are the 671 (830 weighted) women aged 15–24, followed-up since their first sexual intercourse. The observation continues until time t. If a woman has taken up modern contraceptive, the time t is the time of modern contraceptive uptake; otherwise, the time t is the time of the survey (in 2016). The observation ends for a woman at time $T = t$ if she has started using any modern contraceptive method. For example, $T = 0$ if a woman started using modern contraception before one year after her first sexual intercourse. Assuming that T is a continuous random variable with probability density function $f(t)$, the cumulative distribution function (c.d.f), giving the probability that a woman has taken up modern contraceptive by duration t is:

$$F(t) = Prob(T \le t) = \int_0^t f(s)ds \qquad (1)$$

The complement of the c.d.f ($S(t) = 1 - F(t)$), which represents the probability that a woman is yet to take up modern contraceptive by duration t, is the survival function. In this study, we defined the survival function in terms of the hazard function, which is the instantaneous rate of occurrence of the event of interest (here, the uptake of modern contraceptive since first sexual intercourse). The hazard function is defined as:

$$h(t) = \lim_{dt \to 0} \frac{Prob(t < T < t + dt | T > t)}{dt} \qquad (2)$$

The numerator of this expression is the conditional probability that a woman takes up modern contraceptive in the interval $[t, t + dt)$ given that she has not used modern contraceptive before. The denominator is the width of the interval. Dividing one by the other, we obtain a rate of uptake of modern contraceptive per unit of time (i.e. per year). Taking the limit as the width of the interval goes down to zero, we obtain an instantaneous rate of uptake of modern contraceptive.

The survival analysis for this paper proceeded in two steps. First, we used Nelson-Aalen nonparametric estimates of cumulative hazard rate function for the descriptive analysis. Especially, we drew cumulative hazard rate curves of time to modern contraceptive uptake for all women aged 15–24, and by groups

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[1]The PMA2020 sampling design follows DHS' standard, and as described in https://dhsprogram.com/pubs/pdf/DHSG1/Guide_to_DHS_Statistics_DHS-7.pdf, such data must be weighted. The PMA2020 also includes the sampling weight variable. Weighting the female data, the corresponding number of observations is 830.

(stratifying by education and place of residence). We used log-rank tests to test the equality of the cumulative hazard rate functions across groups. Second, we employed (multivariate) Cox semi-parametric proportional-hazards models to predict how the place of residence and education affect the time to uptake of modern contraceptive. The hazard rate in a Cox proportional-hazards model is defined as:

$$h(t|x,\beta) = h_0(t) \exp(x'\beta) \tag{3}$$

where x is the vector of independent variables (education, place of residence, age, and wealth tertile), $h_0(t)$ is the baseline hazard function, and β is the vector of coefficients. The multivariate analysis consisted of three different models. All models

were controlled for age and wealth tertile. The first model (Model 1) presents the effect of the place of residence on the time to uptake of modern contraceptive use. The second model (Model 2) is equal to Model 1 plus the education variable. The third model (Model 3) shows how the interaction between the place and residence and education influences the timing to modern contraceptive uptake. We applied sampling weights for the analysis. Stata 13 was used to analyse the data.

Results

We first report descriptive statistics of the variables used in the analysis in Table 1. Mean age at the first sexual intercourse among women aged 15–24 was 19.7 years. Just under one-quarter (197 out of 830; 23.7%) of the respondents (ever-sexually-active

Table 1. Distribution of factors concerning contraceptive use and demographic variables.

Variable*	Number of weighted observations = 830		
	Percentage	Mean	Std. Dev.
Contraceptive use			
Modern methods	18.7		
Implants	1.8		
Injectables	4.6		
Pill	11.8		
Male condoms	0.6		
Traditional	4.9		
Lactational Amenorrhea Method (LAM)	0.2		
Rhythm	0.1		
Withdrawal	0.1		
Other traditional	4.6		
Total users	23.7		
Nonusers	75.3		
Unknown	1.0		
Place of residence			
Urban	13.6		
Rural	86.4		
Education			
No education	68.3		
Primary	19.5		
Secondary or higher	12.2		
Wealth tertile			
Poorest	33.0		
Middle	31.9		
Richest	35.1		
Age, years		19.7	2.3
Time to modern contraceptive uptake, years [a]		3.0	2.1
Time between first sex and interview date, years [b]		4.4	2.7
Total	100.0		

*No variable contains missing value; [a] For women who have ever used modern contraceptive (18.7%); [b] For women who have never used modern contraceptive (75.3%). Std. Dev., standard deviation.

women aged 15–24) had used contraception. Over three-quarters of (first-time) contraceptive users (156 out of 197) had practiced modern methods. The pill is the most widely used modern method, accounting for more than three-fifths of modern contraceptive use and 11.8% of the respondents. Of all women aged 15–24, very few (0.6%) had used condoms for their first contraceptive experience. Table 1 also indicates that the vast majority of the respondents (86.4%) were living in rural areas. At the time of the survey, only 12.2% of ever-sexually-active women aged 15–24 had attained secondary or higher level of education, whereas more than two-thirds (68.3%) had never attended school. The mean time between first sexual intercourse and first use of modern contraceptive was 3 years with a standard deviation of 2.1 years.

We then compared the incidence rate of modern contraceptive uptake among ever-sexually-active young women by place of residence (Figure 1B) and education (Figure 1C). Figure 1B reveals two important findings. First, the incidence rate of modern contraceptive uptake increases very fast in the first six years after sexual initiation. Between six and eight years post sexual initiation, the incidence rate continues to rise steadily though slower than the first six years. Secondly, the incidence rate of modern contraceptive uptake since sexual initiation was higher among urban women than rural women. In addition, the cumulative hazard curve of modern contraceptive uptake reached its peak faster among urban women (61.8% at the tenth year) than rural women (37.8% at the fourteenth year). As expected, the incidence rate of modern contraceptive uptake is higher
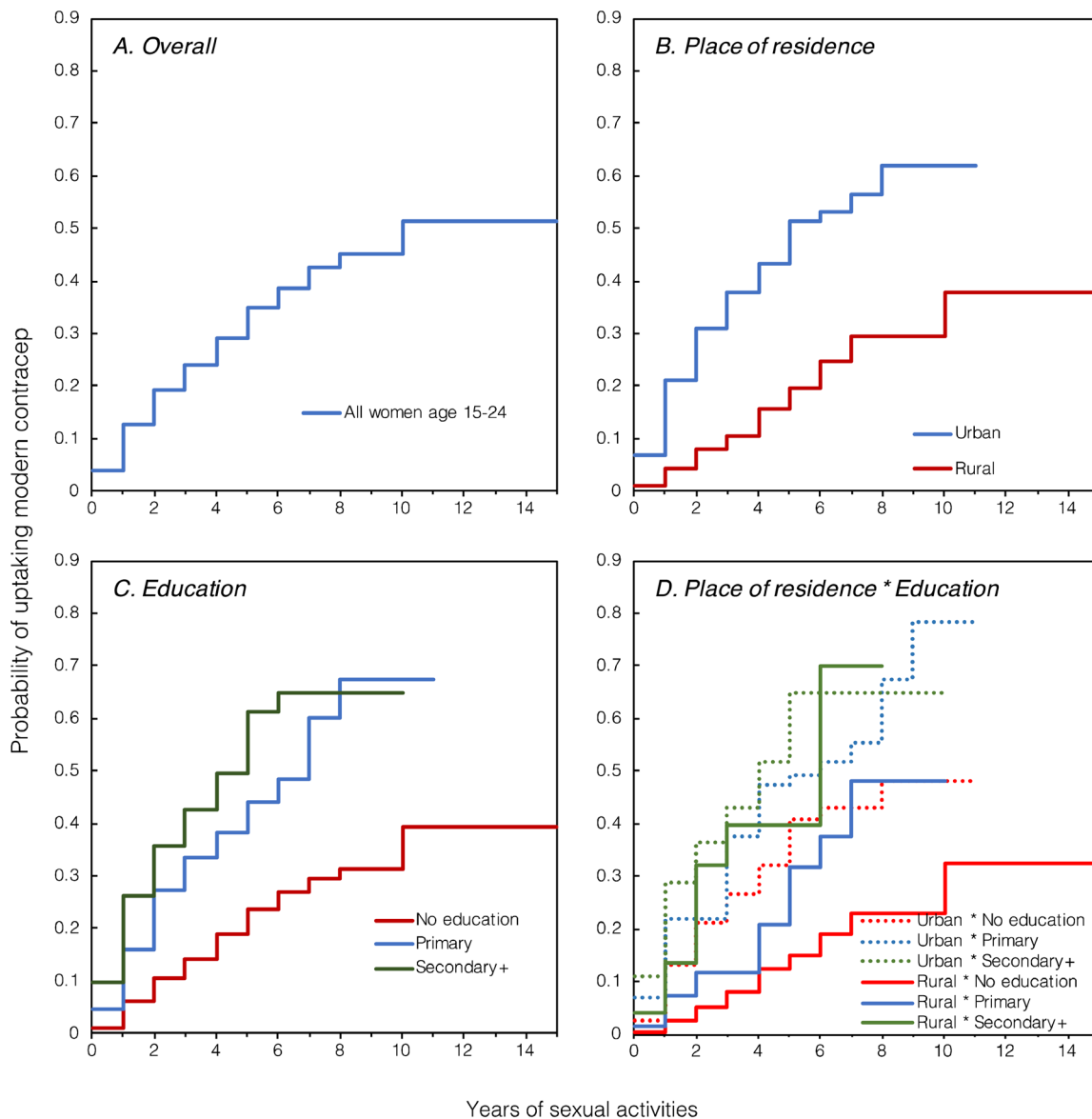

Figure 1. Nelson-Aalen curve showing the cumulative hazard of modern contraceptive uptake among women aged 15–24 in Niger, according to the place of residence and education.

among women with higher education than those with no education (Figure 1C). Also, the higher the educational level, the faster the modern contraceptive uptake. Figure 1D shows how interaction between place of residence and education is associated with the chances of modern contraceptive uptake. Urban women with primary or higher education and rural women secondary or higher education had the highest incidences of and shorter delays in modern contraceptive uptake. The Log-rank test for equality of survival functions shows significant differences in the cumulative hazard function of place of residence and education.

Table 2 presents the results of Cox semi-parametric proportional-hazards models of the effects of the place of residence and education on time to modern contraceptive uptake. We fitted three models for the survival data. Model 1 was restricted to place of residence (with wealth and age as control variables). Significant differences are observed between urban and rural women. The probability of modern contraceptive uptake was 1.73 (95% CI: 1.09–2.73) times higher for urban women as compared with rural women. According to the wealth status, women

in the richest wealth tertile were more than twice as likely to take up modern contraceptive than women in the poorest wealth tertile. The chances of modern contraceptive uptake increased by 11% per one-year increase in age, all other factors being equal.

In Model 2, we introduced education, which was not included in Model 1. There was no significant difference in modern contraceptive uptake between urban and rural women after including education. Findings from Model 2 in Table 2 show that the higher the education the higher the hazard of modern contraceptive initiation. The hazard ratio (HR) of modern contraceptive uptake was higher among women with primary education (HR = 1.80, $p < 0.01$, 95% CI: 1.20–2.72) and women with at least secondary education (HR = 2.30, $p < 0.01$, 95% CI: 1.43–3.70) compared with their peers with no education.

Model 3 included the interaction terms between place of residence and education without the separated variables (education and place of residence). Urban women with primary education had the highest hazard of modern contraceptive uptake (HR = 3.17,

Table 2. Relative risks (hazard ratios) of modern contraceptive uptake among women aged 15–24 in Niger.

Variable	Model 1		Model 2		Model 3	
	HR	(95% CI)	HR	(95% CI)	HR	(95% CI)
Place of residence						
Urban	1.73**	(1.09–2.73)	1.46	(0.92–2.33)		
Rural	1		1			
Education						
No education			1			
Primary			1.80***	(1.20–2.72)		
Secondary or higher			2.30***	(1.43–3.70)		
Place of residence * Education						
Urban * No education					1.72	(0.87–3.40)
Urban * Primary					3.17***	(1.54–6.53)
Urban * Secondary or higher					2.87***	(1.42–5.79)
Rural * No education					1	
Rural * Primary					1.74**	(1.08–2.79)
Rural * Secondary or higher					2.82***	(1.60–4.96)
Wealth tertile						
Poorest	1		1		1	
Middle	1.46	(0.91–2.33)	1.52*	(0.95–2.44)	1.50*	(0.94–2.40)
Richest	2.18***	(1.37–3.49)	1.99***	(1.23–3.22)	1.88**	(1.15–3.08)
Age	1.11**	(1.02–1.21)	1.10**	(1.01–1.21)	1.11**	(1.01–1.21)
Subjects	773					
Time at risk	3,409					
Failures	140					

*p<0.1; **p<0.05; ***p<0.01. HR, hazard ratio; CI, confidence interval.

$p < 0.01$, 95% CI: 1.54–6.53). They are followed by their peers with secondary or higher education (HR = 2.87, $p < 0.01$, 95% CI: 1.42–5.79) and rural women with secondary or higher education (HR = 2.82, $p < 0.01$, 95% CI: 1.60–4.96). Also, women with no education had similar hazard rates of modern contraceptive uptake whether living in urban or rural areas. In other words, the educational status is the most discriminating factor for modern contraceptive uptake.

Discussion
Identifying investments needed to improve family planning programmes in developing countries remains a source of concern for health advocates and professionals, policies makers and funding agencies (Sedgh *et al.*, 2016). Improvement in modern contraception use should enable women—irrespective of their place of residence and socioeconomic status—to prevent reproductive health complications. This study used data from a nationally representative sample of Niger young women (aged 15–24 years) to examine how the place of residence and education, as well as their interaction, affect the time to uptake of modern contraceptives. Findings from the analysis show that residing in urban areas, having a high educational level and living in the richest wealthy tertile are associated with higher hazard rates of and shorter delays in modern contraceptive uptake. Moreover, the hazard ratio of using modern contraceptive among young women also increases with age.

Findings from multivariate (survival) analysis showed a minor effect of the place of residence on the time to modern contraceptive uptake when adjusted for education (and the main control variables: age and wealth tertile). Indeed, the difference between urban and rural women in modern contraceptive uptake become non-significant after adjusting for the level of education. Thus, the level of education seems to counterbalance the effect of increased time to uptake of modern contraceptives among rural women (ages 15–24) in Niger.

Therefore, the positive relationship between education and the hazard rates of modern contraceptive uptake confirms previous work on the association between education and contraceptive use (Khan & Mishra, 2008; O'Regan & Thompson, 2017; Selassie, 2017). Better education is not only positively associated with early use of contraception, but also contributes to empowerment of women (Family Planning 2020, 2014; Tadesse *et al.*, 2013; Tuladhar *et al.*, 2013). Also, women who attend at least a primary level of education (and those who are literate)

are more likely to know about family planning services through media (Fagbamigbe *et al.*, 2015; Shapiro & Tambashe, 1994). Finally, we further our analysis by introducing interaction terms between the place of residence and education. In so doing, statistically significant differences emerged. Urban women with at least primary education and rural women with secondary or higher education have approximatively the same hazards of modern contraceptive uptake. This confirms the key role played by education in modern contraceptive uptake among young women in Niger.

Conclusion
Our results suggest that the delay in modern contraceptive uptake is relatively high. This delay is higher among rural and less educated women than among urban and more educated women. Therefore, adolescents and youths in Niger, especially those living in rural areas and those with a low educational level, are at risk of early childbirth and its consequences. These consequences include among others, child and maternal mortality, school dropout and low participation in the labour market. In consequence, there is a need for policies and programmes that empower adolescents and youths through improving information about the access to, and utilization of reproductive health services. It is necessary to reduce all barriers to access and improve the contraceptive distribution system by integrating family planning activities into national policies on reproductive health with more focus on women with no education.

Data availability
Underlying data used in this study were obtained from PMA2020 (Niger Round 2, 2016) (Performance Monitoring and Accountability 2020 Project, 2016). All PMA2020 datasets are free to download and use, although users are required to register for a PMA2020 dataset account. The request form must include a brief description of the research or analysis that the user would like to conduct using the requested data. Information about the data and terms of use are available here.

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Open Peer Review

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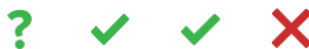
Version 1

Reviewer Report 28 October 2019

✗   **Michael J. Mahande** (iD)

Department of Epidemiology and Biostatistics, Institute of Public Health, Kilimanjaro Christian Medical University College, Moshi, Tanzania

Section
Comment, question, suggestions.
Abstract
1. Well-constructed clear and short abstract.
2. Easily understandable.

Introduction
Background
1. Clear background with enough information.
2. A broader explanation as to what we can't do by not having the data on timing would be important to the readers i.e. what is the knowledge gap?

Objectives
1. It was better to clearly explain what was meant by separate and joint effects of residence and education.

Methodology
1. WHO and UNICEF have standard definitions of adolescent and youths. It would better to use standard references from the WHO/UNICEF rather than citing papers.

2. The information regarding exclusion criteria would have been easier to understand if presented using a flow chart rather than narratives.

3. Why only focus on age and residence as the adjusting variables? What about other independent variables? Such as partner information (age and education levels), Family Planning media exposure, marital status, religion etc? All these have also been shown to affect modern contraceptive use. I am concerned with the aspect of residual confounding caused by leaving these variables out from the analysis.

4. The dependent variable was measured in years. Is it complete years? What if a woman started using a modern method 3 months after her first sexual encounter? How would she be recorded?

5. Do you mean multi-variate or multi-variable analysis? Please check these as they are totally different

6. I have some few concerns with the model building process.
    1. Generally, model 1 should be an empty model containing the crude estimates of an exposure variable on the outcome, in this case a model with education alone or a model with residence alone.

    2. Model 2 continues to start adjusting for other exposure variables and estimating confounding effect when an exposure var results in a 10%- 15% change in the estimates of the primary predictor of interest.

    3. An interaction is looked at based on plausibility of its effect, for instance, do we have reason to believe that modern contraceptive use differs among urban women based on the levels of their education? Similarly, with women residing in rural areas.

    4. Finally, was model diagnostics performed for the Cox-ph models? Was the Ph assumption holding or was it violated?

7. Was the data both st and svyset?

Results

1. In the narratives you mention the frequencies of the variables, these are not shown in table 1. Would be better to present them as well since they are present in your narratives.

2. Would have also been interesting to show during the first sexual encounter, how many women utilized modern contraceptives?, and who are these women? (if this information is available in the dataset).

3. Why was it important to show in table 1 the time between first sexual encounter and the date of interview? What was this information telling the readers?

4. The information on median time to contraceptive use should appear earlier in the narratives since it is of much interest.

5. Please correct the y-axis in figure 1 to say cumulative hazards and not probabilities. Nelson Aalen curves are not probabilities.

6. Please indicate the log-rank p-values on the graphs in order to show the significance difference in modern contraceptive uptake.

7. Most of the interpretations are in-correct. For survival analysis cox Ph models we interpret the "Hazards", and not probabilities/chance/likely. **Please correct this -major comment.**

8. For model 3: Why did you leave out the main effects and only included the interaction term alone? This information is necessary and important.

9. Why focus on a significance level of <0.1 rather than the tradition <0.05 for table 2? Please provide description in the methodology under data analysis section.

10. "In other words, the educational status is the most discriminating factor for modern contraceptive uptake."

    1. Since this is an interaction, it indicates that modern contraceptive use among urban women differs according to their levels of education and similarly, among modern contraceptive use, rural women differs according to their levels of education.

    2. An interaction shows that the outcome among each level of an exposure variable differs across the levels of a third variable.

    3. Which means that residence has an effect on modern contraceptive use differently across education categories.

    4. Had you included the main effects in this model 3, it would also have added some information on the significance of the individual variables.

Discussion
Can be better synthesized to bring out the meaning of the results and their implications to policy and practice.

Strengths and limitations
Missed the section on strengths and limitations of the study.

Conclusion + Recommendations
Conclusion and recommendation were focused on variables which were not assessed in the study i.e. FP media exposure, roles of empowerment of women and removing barriers to access and distribution of modern contraceptives. All these were not measured in the present study.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Partly

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Epidemiology and Biostatistics

I confirm that I have read this submission and believe that I have an appropriate level of expertise to state that I do not consider it to be of an acceptable scientific standard, for reasons outlined above.

Reviewer Report 15 October 2019

https://doi.org/10.21956/gatesopenres.14079.r28038

✔   **Waliu Jawula Salisu** iD

School of Nursing and Midwifery, Tehran University of Medical Sciences, Tehran, Iran

The paper sheds light on the relationship between education and place of residence concerning modern contraceptive use among young women in Niger.

The author's highlight on the gap in the literature however, seems to focus primarily on Sub Saharan Africa rather than the original study context. The gap in the literature that necessitates the study in Niger is unclear. A little emphasis on the literature gap in Niger is needed.

In the results section, the following statement meant to describe Figure 1 seems misleading since it did not feature any percentages on either axis of the figures. "…the cumulative hazard curve of modern contraceptive uptake reached its peak faster among urban women (61.8% at the tenth year) than rural women (37.8% at the fourteenth year)...". I suggest the authors take note and amend it appropriately.

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
I cannot comment. A qualified statistician is required.

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Nursing and Midwifery Education.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 08 July 2019

https://doi.org/10.21956/gatesopenres.14079.r27393

✔️ **Nouhou Abdoul Moumouni**

Organiser l'avancement des solutions au Sahel, L'Initiative OASIS Niger, Niamey, Niger

Model 3 explains the modern contraceptive uptake by the (education)*(place of residence) interaction (controlling by wealth tertile and age). What about the marginal effects of both education and place of the residence in this model? These two factors may still have some marginal effects, something to be checked by adding them into the Model 3, along with the interaction terms (let's call this Model 4). You could estimate this Model 4 and not to include the results in the Table 2, but rather explain and comment them in few sentences (what did you find? What are the implications). If this is not feasible because of a "small sample size" problem (preventing non-accurate p-value), it should be mentioned clearly.

The Model 3 shows that "urban women with primary education had the HIGHEST hazard of modern contraceptive uptake (HR = 3.17, $p < 0.01$, 95% CI: 1.54–6.53)". Indeed, when comparing the different sub-groups from Model 3, the Relative risks (RR) could be ranked as (Urban * Primary) > (Urban * Secondary or higher) =~ (Rural * Secondary or higher). This important result was not sufficiently discussed. According to these results, when a woman attains a secondary or higher education level, the place of residence is of no importance whatsoever when it comes to modern contraceptive uptake. On the other hand, even with a primary level, women living in urban areas have a greater chance of turning to modern contraception faster after their first sexual intercourse. This result highlights an important role of the urban environment (accessibility to methods, quality, confidentiality, etc., see PMA2020 data on the quality of FP services in Niamey and complete the discussions section accordingly).

Is the work clearly and accurately presented and does it cite the current literature?
Yes

Is the study design appropriate and is the work technically sound?
Yes

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Yes

Are all the source data underlying the results available to ensure full reproducibility?
Yes

Are the conclusions drawn adequately supported by the results?
Yes

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Fertility and family planning, statistics, demography

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard.

Reviewer Report 01 July 2019

? **David Lindstrom**
Population Studies Centre, Brown University, Providence, RI, USA

The paper addresses an important topic and the analysis is reasonably constructed, but there are a number of problems with the presentation and interpretation of the results.

1. The purpose of the paper, which is stated at the end of the last paragraph before the Methods section, should appear sooner in the paper. Perhaps, at the end of the first paragraph.

2. For the table with the descriptive statistics, the number of observations with weights should be the same as the unweighted number of observations. Multiplying the weights by the ratio of the unweighted number of observations and the weighted number of observations will preserve the relative differences in the weights and not change the total n.

3. Figure 1 presents cumulative hazards. Cumulative hazards are not probabilities. The vertical axis title should be changed to cumulative hazard. In the text the authors interpret the cumulative hazards as percents - this is not correct).

4. The log rank test is a test of the null hypothesis of no group differences. It is not a test of comparisons between groups when there are more than 2 groups. Rejecting the null hypothesis when there are 3 or more groups means that at least one group is different from the others.

5. The authors interpret the hazard ratios in Table 2 in terms of probabilities. Strictly speaking, the hazard ratio compares two hazards, which are instantaneous failure rates and not necessarily probabilities.

6. The authors find that place of residence is not significant when education is included in the model. Why then are interactions between place of residence and education tested?

7. A proper test of the interactions between place of residence and education would also include the main effects in the model. Including the main effects provides a clearer test of whether there are indeed any significant differences in the effects of education by place of residence than a model that only includes interaction terms.

Is the work clearly and accurately presented and does it cite the current literature?
Partly

Is the study design appropriate and is the work technically sound?
Partly

Are sufficient details of methods and analysis provided to allow replication by others?
Yes

If applicable, is the statistical analysis and its interpretation appropriate?
Partly

Are all the source data underlying the results available to ensure full reproducibility?
Partly

Are the conclusions drawn adequately supported by the results?
Partly

Competing Interests: No competing interests were disclosed.

Reviewer Expertise: Reproductive health, adolescents, migration.

I confirm that I have read this submission and believe that I have an appropriate level of expertise to confirm that it is of an acceptable scientific standard, however I have significant reservations, as outlined above.