ORIGINAL RESEARCH ARTICLE

Using Total Cohort Fertility in Adolescence (TCFA) to analyse adolescent fertility trends and factors in Niger: Evidence from 1992 to 2012 demographic and health surveys

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Abstract

Girls aged 10-19 currently represent 12% of Niger's population (2020). And this number continues to grow as the fertility rate is higher while mortality is declining faster. Using Niger's demographic and health surveys carried out between 1992 and 2012, the study investigated adolescent fertility, its trends and associated factors. It mobilised descriptive methods (Total cohort fertility in adolescence (TCFA) computation, distribution of the number of adolescent births, and computation of adolescent cohort childbearing mean age) and multivariate Logistic and Poisson models. The result shows the TCFA went from 1.29 in 1992 to 1.17 in 2012. Early sexual intercourse and marriage, infant mortality, the desire for a large family, and urbanisation are among the factors significantly associated with adolescent fertility in Niger. The study concludes that the high level of adolescent fertility in Niger does not seem to be changing. *(Afr J Reprod Health 2024; 28 [2]: 13-30).*

Keywords: Adolescent cohort fertility, mean age at adolescent childbearing, fertility trends, early fertility factors, demographic and health surveys, Niger

Résumé

Les adolescentes représentent 12 % de la population Nigerienne (2020). Ce chiffre continue de croître car la fécondité reste elevée alors que la mortalité diminue rapidement. Utilisant les enquêtes démographiques et de santé du Niger entre 1992 et 2012, cette étude s'est intéressée aux tendances et facteurs de la descendance finale à l'adolescence (DFA). Elle a mobilisé des méthodes descriptives (calcul de la DFA, distribution du nombre de naissances adolescentes, calcul de l'âge moyen à la maternité adolescente) et des modèles multivariés de régression logistique et de Poisson. Les résultats montrent que la DFA est passée de 1,29 en 1992 à 1,17 en 2012. Les rapports sexuels et le mariage précoces, la mortalité infantile, le désir d'une famille nombreuse et l'urbanisation sont parmi les facteurs significativement associés à la fécondité adolescente au Niger. L'étude conclut que le niveau élevé de la fécondité des adolescentes au Niger ne semble pas évoluer. *(Afr J Reprod Health 2024; 28 [2]: 13-30).*

Mots-clés: Descendance finale adolescente, Âge moyen à la maternité des adolescentes, Tendances de fécondité, Facteurs de fécondité précoce, Enquêtes démographiques et de santé, Niger

Introduction

Niger is undoubtedly the country with the highest current fertility rate in the world: 7 children per woman on average in 2020[1], 7.6 in 2012[2]. At the same time, mortality (although still high) has fallen significantly, particularly among children[3]. This makes it a country with a young demographic profile: 60% of its population was under 20 in 2020, and 2.87 million are adolescent girls aged 10-19, equivalent to 12% of the total population[4]. The large proportion of adolescent girls (and, of course, adolescent boys as well) poses significant sexual and reproductive health challenges for Niger, where the minimum legal age of marriage is 18 for boys and 15 for girls (2015), and the age of sexual majority is 13[5,6].

Adolescent fertility is a substantial issue in promoting healthy fertility in sub-Saharan Africa, not only because it has consequences for the mother's health[7] but also because there are few health facilities and medical personnel to provide

adequate prenatal and obstetric care for adolescent pregnancies[8]. Adolescent fertility is also subject to other significant challenges, such as poverty[9], school drop-out[10,11], domestic violence[12] and unsafe abortion[13]. However, in Niger, as in many other sub-Saharan countries, adolescent fertility escapes consistent analysis to measure its magnitude and factors effectively. The main reason is the need for more adequate data. Demographic and health surveys (DHS) are often used to measure and serve the purpose well. However, the problem arises with the indicators commonly used, i.e., cross-sectional indicators focused on 15–19-year-olds. The relatively low number of births in this age group means that the corresponding cross-sectional indicators are often difficult to analyse to show reliable dynamics. For example, in Niger, the fertility rate of 15–19-year-olds was 215‰ in 1992, 218‰ in 1998, 199‰ in 2006 and 206‰ in 2012 (https://www.statcompiler.com/fr/). But can these figures be used as a basis for suggesting a drop in adolescent fertility in the country since they do not take into account the under-15s, who are a group that should not be neglected in the context of early marriage in Niger? The cross-sectional fertility rates for 10-14 in the country were 4‰ in 1992 and 6‰ in 2012 (https://www.statcompiler.com/fr/). But again, they can't be used for suggesting a drop as the trend is quiet flat. Is Niger's high fertility rate partly a consequence of the entrenchment of early adolescent fertility as a societal norm? How widespread, early and dynamic is adolescent fertility in Niger? What are the determining factors of adolescent fertility in the country? Approaches to the determinants of adolescent fertility usually use methods that seek to identify the characteristics that distinguish women who have had a child in their teens from those who have not. What could bring a complementary approach that focuses on adolescent mothers only and analyses the factors associated with how often they became mothers during their teenage years?

Some rare studies have shown that it is possible to better understand and analyse adolescent fertility in other ways, for example, by producing cohort indicators using DHSs, such as completed cohort fertility (also called total cohort fertility). However, this longitudinal indicator in its traditional form poses the phase shift problem. It refers to the average number of births (children born alive) per woman in a generation or cohort that has already completed its reproductive life. It informs, but because of a time lag, it is less useful in action research. Even so, suppose it is modified to adolescent fertility. In that case, it can be used to calculate total cohort fertility in adolescence (average number of births per woman in a generation or cohort during the teenage period), which may concern a population for which action can still be taken to influence (in one direction or another) fertility choices during the remaining (post-adolescent) fertility period. This is the interest of this study. Using the Niger DHSs (1992, 1998, 2006 and 2012), it aims first to produce indicators of total cohort fertility in adolescence (10-19 years) for cohorts of young women aged 20-24 years at the time of each survey and to analyse their trends. It then looks at the distribution of women in these cohorts according to the number of births they had during their teenage years. Similarly, the study analyses the cohort mean age at adolescent childbearing and its evolution. Finally, the last objective of this work is to study the factors associated with cohort fertility in adolescence.

Short empirical literature on the determinants of adolescent fertility in Sub-Saharan Africa

Adolescent fertility in sub-Saharan Africa has been the subject of numerous studies in the literature. Its determinants are generally classified into several categories, including demographic, socio-economic, socio-cultural and health factors.

Simplus and Houlio[14] and Jean Simon *et al*.[15] have shown in their respective studies that sexual precocity and early marriage or cohabitation, in a context where contraceptive methods use is low, are factors very strongly associated with adolescent fertility.

Poverty and low socio-economic status are often associated with higher rates of adolescent fertility. Teenage girls from disadvantaged backgrounds have less access to education, reproductive health services and contraception[16]. Moshi and Tilisho[17] have also shown that girls' level of education is inversely related to adolescent fertility. Adolescent girls with limited access to education are more likely to start their sexual lives earlier and to have unplanned pregnancies.

Cultural and social norms are also factors favouring early marriage, but also teenage girls' reproductive decisions. Family pressures could likewise influence adolescent girls' reproductive choices, as shown by Ahinkorah[18].

Another factor is the inadequate knowledge of the ovulatory cycle that can lead adolescent girls, who are the least informed about their menstrual cycle, to misuse contraception and lack control over the risk of unwanted pregnancy[19].

Methods

Data sources

This study used data from four Demographic and Health Surveys (DHS) in Niger: 1992, 1998, 2006, and 2012. The DHSs are retrospective cross-sectional national surveys conducted in many developing countries around the world (https://dhsprogram.com/), and they collect information on several topics, including women's fertility. The main population surveyed is women of childbearing age. The DHS data are divided into several data files, including the *Individual Recode* (IR) file used for this study.

Cohort fertility studies require longitudinal data. Although DHSs are cross-sectional, cohorts can be extracted based on the age of women at the time of the survey (i.e., on years of birth). For each of the four surveys, a cohort of young women who had recently emerged from adolescence was considered. For these cohorts to be meaningful, they included women aged 20-24 at the time of each survey (Table 1).

Table 1: Studied data

Survey year	Size of the cohort of women aged 20 – 24 at the time of the survey	Corresponding birth year cohort
1992	1,234	1968 – 1972
1998	1,372	1974 -1978
2006	1,676	1982 – 1986
2012	1,968	1988 – 1992

Adolescent cohort fertility and mean age at childbearing computation

This study has used two main approaches: trend and factor analysis. The trend analysis involved the following indicators: total cohort fertility in adolescence (TCFA), distribution of women by the number of births in adolescence, and cohort mean age at adolescent childbearing.While the last two indicators are well known, the TCFA should be explained. For a given cohort of women, the TCFA is a ratio of the total number of births during their adolescent period (10-19 for this study) to the total number of cohort members. It can also be obtained by summing the cohort's age-specific fertility rates (f_x^c) in adolescence[20–22].

Note that the definition of the end of adolescence is not a consensus. It is often based on the age of the civil majority, which is 18 in many countries. But for many actors in the field of reproductive health, such as the WHO and DHS program, adolescence covers the age 10 to19: 10-14 is *young* or *early adolescence*; 15-17 is *middle adolescence*; 18-19 is *late adolescence*[23,24].

$$TCFA = \frac{total\ number\ of\ births\ in\ adolescence\ of\ women\ in\ the\ cohort}{total\ number\ of\ women\ in\ the\ cohort} = \sum_{x=10}^{19} f_x^c$$

The mean age at adolescent childbearing was calculated using the following method:

$$Mean\ age\ at\ adolescent\ childbearing = \frac{\sum_{x=10}^{19} f_x^c * x}{\sum_{x=10}^{19} f_x^c}$$

Methods for analysing the factors associated with Total Cohort Fertility in Adolescence in Niger

The factors associated with cohort fertility in adolescence was analysed in two ways. The first examined the factors associated with adolescent fertility (i.e. the associated factors on whether or not they had a birth during adolescence). The second way was the analysis of the factors associated with the number of children born alive during adolescence.

The choice of the explored independent variables was based on rigorous literature while considering the constraints related to the data. The analysis was made using SAS software version 9.4. The univariate analyses were used to process the

data, and bivariate ones to explore the unadjusted relationship between the response and each independent variable. Thereafter, multivariate regressions were used to build the final adjusted models.

- *Logistic regression method*

Logistic Regression is a method using the logit function. This function aims to identify the characteristics that distinguish two groups (in the present case, *adolescent mothers* and *other young women*). It uses a qualitative dependent variable. In concrete terms, Logistic Regression was used in this study to identify the factors that affect the chances of being a mother before 20, all else being equal. For more information on Logistic Regression, see the following link: https://www.sciencedirect.com/topics/computer-science/logistic-regression.

- *Poisson regression method*

It is a generalised linear model with the advantage of nonlinear fitting models. The Poisson model assumes that for a sample of observations, the variance is approximately equal to the mean, which violates the equal variance assumption of classical linear regression. Poisson Regression mainly involves counting data such as the number of children born to a woman. Many researchers[25-27] have already used it to model fertility, which works well. More information on Poisson Regression is given here: https://www.sciencedirect.com/topics/mathematics/poisson-regression.

Results

Trends of total cohort fertility in adolescence (TCFA) in Niger

a. Trends of TCFA

In Niger in 1992, in the 20-24 age cohort, the TCFA was 1.29 (Figure 1). It declined to 1.13 in 1998, 1.08 in 2006 and then increased to 1.17 in 2012. Figure 1 also shows trends in total cohort fertility at ages 18, 17, 16, 15, and under 15. These trends show that the Total Cohort Fertility (TCF) at 18 decreased from 0.98 in 1998 to 0.90 in 2012, the TCF at 17 decreased from 0.73 in 1998 to 0.63 in 2012, the TCF at 16 decreased from 0.49 in 1998 to 0.40 in 2012, the TCF at 15 decreased from 0.28 in 1998 to 0.24 in 2012, and the TCF under-15 decreased from 0.15 in 1998 to 0.11 in 2012. However, these overall downward trends conceal an upward trend for the most recent period covered by this study (2006 to 2012).

Geographic variation in the TCFA in Niger (Figure 2) showed that in 1992, of the eight current regions of the country, only Niamey had a TCFA below 1 (0.75). Six of the other seven regions had a TCFA between 1.25 and 1.50. One region (Maradi) had a TCFA greater than 1.50 (1.66). Analysis of the trends in the TCFA in the country's regions between 1992 and 2012 showed that it decreased significantly in the regions of Agadez (from 1.45 to 0.62), Dosso (from 1.41 to 1.01), Tillaberi (from 1.31 to 1.10), Tahoua (from 1.44 to 1.25), and Niamey (from 0.75 to 0.61). It declined slightly in Maradi (from 1.66 to 1.57) and Zinder (from 1.41 to 1.38). But in the Diffa region, the TCFA went from 1.42 in 1992 to 1.56 in 2012.

b. Distribution of cohort members according to the number of their adolescent births

The box plot (Figure 3.A) on the number of births per woman during adolescence allows to highlight extreme values. For example, for the 1998 survey, a woman in the cohort had 7 births before her 20th birthday. This maximum was 6 births (only one woman was involved) in 1992, 5 in 2006 (4 women were each involved) and 5 in 2012 (4 women were each involved). Of course, the minimum value was 0 children per woman. And Figure 3.B shows that in each of the cohorts, between 30% and 35% of young women had 0 births by age 20, between 30% and 34% had a single birth, about 25% had 2 births, and between 9% and 14% had 3 or more births.

c. Cohort mean age at adolescent childbearing

The mean age at adolescent childbearing (Figure 4.B) was around 17 years old in each cohort (17.1 for the 1992 survey cohort, 17.3 for the 1998 survey cohort, 17.2 for the 2006 and 2012 survey cohorts, respectively). The mean age at first adolescent childbearing was 16.5 years old overall,

Table 2: Analysing the factors associated with cohort fertility in adolescence in two ways

Analysing the factors associated with adolescent fertility	**Analysing the factors associated with the number of children born alive during adolescence**
DEPENDENT VARIABLE	
Whether or not the woman had a birth during her teenage years.	**The number (>0) of children a woman born alive in her adolescence.**
INDEPENDENT VARIABLES EXPLORED	
***Events occurred during the woman's adolescence*:**	
Age at first sexual intercourse, age at first marriage.	Number of dead children, multiple births, age at first sexual intercourse, age at first marriage, and age at first birth.
Woman's socio-demographic characteristics at survey time:	
Ideal number of children, knowledge of the ovulatory cycle, exposure to Family Planning messages through the media, modern contraceptive method use, marital status, education attainment, household wealth index, working status, urban/rural residence, region, and cohort designation variable.	
DATA	
All data in Table 1.	Table 1 data, keeping only women who had at least one birth during their teenage years.
DATA ANALYSIS METHODS	
Univariate analyses, cross-tabulation with Rao-Scott chi-square test, multivariate Logistic regression.	Univariate analyses, ANOVA, bivariate Poisson regression, multivariate Poisson regression.

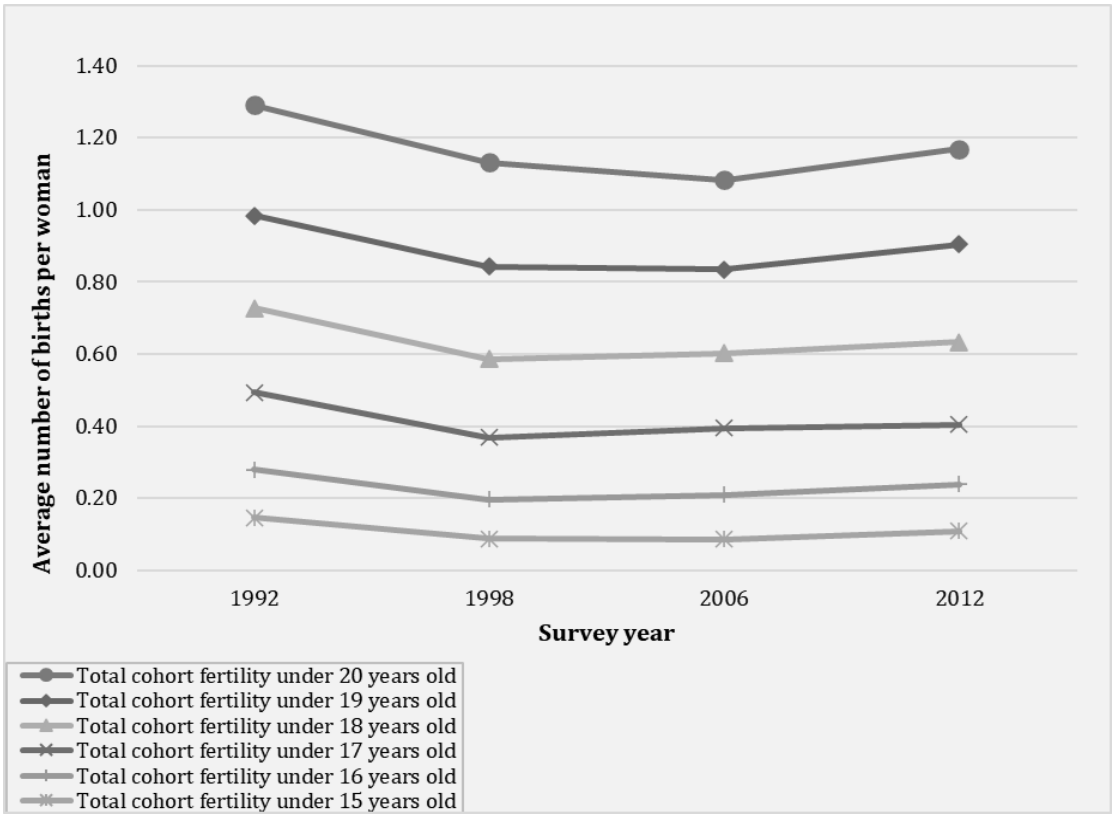

Figure 1: Variation in the total cohort fertility in adolescence in Niger, 1992-2012

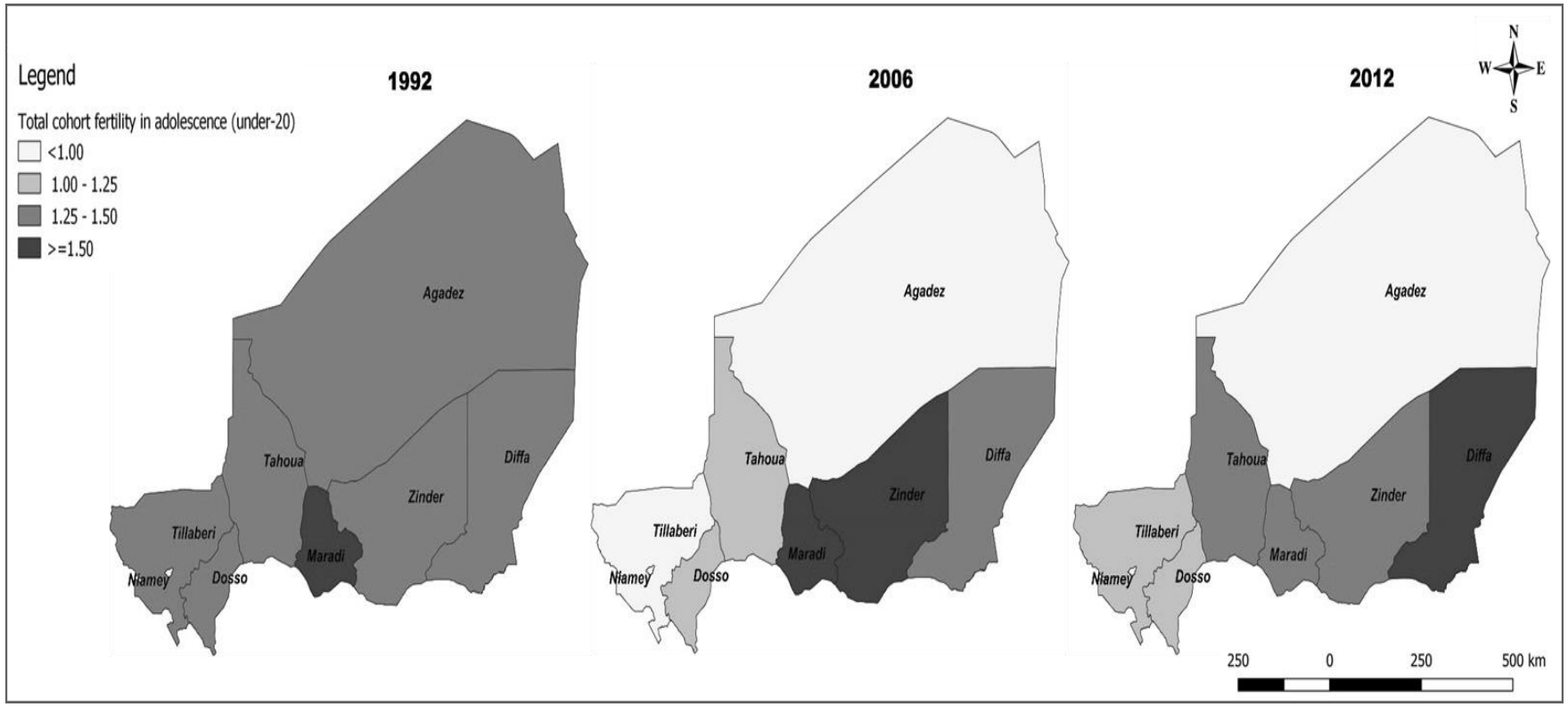

Figure 2: Regional variations in the total cohort fertility in adolescence in Niger, 1992-2012

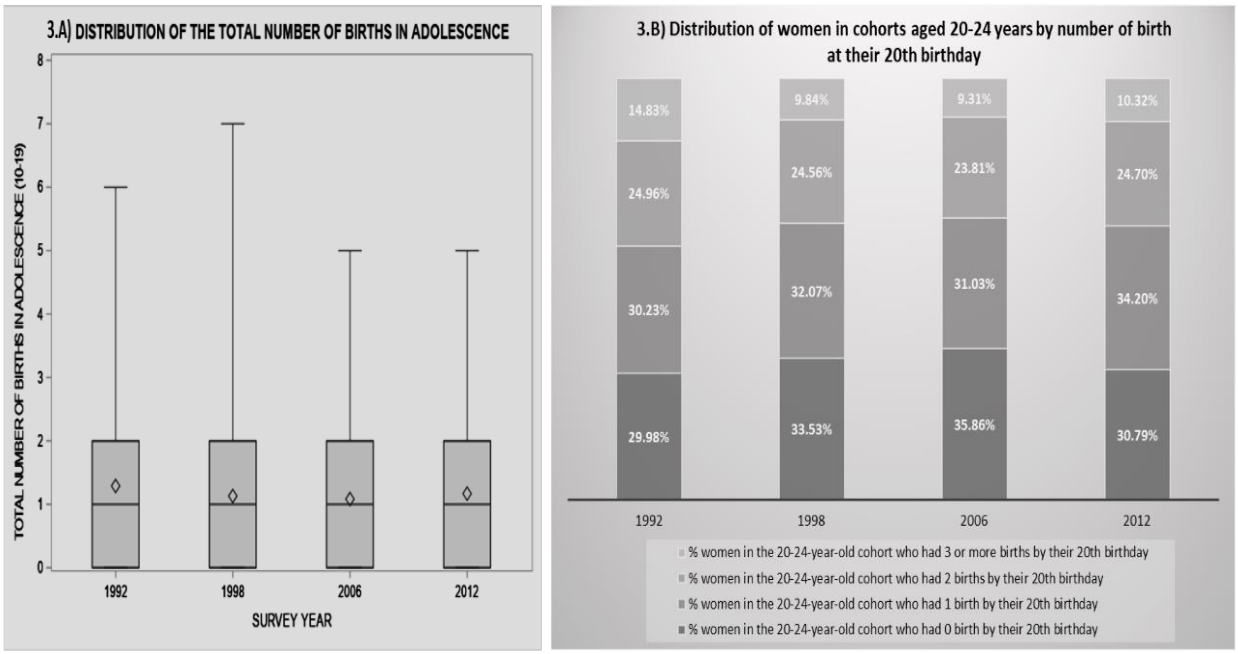

Figure 3: Number of births and cohort members' distributions

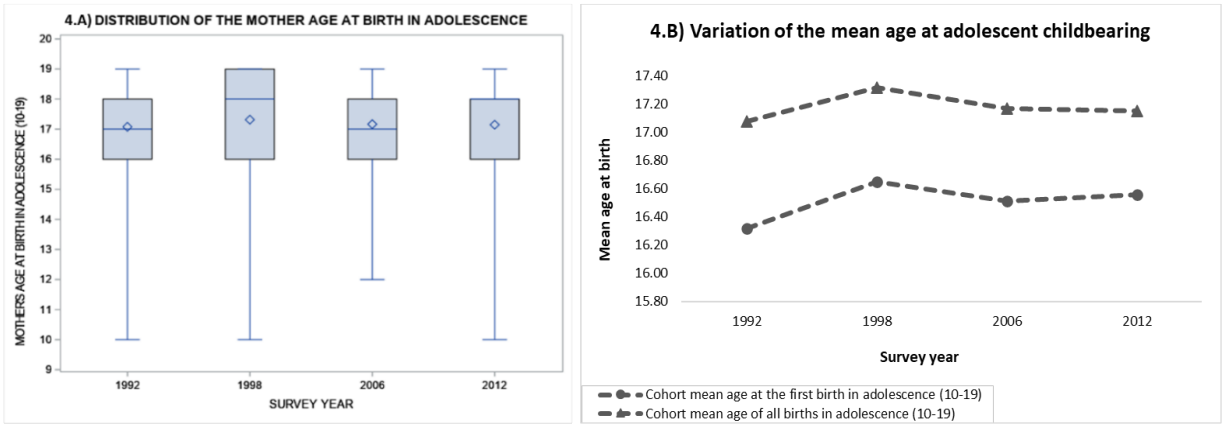

Figure 4: Distribution of the mother's age and variation of mean childbearing age

with 16.3 (the lowest) for the 1992 survey cohort and 16.7 (the highest) for the 1998 survey cohort. Note that for all cohorts combined, the minimum maternal age was 10 years (the maximum was obviously 19 years, i.e., the end of adolescence) (Figure 4.A).

Factors associated with adolescent cohort fertility in Niger

a. Sample description

The sample used to analyse factors associated with having been an adolescent mother or not was made up of 6250 young women aged 20-24 (Table 3) at the time of each survey (20% from the 1992 DHS cohort, 22% from the 1998 DHS cohort, 27% from the 2006 DHS cohort, 31% from the 2012 DHS cohort). In this sample, 67% had births during adolescence. But the sample used to analyse factors associated with the number of births during adolescence was drawn from the previous one. It consisted only of 4213 women (Table 4) who had at least one birth during adolescence (21% from the 1992 DHS cohort, 22% from the 1998 DHS cohort, 26% from the 2006 DHS cohort, 32% from the 2012 DHS cohort). In this second sample, 49% had one birth during adolescence, 36% had two, and 15% had

Table 3: Factors associated with adolescent cohort fertility in Niger (Logistic model)

Variables	N (%)	dds ratio (OR)	95% Confidence Limits		p-Value
Age at 1st sexual intercourse					
<13	443 (7%)	Ref (OR=1.000)			
13	504 (8%)	0.587	0.267	1.291	0.186
14	926 (15%)	0.505	0.238	1.070	0.074
15	1,238 (20%)	0.648	0.305	1.380	0.261
16	707 (11%)	0.536	0.238	1.206	0.132
17	650 (10%)	0.411	0.178	0.948	0.037
18-19	734 (12%)	0.164	0.073	0.369	<.0001
Did not have sex before 20	1,048 (17%)	0.007	0.003	0.017	<.0001
Age at first marriage/union					
<13	497 (8%)	5.730	2.283	14.386	0.0002
13	525 (8%)	9.330	3.491	24.936	<.0001
14	909 (15%)	11.125	4.581	27.015	<.0001
15	1,154 (18%)	5.126	2.208	11.902	0.0001
16	688 (11%)	4.274	1.873	9.751	0.0006
17	598 (10%)	2.535	1.121	5.732	0.0254
18-19	690 (11%)	1.592	0.734	3.450	0.2390
Not married before 20	1,189 (19%)	Ref (OR=1.000)			
Ideal number of children					
3 or less	294 (5%)	Ref (OR=1.000)			
4-6	2047 (33%)	2.222	1.435	3.440	0.0003
7-9	1,342 (21%)	2.867	1.831	4.490	<.0001
10 or more	1,839 (29%)	2.414	1.557	3.741	<.0001
Don't know & Other non-numerical response	728 (12%)	3.525	2.185	5.687	<.0001
Knowledge of the ovulatory cycle					
Correct knowledge	1,049 (17%)	Ref (OR=1.000)			
Questionable knowledge	3,320 (53%)	1.171	0.932	1.471	0.1765
Lack of knowledge	1,881(30%)	0.827	0.648	1.055	0.1262
Knowledge of any contraceptive method					
At least 1 method	5,276 (84%)	Ref (OR=1.000)			
Knows no method	974 (16%)	0.502	0.413	0.611	<.0001
Current use of any contraceptive method					
At least 1 method	752 (12%)	Ref (OR=1.000)			
Use no method	5,498 (88%)	0.632	0.482	0.829	0.0009
Current marital status					
Never in union	853 (14%)	Ref (OR=1.000)			
Married/in union	5,136 (82%)	1.094	0.511	2.341	0.8166
Widowed/Divorced/separated	261 (4%)	0.517	0.227	1.176	0.1156
Type of place of residence					
Urban	2,289 (37%)	1.287	1.029	1.609	0.0273
Rural	3,961 (63%)	Ref (OR=1.000)			
Cohort					
Women aged 20-24 at 1992 DHS	1,234 (20%)	Ref (OR=1.000)			
Women aged 20-24 at 1998 DHS	1,372 (22%)	0.981	0.773	1.244	0.8735
Women aged 20-24 at 2006 DHS	1,676 (27%)	1.499	1.181	1.902	0.0009
Women aged 20-24 at 2012 DHS	1,968 (31%)	1.352	1.075	1.700	0.0099
Total	**6,250 (100%)**				

Table 4: Factors associated with the number of children (>0) born alive during adolescence in Niger (Poisson model)

Variables	N (%)	Incidence rate ratio (IRR)	95% Confidence Limits		p-Value
Number of children died before the mother's 20th birthday (numerical variable)					
		1.169	1.152	1.186	<.0001
Had at least one multiple births before age 20					
Yes	73 (2%)	1.215	1.133	1.303	<.0001
No	4,140 (98%)	Ref (IRR=1.000)			
Age at first marriage/union					
<13	449 (11%)	1.227	1.136	1.325	<.0001
13	482 (11%)	1.181	1.095	1.274	<.0001
14	842 (20%)	1.173	1.090	1.263	<.0001
15	1,024 (24%)	1.148	1.068	1.234	0.0002
16	586 (14%)	1.150	1.069	1.238	0.0002
17	443 (11%)	1.110	1.031	1.194	0.0053
18-19	286 (7%)	1.066	0.992	1.146	0.0826
Not married before 20	101 (2%)	Ref (IRR=1.000)			
Age at first birth					
<13	66 (2%)	Ref (IRR=1.000)			
13	159 (4%)	0.863	0.798	0.933	0.0002
14	340 (8%)	0.781	0.727	0.839	<.0001
15	624 (15%)	0.686	0.639	0.736	<.0001
16	799 (19%)	0.603	0.562	0.647	<.0001
17	810 (19%)	0.487	0.453	0.524	<.0001
18-19	1,411 (33%)	0.363	0.338	0.389	<.0001
Ideal number of children					
3 or less	84 (2%)	Ref (IRR=1.000)			
4-6	1,149 (27%)	1.083	0.992	1.182	0.0740
7-9	1,032 (25%)	1.118	1.024	1.221	0.0124
10 or more	1,391 (33%)	1.108	1.016	1.209	0.0209
Don't know & Other non-numerical response	557 (13%)	1.123	1.027	1.227	0.0112
Current use of any contraceptive method					
Use no method	3,641 (86%)	0.950	0.923	0.978	0.0005
At least 1 method	572 (14%)	Ref (IRR=1.000)			
Highest educational level					
Primary	560 (13%)	1.041	1.010	1.073	0.0099
Secondary or more	191 (5%)	0.983	0.934	1.035	0.5217
No education	3,462 (82%)	Ref (IRR=1.000)			
Region of the country					
Tahoua/Agadez	883 (21%)	1.009	0.967	1.053	0.6785
Zinder/Diffa	966 (23%)	1.035	0.992	1.080	0.1124
Dosso	563 (13%)	0.987	0.945	1.032	0.5745
Maradi	826 (20%)	1.048	1.004	1.093	0.0309
Tillaberi	556 (13%)	0.971	0.927	1.016	0.2011
Niamey	419 (10%)	Ref (IRR=1.000)			
Total	**4,213 (100%)**				

three or more. For conciseness, only the composition of the original sample (6250 women) is described below. 17% of the women in the sample did not have sex before 20 years old, 50% had their first sexual intercourse before age 16, and 33% had it between 16 and 20 years old. 19% of women were unmarried during their teenage years, while 49% entered their first marriage before age 16, and 32% were between 16 and 20. 33% of women were not adolescent mothers, 19% had their first birth before age 16, and

48% had it between 16 and 20 years old. 1.4% of the women have had at least one multiple births (twins or more).

Only 5% of women reported less than three children as the ideal number, 33% reported 4-6 children, 21% reported 7-9 children, 29% reported 10 or more children, and 12% did not give a numerical response. 53% of the women in the study had questionable knowledge of the ovulatory cycle, 30% had poor knowledge, and only 17% had correct knowledge. 84% of the women were aware of at least one modern contraceptive method, while only 12% used at least one method. 14% of the women had never been married or in a union. 82% were married/union, and 4% were widowed, divorced or separated.

Women with no education represented 72%, those with a primary educational level accounted for 15%, and women with a secondary educational level or more represented 13%. The 1992 DHS (representing 20% of the sample) did not collect the information needed to construct a household wealth index comparable to the other surveys. For the other three surveys, 11% of women belonged to very poor households, 13% to poor households, 13% to average households, 15% to rich households, and 28% to very rich households.

In terms of place of residence, 63% of the sample was composed of women living in rural areas, compared to 37% living in urban areas. 22% of the women lived in the Tahoua/Agadez region, 20% in the Zinder/Diffa region, 17% in the Niamey region, 16% in the Maradi region, 13% in the Dosso region, and 13% in the Tillaberi region.

b. Factors associated with being an adolescent mother

- *Some bivariate results*

The Rao-Scott chi-square test (*see crosstabs table in appendix*) of independence revealed the primary relationships between some independent variables and the dependent variable (being an adolescent mother or not).

The precocity of sexual intercourse was associated with adolescent fertility (*p-value <0.0001*), because the age at first sexual intercourse was relatively earlier among adolescent mothers. A similar result was found with age at first marriage (*p-value <0.0001*).

The reported ideal number of children was higher among adolescent mothers than non-adolescent mothers (*p-value <0.0001*).

The share of adolescent mothers was lower among women with correct knowledge of the ovulatory cycle than those with questionable knowledge (*p-value <0.0001*). For women who knew at least one modern contraceptive method, there was a higher proportion of adolescent mothers than those who knew no contraceptive method (*p-value <0.001*). Similarly, the group of women who used at least one modern contraceptive method contained a higher proportion of adolescent mothers than those who did not use any contraceptive method (*p-value <0.0001*).

Regarding current marital status, the cross-tabulations revealed that women in union included a higher proportion of adolescent mothers than widowed/divorced/separated women and single women (*p-value <0.0001*).

Educational level was associated with adolescent fertility (*p-value <0.0001*), with the result that the share of adolescent mothers decreases as the level of education increases.

Among women from very poor, poor, middle-income and rich households, the proportions of adolescent mothers were almost similar. Still, these proportions were all significantly higher than among women from very rich households (*p-value <0.0001*). Regarding employment status, the cross-tabulations found no significant primary relationship (5% statistical significance level) between this variable and adolescent motherhood.

Women living in rural areas compared to urban areas included a higher proportion of adolescent mothers (*p-value <0.001*). A link was also found between the variable *region of the country* and adolescent motherhood. Indeed, among women in the Niamey region, the share of adolescent mothers was very low compared to women in the other regions (*p-value <0.001*).

No significant bivariate relationship (5% statistical significance level) was found between the cohort designation variable and adolescent motherhood, wich mean that there is no evolution of adolescent motherhood over time.

- *Multivariate results*

The results of the multivariate Logistic Regression on whether or not the woman had a birth during her

teenage years are reported in Table 3. They show that the following factors were associated with adolescent fertility in Niger: precocity of sexual intercourse and marriage, high ideal number of children, correct knowledge and use of at least one modern contraceptive method, living in an urban area, and women in recent cohorts.

With 95% confidence, women who had their first sexual intercourse at 17 or 18-19 years of age compared to those who had it before the age of 13 have adjusted odds ratios (*OR*) for adolescent fertility which are 59% (*p-value=0.0372*) and 84% (*p-value <0.0001*) lower respectively. Women who entered into their first marriage (or union) before the age of 13, at 13, at 14, at 15, at 16 or at 17 have adjusted OR for adolescent fertility that are 5.7 (*p-value=0. 0002*), 9.3 (*p-value<0.0001*), 11.1 (*p-value<0.0001*), 5.1 (*p-value=0.0001*), 4.3 (*p-value=0.0006*) and 2.5 (*p-value=0.0254*) times higher than those who were not married before the age of 20.

The adjusted OR for adolescent fertility for women reporting an ideal number of children in the range of 4-6, 7-9, and 10 or more are 2.22 (*p-value=0.0003*), 2.87 (*p-value <0.0001*), and 2.41 (*p-value <0.0001*) times higher, respectively than women reporting an ideal number of 3 or less.

Women who knew at least one modern contraceptive method, as well as those who used at least one method, have adjusted ORs for adolescent fertility that are 50% (*p-value <0.0001*) and 37% (*p-value=0.0009*) higher, respectively, than women who knew no method and those who used none.

The women living in urban areas have adjusted OR for adolescent fertility 1.3 (*p-value=0.0273*) times greater than those living in rural areas.

The cohort of women aged 20-24 in the 2006 DHS and the 2012 DHS have adjusted ORs for adolescent fertility that are 1.50 (*p-value=0.0009*) and 1.35 (*p-value=0.0099*) times higher than those of the 1992 cohort, respectively.

c. Factors associated with the number of children born alive during adolescence

- *Some bivariate results*

Bivariate analyses (ANOVA and bivariate Poisson regression) showed that (*see ANOVA and bivariate Poisson regression tables in appendix*), in the cohorts studied, the following covariates were correlated to the dependent variable (i.e. the number of children born alive in adolescence): the number of children who died during the mother's adolescence (*p-value<0.0001*), having at least one multiple births before 20 (*p-value<0.0001*), age at first sexual intercourse (*p-value<0.0001*), age at first marriage (*p-value<0.0001*), age at first birth (*p-value<0.0001*), the ideal number of children (*p-value<0.0001*), knowledge of the ovulatory cycle (*p-value=0.0030*), knowledge of modern contraceptive method (*p-value<0.0001*), use of a modern contraceptive method (*p-value=0.0232*), current marital status (*p-value<0.0001*), educational level (*p-value<0.0001*), household wealth index (*p-value<0.0001*), working status (*p-value=0.0616*), urban/rural residence (*p-value<0.0001*), region area (*p-value<0.0001*), and the cohort (*p-value<0.0001*).

- *Multivariate results (Poisson Regression)*

In Niger, for women who have been adolescent mothers, the main factors associated with a high number of births during adolescence are child mortality, multiple births (twins or more), age at first marriage/union and first birth, the ideal number of children, modern contraceptive method, educational level, and the country region of residence (Table 4).

The adjusted (all else being equal) incidence rate ratio (IRR) for the number of children who died during the mother's adolescence was 1.17 (*p-value<0.0001*). This indicates that all else being equal, one unit increase in the number of dead children will increase the adolescent cohort fertility rate by about 1.17 times.

Women who had at least one multiple births before 20 (compared to those who had not) were associated with an adjusted IRR of 1.215 (*p-value<0.0001*). Therefore, having had at least one multiple births in adolescence increases the adolescent cohort fertility rate by 1.215 times.

Women who entered into a first marriage/union before the age of 13, at 13, at 14, at 15, at 16, at 17 or at 18-19, compared to those not married before 20, increase the adolescent cohort fertility rate by respectively 1.23 (*p-value<0.0001*), 1.18 (*p-value<0.0001*), 1.17 (*p-value<0.0001*), 1.15 (*p-value=0.0002*), 1.15 (*p-value=0.0002*), 1.11 (*p-value=0.0053*), and 1.07 (*p-value=0.0826*) times. Also, women who had their first birth at 13, 14, 15, 16, 17 or 18-19, compared to those who had it before

the age of 13, reduced the adolescent cohort fertility rate by respectively 0.86 (*p-value=0.0002*), 0.78 (*p-value<0.0001*), 0.69 (*p-value<0.0001*), 0.60 (*p-value<0.0001*), 0.49 (*p-value<0.0001*), and 0.36 (*p-value<0.0001*) times.

Women who report an ideal number of children in the range of 4-6, 7-9, or 10 or more, compared to those who said 3 or fewer, improve the adolescent cohort fertility rate by 1.08 (*p-value=0.0740*), 1.12 (*p-value=0.0124*), and 1.11(*p-value=0.0209*) times, respectively.

Compared to women using at least one modern contraceptive method, those using no method reduced the adolescent cohort fertility rate by 0.950 (*p-value=0.0005*) times.

Compared to those with no education level, women with a primary education level increase the adolescent cohort fertility rate by 1.04 (*p-value=0.0099*) times.

Women living in the Maradi region, compared to those living in the Niamey region, increase adolescent cohort fertility rate by 1.05 (*p-value=0.0309*) times..

Discussion

No real decline over time in adolescent cohort fertility indicators in Niger

Trend analysis showed that in Niger, the average number of births per woman during the teenage period was 1.29 in the cohort of women aged 20-24 at the time of the 1992 DHS. It reduced to 1.13 in the 1998 DHS, then to 1.08 in the 2006 DHS and increased to 1.17 in the 2012 DHS. The share of women who had at least one adolescent birth also did not change significantly over time: 70% in the cohort of women aged 20-24 at the time of the 1992 DHS, 66.5% in the 1998 DHS, 64% in the 2006 DHS and 69% in the 2012 DHS. The multivariate results showed that women in the 2006 and 2012 DHS cohorts are likelier to be adolescent mothers than those in the 1992 DHS. These results are consistent with Garbett *et al*.[23]. In addition to describing a high level of adolescent fertility in Niger, these different results provide information on an established and stable phenomenon. They should be linked to the country's high fertility rate[1]. Some reasons that could explain this situation are the low level of education[28], the context of a patriarchal society that does not favour women's empowerment[29,30], and traditional values that make children social and old age insurance for parents[31,32].

Precocity of sexual intercourse and marriage

The results showed that early sexuality and early marriage are associated with a higher likelihood of adolescent childbearing and an increased number of births during adolescence. Pison[33] and Jean Simon and Tokpa[34] also highlighted the role of these two factors in their studies. In the case of Niger, the results align with family, traditional and religious values on the ban on sex outside marriage, which are said to be more deeply rooted than elsewhere[35]. In addition, the country's legislation supports early marriage, as it sets the minimum legal age of marriage for girls at 15 years (2015), and the sexual majority at 13 years old[5,6]. In this context, marriage is still focalised on its traditional meaning, i.e. connected to sexuality and fertility. For instance, across all cohorts, 70% of the girls in this study had entered their first marriage/union before 18.

The burden of child mortality

Reducing mortality, particularly child mortality, is a prerequisite for a fertility transition[36]. In this study, the results showed that the number of children who died during the mother's adolescence is a factor that significantly increases the number of adolescent births. In the context of no or low fertility control and low birth spacing, like in Niger, dead children are quickly replaced by conceiving others ("replacement fertility")[36]. Also, the perception of high infant mortality is synonymous with procreative behaviour aimed at having as many children as possible, even among adolescent girls. This situation can quickly become a vicious circle between child mortality and early fertility.

Starting young as you want many children

This study's findings have shown that the desire for a large family is an important factor in adolescent fertility in Niger because it increases the number of adolescent births. The results are consistent with MacQuarrie[37], who showed that married young women in West Africa report a higher ideal number of children. These results seem to indicate an element of unconstrained will in the pattern of

adolescent fertility in Niger[35]. Indeed, young girls who want to have a large family see early fertility as a way to achieve this. However, this voluntary choice may result from an "unconscious openness" to values that are religiously and traditionally[38] subtly "imposed".

A counter-intuitive effect of contraception?

Women who knew and those who used at least one modern contraceptive method are more likely to have been adolescent mothers, compared to women who knew no method and those who have used none. In addition, the analysis of the factors associated with the number of children born alive during adolescence found that compared to women using at least one modern contraceptive method, those using no method reduced the adolescent cohort fertility rate. These findings, which appear counter-intuitive, may at first reflect that contraceptive methods are more accessible to married adolescents (who may already be mothers) than to unmarried adolescents[39]. Second, these results may also reflect the retrospective nature of the surveys studied. Indeed, knowledge and use of contraceptive methods are information about the moment of the surveys. Consequently, the results cannot be understood as if knowledge and use of modern contraceptive methods during teenage years increased the chances of being an adolescent mother. Instead, they could be explained by the women's awareness of contraceptive methods after having experienced adolescent motherhood[40].

An urban phenomenon?

While the bivariate results showed that women living in rural areas compared to urban areas included a higher proportion of adolescent mothers, the multivariate analysis went in another direction, indicating that women living in urban areas are more likely to be adolescent mothers, all else being equal. This result is counter-intuitive as most existing work has shown the opposite effect[41,42]. However, similar results was found in Tanzania[17] and among black populations in the USA[43]. How can this result be explained? One possible explanation is the combined effect of migration and urbanisation. Migration and urbanisation can expose adolescent girls to different social and economic environments, which can influence their reproductive behaviour and access to health and reproductive services[44,45].

Strengths and weaknesses

The main strength of this study is the cohort approach to adolescent fertility on a national scale. Using the total cohort fertility approach to analyse adolescent fertility is rare, especially in imperfect data. In addition, this study provided a snapshot of adolescent fertility in Niger. In addition, combining the two multivariate models (the binary logistic model and the Poisson linear regression model) produced robust results on the factors associated with adolescent fertility.

The main limitation is that DHSs are not suited to cohort analysis. Additionally, their cross-sectional and retrospective nature is subject to significant time lag bias between the event studied and the information collected. For example, the use of contraceptive methods by a 24-year-old woman at the time of the survey is not the same as when she gave birth in her teens. In this situation, carefully selecting the data to be studied is essential. This is why this study focused on cohorts of women aged 20-24 at the time of each survey. This ensures that the measurements are as close as possible to the time of the survey and to the time of occurrence of teenage pregnancies.

Conclusions

This study analysed adolescent cohort fertility in Niger, its trends and associated factors. The results showed high adolescent fertility levels with a temporal anchorage. They also showed that early sexual intercourse and marriage, infant mortality, the desire for a large family, and urbanisation are among the factors significantly associated with adolescent fertility in the country. This work was based on national surveys conducted between 1992 and 2012. Therefore, it deserves to be perfected with more recent data, which will be carried out soon, to have a more recent view of the situation. Nevertheless, this research confirms that the high level of fertility in Niger does not seem to be changing sharply. It is taking its time! But the country needs to be on track to put in place the necessary policies to capture the benefits of this large demographic underway and to come.

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Conflicts of interest

None.

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Appendices

Frequency of adolescent childbearing by selected socio-demographic characteristics (Cross-tabulation)

Variables	Had at least one birth before the age of 20		P-value (Pr > Khi-2)
	No (%)	Yes (%)	
Age at 1st sexual intercourse			
<13	40 (8.0)	403 (92.0)	<.0001
13	44 (8.3)	460 (91.7)	
14	73 (8.1)	853 (91.9)	
15	143 (11.8)	1,095 (88.2)	
16	108 (15.2)	599 (84.8)	
17	168 (27.6)	482 (72.4)	
18-19	428 (58.0)	306 (42.0)	
Did not have sex before 20	1,048 (100.0)	0 (0.0)	
Age at first marriage/union			
<13	48 (8.7)	449 (91.3)	<.0001
13	43 (8.2)	482 (91.8)	
14	67 (7.4)	842 (92.6)	
15	130 (11.9)	1,024 (88.1)	
16	102 (15.1)	586 (84.9)	
17	155 (27.9)	443 (72.1)	
18-19	404 (58.0)	286 (42.0)	
Not married before 20	1,088 (92.8)	101 (7.2)	
Ideal number of children			
3 or less	210 (65.3)	84 (34.7)	<.0001
4-6	898 (37.9)	1,149 (62.1)	
7-9	310 (20.3)	1,032 (79.7)	
10 or more	448 (22.2)	1,391 (77.8)	
Don't know & Other non-numerical response	171 (20.1)	557 (79.9)	
Knowledge of the ovulatory cycle			
Correct knowledge	411 (32.8)	638 (67.2)	<.0001
Questionable knowledge	936 (22.8)	2384 (77.2)	
Lack of knowledge	690 (32.0)	1191 (68.0)	
Knowledge of any contraceptive method			
At least 1 method	1,680 (26.2)	3,596 (73.8)	0.0017
Knows no method	357 (31.4)	617 (68.6)	
Current use of any contraceptive method			
At least 1 method	180 (20.4)	572 (79.6)	<.0001
Use no method	1,857 (27.9)	3,641 (72.1)	
Current marital status			
Never in union	777 (92.7)	76 (7.3)	<.0001
Married/in union	1,159 (20.2)	3,977 (79.8)	
Widowed/Divorced/separated	101 (38.1)	160 (61.9)	
Education			
No education	1,060 (21.7)	3,462 (78.3)	<.0001
Primary	381 (33.6)	560 (66.4)	
Secondary or more	596 (70.7)	191 (29.3)	
Household wealth index			
Poorest	148 (20.1)	556 (79.9)	<.0001
Poorer	186 (21.3)	641 (78.7)	
Middle	175 (20.2)	619 (79.8)	
Richer	221 (21.8)	702 (78.2)	
Richest	937 (53)	831 (47)	
1992 DHS: Wealth index not available	370 (24.9)	864 (75.1)	
Currently working			

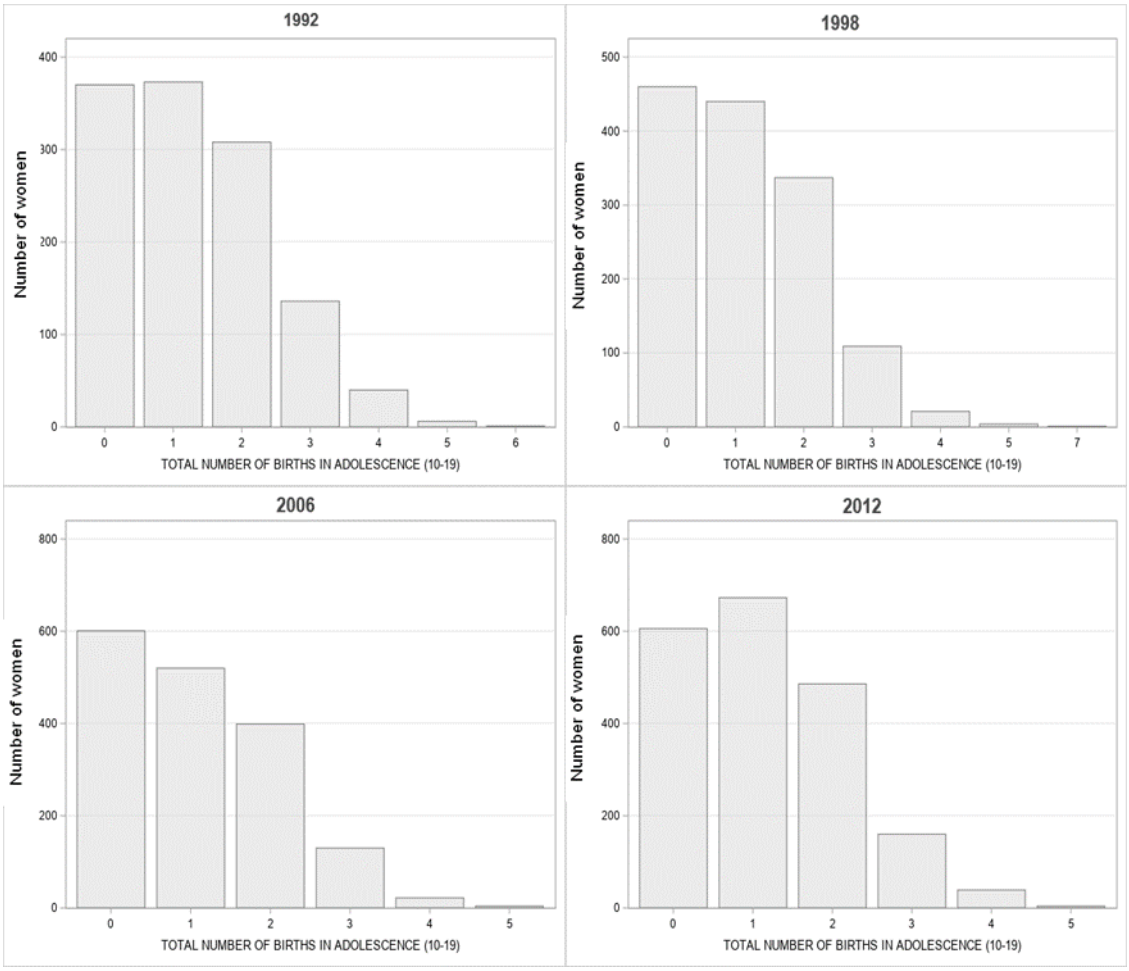
No	1,397 (27.2)	2,934 (72.8)	0.8341
Yes	1,279 (27.0)	1,279 (73.0)	
Type of place of residence			
Urban	1,157 (49.1)	1,132 (50.9)	<.0001
Rural	880 (21.3)	3,081 (78.7)	
Region of the country			
Tahoua/Agadez	466 (27.5)	883 (72.5)	<.0001
Zinder/Diffa	273 (19.3)	966 (80.7)	
Dosso	251 (29.4)	563 (70.6)	
Maradi	171 (15.8)	826 (84.2)	
Tillaberi	256 (29.5)	556 (70.5)	
Niamey	620 (61.2)	419 (38.8)	
Cohort			
Women aged 20-24 at 1992 DHS	370 (24.9)	864 (75.1)	0.0522
Women aged 20-24 at 1998 DHS	460 (29.8)	912 (70.2)	
Women aged 20-24 at 2006 DHS	601 (27.8)	1,075 (72.2)	
Women aged 20-24 at 2012 DHS	606 (26.1)	1,362 (74.9)	
Total	**2,037 (32.6)**	**4,213 (67.4)**	

ANOVA Table

Variables	**Anova Sum of Squares**	**df**	**Mean Square**	**F**	**P**
Had at least one multiple births before age 20	42.43	1	42.43	62.30	<.0001
Age at 1st sexual intercourse	787.97	7	112.57	223.02	<.0001
Age at first marriage/union	783.05	7	111.86	221.11	<.0001
Age at first birth	1624.42	6	270.74	885.46	<.0001
Ideal number of children	53.85	4	13.46	19.83	<.0001
Knowledge of the ovulatory cycle	8.00	2	4.00	5.90	0.003
Knowledge of any contraceptive method	21.12	1	21.12	30.78	<.0001
Current use of any contraceptive method	3.56	1	3.56	5.16	0.023
Current marital status	34.76	2	17.38	25.45	<.0001
Education	52.24	2	26.12	38.47	<.0001
Household wealth index	38.06	5	7.61	11.15	<.0001
Currently working	2.41	1	2.41	3.50	0.062
Type of place of residence	31.02	1	31.02	45.36	<.0001
Region of the country	82.70	5	16.54	24.61	<.0001
Cohort	15.76	3	5.25	7.64	<.0001

Bivariate Poisson regression

Parameter	**df**	**Estimate**	**Standard error**	**95% Confidence Limits**		**Wald Chi-Square**	**Pr>ChiSq**
Intercept	1	0.4328	0.0134	0.4065	0.4592	1037.54	<.0001
Number of children died before the mother's 20th birthday	1	0.3204	0.0148	0.2914	0.3494	468.85	<.0001



Distribution of total number of births in adolescence (10-19)