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Modelling the impact of Ovulatory Cycle Knowledge on the number of children and age of women at first birth

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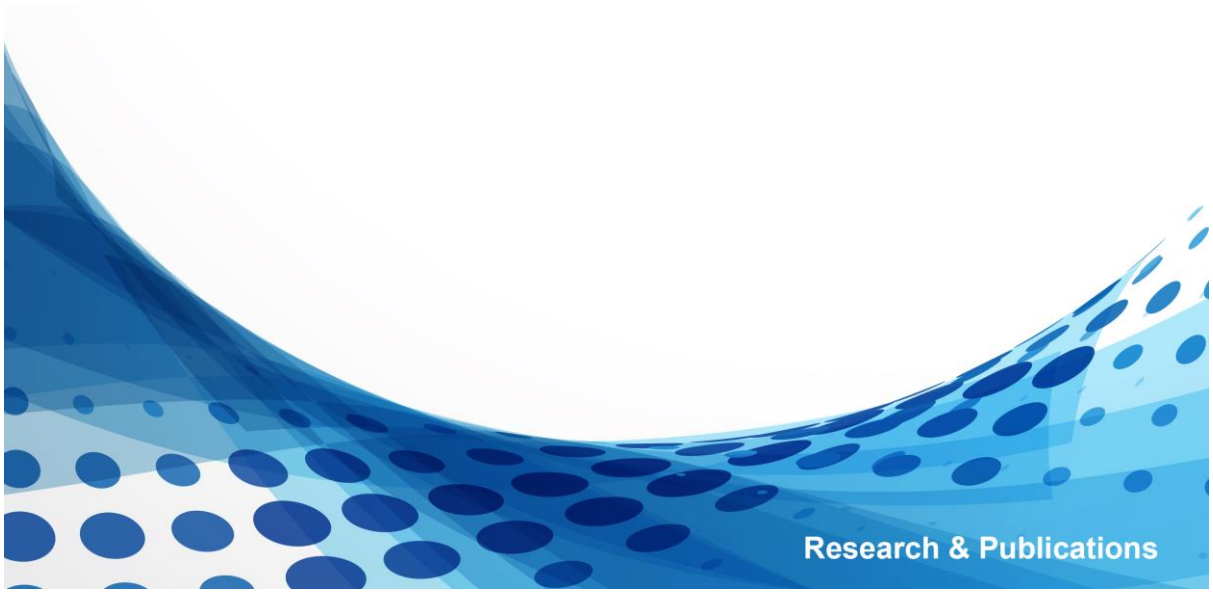

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Abstract

Unplanned pregnancies are an important public health issue, and 15% of unplanned pregnancies across the world happen in India. Ovulatory cycle knowledge (OCK) is an important yet relatively unexplored component in understanding unplanned pregnancies. This study tries to bridge the gap by establishing the causal impact of OCK on the number of children and months to the first birth. We have analysed the data of 459957 women aged 15 to 34 using the Indian Demographic Health Survey for the study. First, a binary logistic regression was used to understand the prevalence and correlates of the OCK. Second, we establish a causal effect of the OCK on the number of children and age of women at the first birth. We consider that OCK is potentially endogenous for both outcomes and instrument it using the average OCK of women above 35 in the same district. Our results establish a causal link and show that OCK is significantly and negatively associated with the number of children and months to the first birth. Governments and policymakers should focus on interventions targeting behavioural change to improve the OCK, especially for girls from disadvantaged socio-economic backgrounds.

Keywords*:* Ovulatory Cycles, Unplanned Pregnancy, Demographic and Health Survey, NFHS-4, India.

1. Introduction

The ovulatory cycle has three phases, i.e., follicular phase, ovulatory phase, and luteal phase. During the ovulatory phase, the egg releases from the ovary. Thus, the ovulatory phase is the fertile time of the menstrual cycle, with the highest chance of pregnancy (Alberda & Simavi, 2018). The knowledge and understanding of the ovulatory cycle by the woman is crucial to her successfully planning for pregnancies. Unfortunately, many women possess limited knowledge about the physiology and hormones associated with the reproductive system (Ayoola et al., 2016). As a result, there are high chances of unplanned pregnancies, which can have severe consequences on women's health and well-being. Understanding the functioning of their reproductive system, i.e., the body's anatomy and ovulation, can help women mitigate unplanned pregnancies (Ayoola et al., 2016). Unplanned pregnancies are prevalent in developed and developing countries, including India, and are recognized as a common public health issue (Gipson et al., 2008). Around 85 million women worldwide face an unplanned pregnancy(Sedgh et al., 2014), and 15% of these cases happen in India(*FP 2020 Core Indicator 2015–16 Summary Sheet*, 2020).

There is a significant lack of ovulatory cycle knowledge among women in India, with around half of the women not aware of ovulatory cycle knowledge before they attain menarche (Garg et al., 2001; Van Eijk et al., 2016). In the Indian context, there are socio-cultural barriers to ovulatory cycle knowledge, leading to poor awareness about fertility time, which has further led to higher levels of unplanned pregnancies(Dunson, 2001; Lampic et al., 2006). While school curricula has been designed to ensure that girls acquire knowledge about menstruation and ovulation, these sexual and reproductive health sessions in school are overly reliant on science-based concepts and do not include practical guidance (Hennegan et al., 2019; Phillips-Howard et al., 2016; Schmitt et al., 2021). Due to lack of formal education, most girls and women acquire the ovulatory cycle knowledge from their mothers and other elderly figures in the home/neighbourhood (Eswi et al., 2012; Van Eijk et al., 2016). Thus, girls and women acquire ovulatory cycle knowledge through these informal channels, i.e., the social networks where women reside. Most women transmit the acquired ovulatory cycle knowledge to their daughters and other women in their families and communities.

Our paper makes multiple contributions to the literature. First, we examine the prevalence and correlates of the ovulatory cycle knowledge. Second, we establish a causal link of the impact of ovulatory cycle knowledge on the number of children and age at birth while controlling for the fact that ovulatory cycle knowledge is potentially endogenous for both of these outcomes. Based on the literature, we use inter-generational knowledge transfer as our instrument for the ovulatory cycle knowledge. We focus on the ovulary cycle knowledge and reproductive outcomes for women in their fertile years, approximated by women aged below 35 years. Our instrument is then estimated by averaging the ovulatory cycle knowledge of women above 35 in the same district. We think our instrument works since knowledge held by older women in the district cannot directly impact the fertility decisions of the individual woman except via having an impact on her ovulatory cycle knowledge. Thus, it fulfils the criteria for a valid IV estimation strategy, i.e., the instrumental variable should affect the dependent variable (the

number of children/ age of women at the first birth) only through its correlation with the endogenous variable (ovulatory cycle knowledge).

The choice of the partners to plan the number of children and time to their first baby birth is a fundamental reproductive right, and lack of reproductive knowledge should not deter this fundamental right. The unavailability of accurate information around pregnancy and sex is a significant factor for the lack of awareness about the ovulatory cycles, leading to a higher number of pregnancies (Lampic et al., 2006). The previous study has shown that women who receive accurate information about ovulation (before they intend to get pregnant) are more likely to delay their pregnancies(Stanford et al., 2002).

Most of the researchers worldwide have focused on exploring the link between unintended and unplanned pregnancies and the use of contraceptives[15–19]. Similarly, studies have shown a strong link between unplanned pregnancies and socio-economic factors(Adhikari et al., 2009; Dutta et al., 2015; Exavery et al., 2014), including education levels, living area, etc. One of the critical factors that can reduce unintended pregnancy is the knowledge around ovulation. However, in schools, either teacher skip this topic, or it is rarely talked about (House et al., 2012). Similarly, very little to no attention is paid to exploring the links around unintended pregnancy and ovulatory cycle knowledge in the research.

Researchers have associated the higher education levels (increased schooling) with the improved levels of the ovulatory cycle knowledge(Dinçer et al., 2014; Getahun & Nigatu, 2020). Improved ovulatory cycle knowledge reduces the odds of getting unintended pregnancy(Habte et al., 2013). However, it doesn't establish a causal impact between the two variables. Therefore, the study's critical component is to provide the updated, and comprehensive evidence on (a) the prevalence of women's understanding of ovulatory cycles and their socio-demographic correlates in India (b) to establish the causal impact of the ovulatory cycle knowledge on the number of children and age of women at the first birth.

The paper next presents data, summary statistics for OCK, reproductive outcomes, and socio-demographic variables in Section 2. In Section 3, we devise an estimation strategy for the determinants of OCK and establish a causal link between OCK and pregnancy outcomes. In Section 4, we present the results for the determinants of OCK and establish the causal link between OCK and pregnancy outcomes. The last section presents the conclusion and policy recommendations.

2. Data

We have used Demographic Health Survey (DHS)- India data (round 4), popularly known as National Family Health Survey-4 (NFHS-4), for the study. NFHS-4 is a nationally representative cross-sectional survey conducted in 2015-16, which gathered information about men aged 15 to 54, women aged 15 to 49, and children below five years. Using a stratified sampling technique, the data is collected on marriage, fertility, nutrition, contraception,

women's reproductive health, sexual behavior, domestic violence, and others. NFHS-4 survey collected data from Jan 2015 to Dec 2016 from 601,509 households and includes data for 699,686 women and 112,122 men. International Institute of Population Studies (IIPS) has published a national report (International Institute for Population Sciences, 2017), which consists of detailed information on the study design, sampling strategy.

For ovulatory cycle-related questions, NFHS-4 provides individual-level data collected from 459,957 women aged 15 to 34.

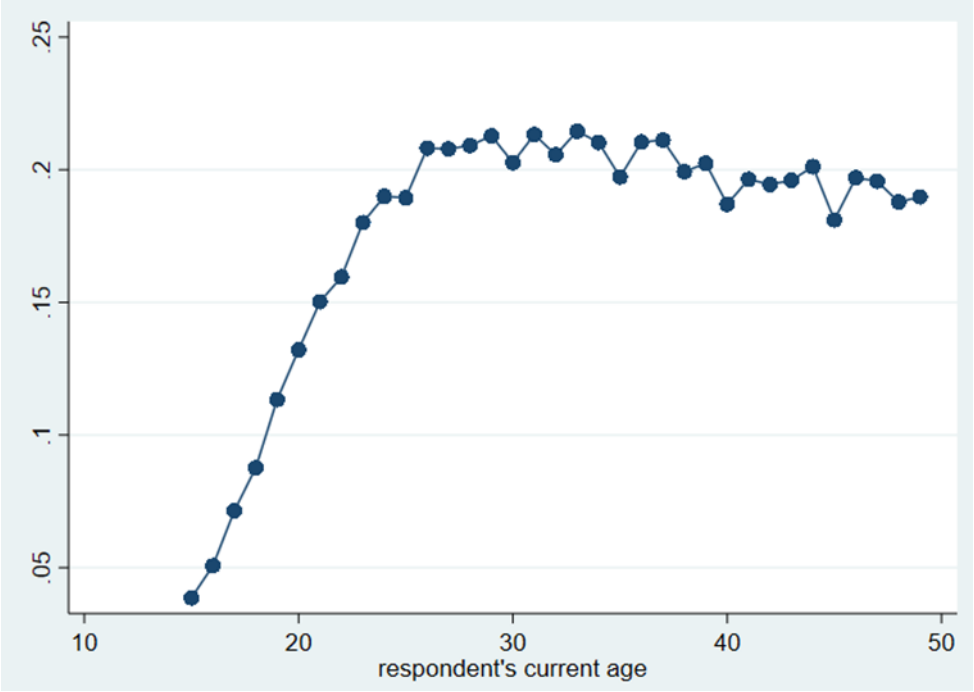
2.1. OCK

The following question has been considered to identify the dependent variable from the NFHS-4 questionnaire.

The question "From one menstrual period to the next, are there certain days when a woman is more likely to become pregnant if she has sexual relations?" has response options 1= Yes, 2= No, 8= Don't Know. If the respondent answers yes, then the next question is asked, "Is this time just before her period begins, during her period, right after her period has ended, or halfway between two periods?" with six response options (1= During her period, 2= After the period ended, 3= Middle of the cycle, 4= Before period begins, 5= At any time, 6= Other, 8= Don't know). The independent variable is also converted into a binary variable, "ovulatory cycle knowledge." It takes the value as "1" if the respondent answers "Middle of the cycle," otherwise "0".

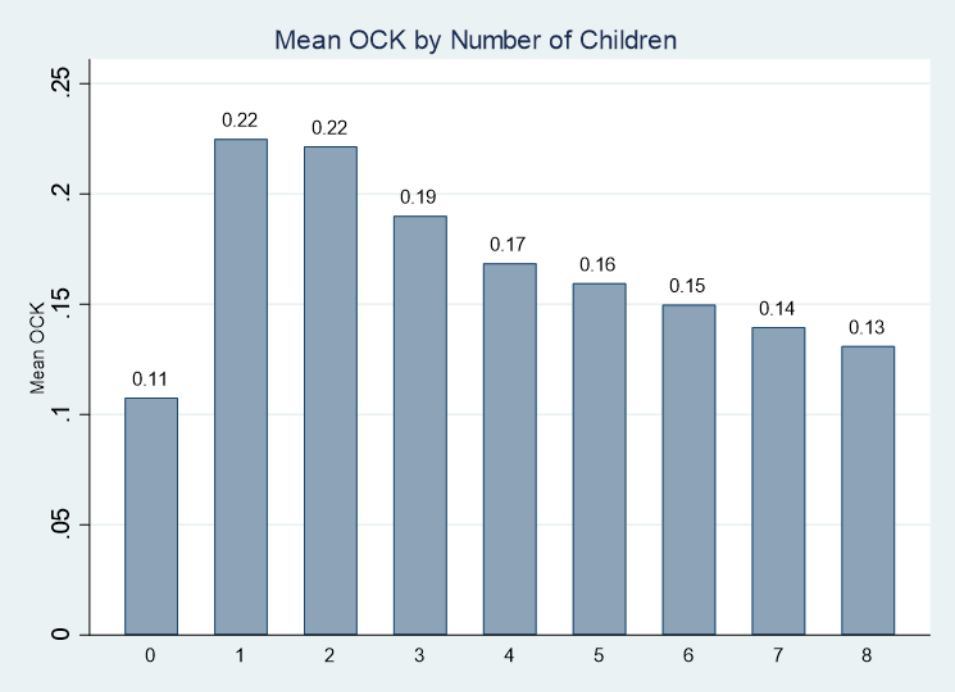
Around 16 percent of women aged 15-34 could correctly identify the ovulatory cycles. Figure 1 shows the ovulatory cycle knowledge by the age. Overall, the ovulatory cycle knowledge is low across all age groups. It starts increasing with age and remains similar after the age of 25. India has one of the highest cases of adolescent pregnancies. It is essential to focus on the rising number of adolescent pregnancies as it has an adverse impact on women’s health. Complications arising during pregnancy and childbirth have become one of the leading causes of adolescent deaths (WHO, 2020). Thus, it is crucial to focus on the formal channels of education around ovulatory cycles as adolescents have abysmal levels of understanding of ovulation.

Figure 1. Mean Ovulatory Cycle Knowledge by Age



National Family Health Survey 4 (NFHS-4) data highlighted the higher-level state variations in understanding ovulatory cycle knowledge. For instance, around 60% of women aged 15-49 in Chandigarh & Punjab have ovulatory cycle knowledge compared to 17% of women at all India level. These higher numbers can perhaps be attributed to midwifery training provided to the middle-class elite women of colonial Punjab in the late 19th and early 20th century(Malhotra, 2003). These midwifery training programs trained women in Punjab with the new hygienic, clean, and scientific practices embodied in the women across the state. Implications of these programs can be seen now with the higher ovulatory cycle knowledge across the state. However, other states fared poorly, and lack of reproductive knowledge is one of the important reasons behind the higher numbers of unplanned pregnancies across the country.

Figure 2. Mean ovulatory cycle knowledge by the number of children



Next, we graphically represent the relationship between ovulatory cycle knowledge and birth outcomes i.e., number of children and age at first birth. Figure 2 shows the mean ovulatory cycle knowledge for the number of children. It offers interesting results. First, ovulatory cycle knowledge is lowest for women with no children, thus, showing lower levels of knowledge among women who are either unmarried or do not have children. Second, ovulatory cycle knowledge increases with the number of children and is highest for women with one or two children. Third, it starts decreasing after the second child as the number of children starts increasing. It indicates that women who are aware of ovulatory cycles might be able to make better fertility decisions. The absence of the ovulatory cycle knowledge is correlated with increasing number of children, thus showing the importance of making women aware of their reproductive physiology.

Figure 3. Mean ovulatory cycle knowledge by age at first birth

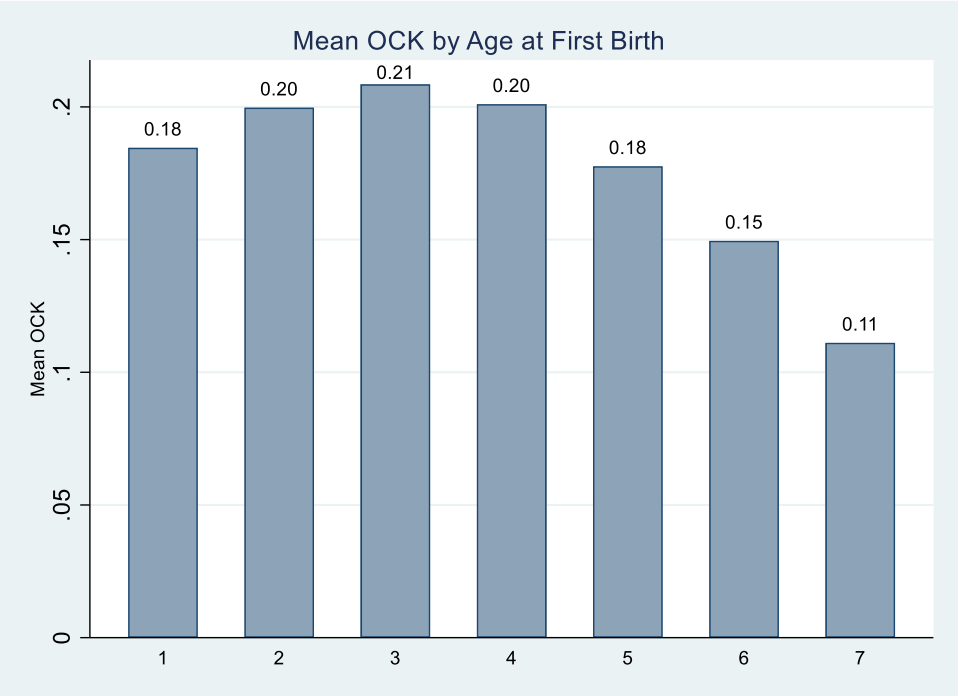


Figure 3 shows the mean ovulatory cycle knowledge by age at first birth across the age groups (groups of 7 starting with 15-19, 20-24 and so on up to 49). First, ovulatory cycle knowledge increases as the age of first birth increases. It is then similar for women whose age at first birth is between 20 and 34, thus, showing that having children post-teenage years is associated with better ovulatory cycle knowledge. Secondly, ovulatory cycle knowledge decreases if the age at first birth is 35 years or more and is lowest for women aged 45-49. Previous studies have shown that there is a strong link between the delayed child birth (post-35 years) and poor knowledge around contraceptives, pregnancy complications and infant outcomes, including low birth weight or pre-mature delivery of infants(Tough et al., 2007).

2.2. Reproductive Outcomes

The following questions have been used to identify the dependent variables from the NFHS-4 questionnaire. The question “Now I would like to ask about all the births you have had during your life. Have you ever given birth?” with options (1= Yes, 2=No). If the respondents answer “yes,” further information is collected on the total number of children living at home, away from home, and those who have died. Thus, the primary outcome variable in our study is the total number of children ever born to women aged 15-34. For robustness checks, we use another variable from the NFHS-4 questionnaire. The questionnaire captures the age of women at the first birth, which is the second dependent variable of our study.

2.3. Socio-Demographic Controls

Studies have suggested the role of socio-cultural factors in understanding the ovulatory cycle knowledge (WHO, 2020). Pregnancies are more likely to occur in socio-economically disadvantaged families, primarily driven by the lack of education and higher poverty levels (*Ending Child Marriage: Progress and Prospects - UNICEF DATA*, 2014). Previous studies have also shown the importance of mass-media exposure in improving the knowledge of the ovulatory cycle (Uddin & Choudhury, 2008). Thus, as a part of this study, we examine these factors to understand the ovulatory cycle knowledge.

We have used several independent variables in this study, divided into three different categories including: Area of living (Urban, Rural), Caste (Scheduled Caste, Scheduled Tribe, Other Backward Classes, General, Don't Know), Wealth (Poorest, Poorer, Middle, Richer, Richest), Religion (Hindu, Muslim, Christian, Sikh, and others), heard/seen about family planning messages on the radio, TV, newspaper, wall (No, Yes), respondent's education level (No education, primary, secondary, higher).

3. Empirical Strategy

3.1. Determinants of OCK

We started our preliminary investigation with the descriptive statistics of the critical study variables. Binary logistic regression was performed to understand the various socio-demographic factors impacting the women's ovulatory cycle knowledge. The study also presents the odds ratio to show our estimates' precision at a 95 percent confidence interval.

3.2. OCK and Pregnancy Outcomes

To understand the causal impact of the ovulatory cycle knowledge on the number of children and months to the first birth, the below-mentioned model was estimated.

$$Y_{ihd} = \beta_0 + \beta_1 OCK_{ihd} + X\theta + \varepsilon_{ihd} \quad \text{--- (1)}$$

where Y_{ihd} denotes the number of children or months to the first birth of women ‘i’ residing in household ‘h’ located in the district ‘d’. The number of children is derived from the survey question on the number of children in the family. The variable OCK_{ihd} denotes the ovulatory cycle knowledge of the woman ‘i’ residing in household ‘h’ located in district ‘d’. β_1 is our coefficient of interest and estimates the association between ovulatory cycle knowledge and the number of children. X is a vector of control that includes socio-demographic and mass-media control variables, as discussed above in the control variable section.

First, the ordinary least square (OLS) regression is implemented to obtain the parameter estimates. However, these estimates may be biased due to the endogeneity issues as age at the first birth and number of children could be determined through other observed factors, including traditional norms and customs in the family. Therefore, two-stage least squares instrumental variables (IV) are carried out to attenuate such concerns and uncover the causal

mechanism underlying ovulatory cycle knowledge and its impact on the number of children and age at the first birth. The second stage regression is based on equation (1) specified above where we use the instrumented value of OCK. The first stage regression is computed using equation (2) as given below:

$$OCK_{ihs} = \beta_2 + \beta_3 Z_d + X\theta' + \varepsilon_{ihd} \quad \text{------- (2)}$$

We consider that ovulatory cycle knowledge is potentially endogenous for both of these outcomes and instrument it. The instrument 'Z_d' is the inter-generational transfer of ovulatory cycle knowledge, and X denotes a similar set of control variables as mentioned under the control variables section.

4. Results

4.1. Descriptive statistics of various socioeconomic factors

The study used data of 459,957 women aged 15 to 34 who participated in the NFHS-4 survey. Descriptive statistics for ovulatory cycle knowledge and ovulatory cycle knowledge by socio-demographics of the women are presented in Table 1. The majority of our sample was Hindu (79.9 percent), 14.7 percent Muslims, 2.21 percent Christians, 1.60 percent Sikh, and the remaining 1.63 percent were from other religions (Buddhist, Jain, Jewish, Parsi, or none). Approximately two-fifths of our sample (45.16 percent) belonged to other backward classes, 21.66 percent to the scheduled caste, 9.80 percent to the scheduled tribe, 22.68 percent to the general category, whereas 0.7 percent of the population the sample participants didn't know their caste. Two-third of our sample live in rural areas, whereas the remaining live in urban areas. Forty percent of our sample came from a poor economic background, 21 percent from middle-class families, whereas 39 percent came from wealthy families.

Table 1. Descriptive Statistics for key variables

Variables	Respondent Characteristics		Ovulatory Cycle Knowledge	
	Number	Percentage (%)	Number	Prevalence (%)
Place of residence				
Urban	154069	33.76%	27309	17.73%
Rural	302253	66.24%	46832	15.49%
Religion				
Hindu	364402	79.86%	56919	15.62%
Muslim	67092	14.70%	10419	15.53%
Christian	10092	2.21%	1676	16.61%
Sikh	7292	1.60%	3679	50.44%
Others	7443	1.63%	1448	19.45%
Caste				
Scheduled Caste	95069	21.66%	15357	16.15%

Scheduled Tribe	43007	09.80%	5700	13.26%
OBC	198210	45.16%	29271	14.77%
None of them	99528	22.68%	20257	20.35%
Don't Know	3075	0.70%	299	09.72%
Education Level of Respondent				
No Education	81115	17.78%	10238	12.62%
Primary	50602	11.09%	7554	14.93%
Secondary	252654	55.37%	40415	16.00%
Higher	71951	15.77%	15934	22.15%
Wealth Index				
Poorest	82793	18.14%	8961	10.82%
Poorer	91254	20.00%	12928	14.17%
Middle	95288	20.88%	14559	15.28%
Richer	96079	21.06%	17003	17.70%
Richest	90907	19.92%	20691	22.76%
Heard Family Planning on Radio				
No	373819	81.92%	59890	16.02%
Yes	82503	18.08%	14250	17.27%
Heard Family Planning on TV				
No	182308	39.95%	22777	12.49%
Yes	274014	60.05%	51364	18.75%
Read Family Planning in Newspaper				
No	273663	59.97%	38309	14.00%
Yes	182660	40.03%	35833	19.62%
Seen family planning message on a wall or hoarding				
No	201117	44.07%	26943	13.40%
Yes	255206	55.93%	47199	18.49%

The ovulatory cycle knowledge is similar among women in urban (17.73%) and rural (15.49%). The ovulatory cycle knowledge is highest among Sikh (50.44%), followed by Others (19.45%), and Christian (16.61%) women. Concerning the social group affiliations of the respondents, ovulatory cycle knowledge is lowest in the Scheduled Tribe group (13.26%). In comparison, the highest proportion of ovulatory cycle knowledge is found in the General category (20.35%). The ovulatory cycle knowledge increases with the increase in the education level of the respondents. It is observed that 22.15% of the women with higher education can recognize the correct period of ovulatory cycles. The prevalence of ovulatory cycles also increases from the bottom to the upper quantile of the women. About 23% of the women in the wealthiest quantile are aware of the ovulatory cycle knowledge compared to 11% of the women in the poorest wealth quantile. Ovulatory cycle knowledge is higher among the women who heard/see the family planning messages via mass media, including radio, tv, newspaper, or wall.

4.2. Determinants of OCK

Table 2 presents the odds ratio for Ovulatory Cycle Knowledge. An important explanatory variable is the first one in the Table 2 capturing inter-generational transfer of ovulatory cycle knowledge. As mentioned earlier, it measures the average ovulatory cycle knowledge of women in the same district aged above 35. The odds ratio of 143.14 indicates that the intergenerational transfer of knowledge is an important source of knowledge for each woman below the age of 35.

Table 2. The odds ratio for Ovulatory Cycle Knowledge

Characteristics	Odds Ratio
Average OCK for women above 35	143.14***
Area of Living	
Urban	
Rural	1.11***
Age Group	
15-19	
20-24	2.59***
25-29	3.66***
30-34	3.87***
Religion	
Hindu	
Muslim	0.97**
Christian	0.99
Sikh	0.67***
Others	1.12***
Caste	
General	
Scheduled Caste	0.88***
Scheduled Tribe	1.00
Other Backward Class	0.97***
Don’t Know	0.59***
Education Level	
No Education	
Primary	1.06***
Secondary	1.20***
Higher	1.32***
Wealth Index	
Poorest	
Poorer	1.04***
Middle	1.08***
Richer	1.11***
Richest	1.18***

Heard Family Planning on Radio	
No	
Yes	1.11***
Heard Family Planning on TV	
No	
Yes	1.18***
Read Family Planning in Newspaper	
No	
Yes	1.13***
Seen Family Planning Message on Wall	
No	
Yes	1.22***
Constant	0.01***
N	440,569

Socio-demographic variables are important in explaining the level of ovulatory cycle knowledge. Religious affiliation is important for ovulatory knowledge and we find that women from the Muslim, Sikh and Christian religions are less likely to know about ovulation cycles than women from the Hindu religion (OR=0.67-0.97). Women in rural areas are more likely to know about the ovulatory cycle than women in urban areas (OR=1.11). Women from affluent families have higher odds of ovulatory cycle knowledge than women from the poorest families (OR=1.18). Compared to women from the general category, those from scheduled caste (OR=0.88) and other backward classes (OR=0.97) have lower odds of ovulatory cycle knowledge.

We also found that access to media platforms (newspaper, radio, and television) positively impacts women's ovulatory cycle knowledge. Women who heard about family planning from the newspaper (OR=1.13) or radio (OR=1.11), or television (OR=1.18) are one and a half times more likely to know about the ovulatory cycle than those who do not. The government's initiatives on family planning awareness, including family planning-related messages on walls, have improved the girl's ovulatory cycle knowledge. Women who have seen family planning messages on a wall or hoarding are one and a half times (OR=1.22) more likely to know about ovulatory cycles.

Our study shows that education plays a crucial role in the understanding of the ovulatory cycle. Women who have completed high school are one and a half times more likely to know about their ovulatory cycle than women who have received no education at all (OR=1.33). However, the coefficients of these variables remain smaller in size.

Overall, we find that ovulatory cycle knowledge is better explained by the inter-generational transfer of knowledge as compared to formal education and other mass-media factors.

4.3. OCK and Pregnancy Outcomes

The OLS estimates for the causal impact of ovulatory cycle knowledge on the number of children and age at first birth are presented in col (1) and (3) of table 3. Estimates of col (1) of table 3 indicate that the ovulatory cycle knowledge is strongly and positively associated with the number of children of women under age 35, i.e., the number of children increases with the increase in ovulatory cycle knowledge. Estimates of col (3) of table 3 indicate that the ovulatory cycle knowledge is strongly and positively associated with the age at first birth of the women under age 35, i.e., the age for first birth increases with the increase in ovulatory cycle knowledge. Results are statistically significant at 99 percent levels.

Table 3. OLS and IV Estimates foe the number of children and age at first birth

Characteristics	Number of children		Age at first birth	
	OLS	IV Estimates	OLS	IV Estimates
Ovulatory Cycle Knowledge	0.06***	-0.27***	0.06***	0.48***
Area of Living				
Urban				
Rural	0.06***	0.07***	0.05***	0.04***
Age Group				
15-19				
20-24	0.75***	0.78***	1.99***	1.99***
25-29	1.69***	1.74***	3.00***	3.00***
30-34	2.35***	2.39***	3.36***	3.35***
Religion				
Hindu				
Muslim	0.08***	0.08***	-0.03	-0.04*
Christian	-0.02**	-0.02**	0.39***	0.40***
Sikh	-0.18***	-0.08***	0.78***	0.61***
Others	-0.15***	-0.15***	0.21***	0.21***
Caste				
General				
Scheduled Caste	0.05***	0.05***	-0.19***	-0.19***
Scheduled Tribe	-0.07***	-0.07***	-0.08***	-0.08***
Other Backward Class	0.04***	0.04***	-0.16***	-0.15***
Don’t Know	0.07***	0.06***	-0.25***	-0.23***
Education Level				
No Education				
Primary	-0.23***	-0.23***	0.17***	0.16***
Secondary	-0.55***	-0.54***	1.07***	1.06***
Higher	-1.10***	-1.08***	3.38***	3.35***
Wealth Index				
Poorest				
Poorer	-0.08***	-0.08***	-0.10***	-0.10***
Middle	-0.15***	-0.15***	0.01	0.01
Richer	-0.21***	-0.21***	0.26***	0.25***
Richest	-0.26***	-0.26***	0.62***	0.59***

Heard Family Planning on Radio				
No				
Yes	-0.02***	-0.02***	0.04***	0.05***
Heard Family Planning on TV				
No				
Yes	-0.04***	-0.03***	-0.08***	-0.10***
Read Family Planning in Newspaper				
No				
Yes	-0.04***	-0.03***	0.05**	0.05**
Seen Family Planning Message on Wall				
No				
Yes	0.01	0.01***	0.09***	0.08***
Constant	0.67***	0.66***	16.38***	16.35***
N	440569	440569	237314	237314
R^2	0.533	0.5259	0.1631	0.1607

Since the OLS estimates, as presented in Table 3 Col (1) and (3), do not consider endogeneity, it is likely to produce inconsistent and biased estimates. To attenuate such concerns and estimate the causal impact of the ovulatory cycle knowledge on the number of children and age at first birth, IV estimation is also carried out. Col (2) and (4) of Table 3 presents the IV estimates for the number of children and age at first birth, respectively. Col (2) shows that the sign for OCK has changed to negative, thus, indicating that after controlling for the endogeneity, we find that ovulatory cycle knowledge in fact reduces the number of children. Col (4) shows that ovulatory cycle knowledge is positively and significantly associated with the age at first birth even after controlling for endogeneity. The signs and level of significance are in a similar direction as in the OLS estimates. However, the magnitude of the IV estimates is larger than that of OLS estimates. Overall, we find that age at first birth is higher with ovulatory cycle knowledge than without it. The F-statistics for both the regressions were greater than 10 i.e., F (1,440544) = 32638.3 and F (1,237289) = 26141 for the number of children and age of respondent at first birth, respectively, implying that the underlying relationship is fairly strong.

5. Discussion

Previous research has shown that one-third of all pregnancies result in abortion, and one out of two pregnancies are unplanned(Singh et al., 2017). Ovulatory cycle knowledge is one of the critical components in making women aware of the reproductive cycle, which will reduce unplanned pregnancies. Our study makes multiple contributions based on the synthesis of a comprehensive literature review and robust empirical analysis. Firstly, we explain the prevalence and correlates of the ovulatory cycle knowledge for women aged 15-34. Secondly, our results establish that the ovulatory cycle knowledge is not explained by formal education but by the inter-generational transfer of knowledge. Thirdly, our results show the causal impact

of the ovulatory cycle knowledge on the number of children and age at the first birth. While reflecting on these findings, the study raises some critical questions in improving the ovulatory cycle knowledge among girls and women in India.

Around 16% of the sample of our study were aware of the ovulatory cycles. Various other studies on ovulation cycle knowledge have found numbers from developing countries in the same range. In a study done among 15683 women aged 15 to 49 in 2016 in Ethiopia (Getahun & Nigatu, 2020) around 24 percent of women correctly identified the fertile period. Similarly, in a cross-sectional study conducted in 29 African countries (Iyanda et al., 2020), the average ovulatory cycle knowledge across countries turns out to be 21.5%. A separate study conducted in India found that around 15 percent of women correctly identified the fertile period (Mahey et al., 2018). As a contrast to the above studies, results than a study conducted among 327 women aged 18 to 44 in 2008-09 in Australia (Hampton & Mazza, 2015) found only 2% of the women correctly identified the fertile period. The variation in results may be attributed to the varying socioeconomic characteristics in the sample chosen for the study, including different education levels, across different contexts (different participants, studies, and populations) (Beeman, 2010). Overall, most of the studies(Getahun & Nigatu, 2020; Hampton & Mazza, 2015; Iyanda et al., 2020; Mahey et al., 2018) have shown a low to moderate level of ovulatory cycle knowledge. Hence, we suggest future studies exploring the various factors that explain the varying levels of ovulatory cycle knowledge.

Our study highlights the importance of socio-demographic factors in determining the ovulatory cycle knowledge of a woman. Household income levels play a critical role in understanding the ovulatory cycle knowledge. Our results show that women from middle- and higher-income households are more likely to know about the ovulatory cycle than those who come from the poorest households. Compared to the women from the general category, those from scheduled caste and other backward classes have lower odds of ovulatory cycle knowledge. Caste is a crucial social identity factor in India, which further determines life opportunities. Our results show there is low awareness of ovulatory cycles among women from lower socioeconomic and disadvantaged groups. It calls for urgent policy measures to improve the level of awareness among women from these groups.

Women in the age group 20 and above are more likely to know about ovulatory cycles than women in the 15-19 age group. Our results are similar to the study conducted in Bangladesh (Uddin & Choudhury, 2008) among 920 adolescent girls aged between 10-19 using a combination of survey and qualitative interviews showing that as women's age increases, their knowledge about ovulatory cycles also increases. Similar results were found in studies conducted in Pakistan (Ali et al., 2011), Spain (García et al., 2016), and United States (Lundsberg et al., 2014). With age, women develop a better understanding of their bodies and the associated processes. There is repeated exposure to sexual activities, and they know more about the ovulatory cycles.

The educational background of girls plays a crucial role in understanding their ovulatory cycle. Women who have completed high school education are more likely to have ovulatory cycle

knowledge than girls who have not. Our results are in line with previous studies conducted across 79 countries with around 10045 participants over nine months (Bunting et al., 2013). NFHS-4 reports (International Institute for Population Sciences, 2017) that approximately 27 percent of Indian adolescent girls get married before 18, and 7 percent get married before 15. Going to school gives them preliminary knowledge about both men's and women's biological processes, thus improving their understanding of reproductive health (Sommer et al., 2015).

Mass-Media has been found to increasingly become a critical factor in improving awareness about ovulatory cycles. Our study suggests that women who have come across family planning in newspapers, radio, or television are more likely to have better ovulatory cycle knowledge. Our results are in sync with a previous study conducted in Bangladesh in 2008 (Uddin & Choudhury, 2008) that has shown exposure to the mass media helps improve the ovulatory cycle knowledge among girls.

Our results show that women who have seen a family planning message on a wall are more likely to know about the ovulatory cycle knowledge than those who are not. Policymakers should provide space for strengthening the interactions between the community and health workers to emphasize the ovulatory cycles. We need more research to understand how and in what ways these government initiatives contribute to enhanced understanding of ovulatory cycles so that the awareness messages, counseling sessions, and ad campaigns can be strategically designed to address the specific needs.

Previous studies have also shown that women's education significantly impacts the number of children born(Zanin et al., 2015). However, endogeneity has been one of the concerns of the policymakers while establishing this relationship. We used the average ovulatory cycle knowledge of women over 35 as an instrumental variable to address this concern. It cannot directly impact the women's fertility decisions except via impacting her ovulatory cycle knowledge. Our results establish the causal effect of ovulatory cycle knowledge on the number of children and age at the first birth. Thus, it is important to include the sessions on ovulatory cycles as part of the sexual and reproductive health programmes to improve the knowledge around ovulation, which will help reduce the number of children and increase the age at the first birth.

The government started Rashtriya Kishor Swasthya Karakaram (RKSK) in 2014 to improve sexual and reproductive health by starting various community-based interventions and behavioural change communication and adolescent health-friendly clinics. Previous studies have shown that RKSK has been a failure on the ground, leading to an increasing number of early marriages and adolescent pregnancies (Suri, 2020). NFHS-4 results also show the lower awareness levels of ovulatory cycles among adolescents. Thus, government and policymakers need to strengthen the existing programs and open discussions around the ovulatory cycle knowledge to reduce adolescent pregnancies. We suggest that the government and policymakers start focusing on improving the ovulatory cycle knowledge of Accredited Social Health Activists (ASHA) and other health workers and school teachers. These two are the primary pillars to conduct the interventions at the school and community levels. Such programs

will empower the ASHA, local health workers, and school teachers to educate the boys and girls in the school and community. They can help improve sex education at the grassroots, thereby reducing the high number of unplanned pregnancies.

6. Conclusion

Lower ovulatory cycle knowledge led to higher chances of unplanned pregnancy, having children at an early age, thus, making women of a younger generation more vulnerable. They are more likely to be diagnosed with anaemia, unplanned and complicated pregnancies, and a higher death rate during pregnancy (Prakash et al., 2011). The Indian government has started various initiatives like Beti Bachao, Beti Padao Abhiyaan (Ministry of Women and Child Development Government of India New Delhi, 2018) to improve girls' education, which will help increase their average age of getting married. However, school curricula focus more on the scientific terms and do not include the practical guidance required to improve ovulation and menstrual cycle knowledge. Thus, girls and women receive information around ovulatory cycles via informal channels, i.e., mothers and other community members.

Ovulatory cycle knowledge can be improved by starting school and community-related education programs to enhance the communication around sexual and reproductive health issues within the schools and family (Phillips-Howard et al., 2016). For school-based programs, the approach needs to go beyond just providing mid-day meals, clean toilets, providing free/subsidized sanitary napkins to including a revised curriculum and sensitization workshops for both boys and girls around sexual and reproductive health. Policymakers can design RKSK's community-based interventions (including parents, their children, and the community) to improve the awareness around ovulatory cycles. The government and policymakers should also try to widen the base of creating awareness by including men along with women. Both levels of interventions should encourage open dialogues with the family members, classmates and focus on behavioural change at a broader level.

7. References

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