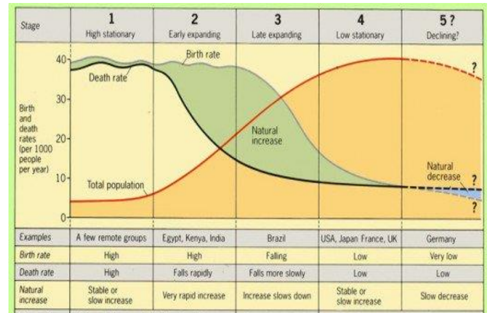



# WHAT FACTORS EXPLAIN THE FERTILITY TRANSITION IN INDIA?

April 2018
This publication was produced for review by the United States Agency for International Development.
It was prepared by A.A. Jayachandran and John Stover for the Health Finance and Governance Project.

**The Health Finance and Governance Project**

USAID's Health Finance and Governance (HFG) project helps improve health in developing countries by expanding people's access to health care. Led by Abt Associates, the project team works with partner countries to increase their domestic resources for health, manage those precious resources more effectively, and make wise purchasing decisions. As a result, this six-year, $209 million global project increases the use of both primary and priority health services, including HIV/AIDS, tuberculosis, malaria, and reproductive health services. Designed to fundamentally strengthen health systems, HFG supports countries as they navigate the economic transitions needed to achieve universal health care.

**April 2018**

**Cooperative Agreement No:** AID-OAA-A-12-00080

**Submitted to:** Scott Stewart, AOR
Office of Health Systems
Bureau for Global Health

**Recommended Citation:** Jayachandran, A.A., and John Stover. April 2018. *What factors explain the fertility transition in India?* Bethesda, MD: Health Finance and Governance Project, Abt Associates Inc.

Abt Associates Inc. | 6130 Executive Boulevard | Rockville, Maryland 208524
T: 301.347.5000 | F: 301.652.3916 | www.abtassociates.com

Avenir Health | Broad Branch Associates | Development Alternatives Inc. (DAI) |
| Johns Hopkins Bloomberg School of Public Health (JHSPH) | Results for Development Institute (R4D)
| RTI International | Training Resources Group, Inc. (TRG)

# WHAT FACTORS EXPLAIN THE FERTILITY TRANSITION IN INDIA?

# CONTENTS



## List of Tables



## List of Figures

# ACRONYMS

| | |
|---|---|
| **ASFR** | Age-specific fertility rate |
| **CPR** | Contraceptive prevalence rate (any method) |
| **NFHS** | National Family Health Survey |
| **P-D** | Proximate determinants |
| **PPI** | Postpartum insusceptibility |
| **RTF** | Return to fertility |
| **TF** | Total fecundity |
| **TFR** | Total fertility rate |
| **UT** | Union territory |

# ACKNOWLEDGMENTS

The Health Finance and Governance Project (HFG), supported by the United States Agency for International Development (USAID), expresses its appreciation to all institutions and individuals who contributed to this report.

Thanks to May Post, Chris Cintron, Peter Vaz, Rashmi Kukreja, Alia Kauser, and Faujdar Ram for technical reviews and quality assurance, Arvind Pandey and Kristin Bietch for data analysis and extraction assistance, Linda Moll for text editing, and Maria Claudia de Valdenebro for formatting and graphic design.

# EXECUTIVE SUMMARY

India's total fertility rate (TFR) has declined steadily as measured by three National Family Health Surveys in 1998-99 (NFHS-2), 2005-06 (NFHS-3), and 2015-16 (NFHS-4). The contraceptive prevalence rate (CPR) increased between the first two surveys but apparently declined between the third and fourth surveys. The purpose of this study was to investigate the apparent discrepancy between trends in TFR and CPR.

The model of Proximate Determinants (P-D) of Fertility describes changes in TFR as being due to changes in four main determinants: CPR (this study considers all methods, including traditional methods, under CPR), proportion married, duration of the period of postpartum insusceptibility, and abortion. We applied both the aggregate and age-specific version of this model to data at the national level and for 18 major states. The model completely explains the changes in TFR from NFHS-2 to NFHS-3 but underestimates changes in TFR from NFHS-3 to NFHS-4.

Contraceptive use is the major factor determining TFR at NFHS-2 and 3 and the second most important factor (after marriage) at NFHS-4. The decline in TFR from NFHS-2 to 3 is mostly explained by changes in CPR with a smaller contribution from rising age at marriage. The decline in TFR from NFHS-3 to 4 is explained by rising abortion rates and rising age at marriage. CPR seems to have had little effect during this period and may even have lessened the decline in TFR. However, the model indicates that CPR may be underestimated in NFHS-4.

As just noted, the major factor contributing to TFR decline between NFHS-3 and 4 is rising abortion rates. The rising abortion rate is probably due to the expanded availability of medical abortion. However, it is also an indication of a high number of unintended pregnancies. NFHS-4 reports that 12.9 percent of women have an unmet need for contraception and another 5.7 percent are using traditional methods with high failure rates. While some level of unmet need seems inevitable, the family planning program should strive to address unmet need, traditional method use, and knowledge gaps in order to help more couples meet their family planning needs. It is hoped that the recent introduction of new methods (injectables and centchroman) into the program can help to meet this challenge.

# 1. INTRODUCTION

## 1.1 Background

India's total fertility rate (TFR) declined consistently from 2.85 births per woman estimated by National Family Health Survey (NFHS)-2 (1998-99) to 2.18 as reported by NFHS-4 (2015-16). During this period, TFR dropped 23 percent according to NFHS rates, while Sample Registration System estimates of TFR dropped by 30 percent (from 3.25 to 2.26) during the same period. Overall contraceptive use increased modestly, from 48.2 percent to 53.5 percent, in the 17-year survey period; however, it declined by 2.8 percentage points between NFHS-3 and NFHS-4 (56.3% to 53.5%). The reported recent decline in contraceptive use does not seem to be consistent with the continued decline in fertility. However, contraceptive use is only one of the factors that affect fertility. Other factors, such as marriage rates, breastfeeding patterns, the duration of postpartum abstinence, method mix, and abortion rates can all affect fertility. The purpose of this analysis is to examine all of these factors to see if they explain why fertility has continued to decline even though contraceptive use has also declined recently.

The determinants of fertility are diverse, but they are categorized as proximate or direct determinants and intermediate or indirect determinants (Davis and Blake 1956). Proximate determinants (P-Ds) act to reduce fertility from its theoretical maximum, known as total fecundity (TF). Bongaarts defined eight P-Ds of fertility: the proportion of women of reproductive age who are married, the proportion using contraception, induced abortion, postpartum insusceptibility (PPI), frequency of intercourse, sterility, spontaneous intrauterine mortality, and duration of the fertile period (Bongaarts 1978). Among these eight predictors, the first four explain nearly 96 percent of fertility variations in a population (Bongaarts and Potter 1983).

The original P-D model developed by Bongaarts was updated by Stover (1998) and again by Bongaarts (2015). In this analysis, we use the 2015 version of the model. The availability of NFHS-4 data (released early 2018) provides a good opportunity to study changes in the P-Ds and their relationship to fertility trends. Findings from this study are intended to help policymakers and family welfare program implementers better understand the causes of India's fertility transition and formulate appropriate strategies for meeting the population's family planning needs.

## 1.2 Study objectives

The purpose of this study is to explain the main causes of fertility change and its implications in India over the time period 1998 to 2016. To accomplish this, we first test the P-D model to see if it is valid in the Indian context and then use it to estimate the contribution of each determinant to changes in TFR. The findings are intended to inform program managers, donors, and researchers about the link between contraceptive prevalence rate (CPR) and fertility decline.

# 2. METHODS AND DATA SOURCES

## 2.1 Data sources

The data used for this analysis are from the last three NFHS survey waves, viz., NFHS-2 1998-99 (IIPS and ORC Macro 2000), NFHS-3 2005-06 (IIPS and Macro International 2007) and NFHS-4 2015-16 (IIIPS and ICF 2017). These surveys were designed to provide essential data on health and family welfare as well as data on emerging issues in these areas. Table 1 provides a snapshot of the three rounds of NFHS. Unlike previous rounds, the latest survey (NFHS-4, 2015-16) was intended to produce indicators at the district, state/union territory (UT), and national levels, as well as separate estimates for urban and rural areas, with a reasonable level of precision (IIPS and ICF 2017). To achieve this objective, information was collected from 699,686 eligible women under NFHS-4. Interviews were also completed with 112,122 men and 601,509 households by administering man's schedule and household schedules respectively. Previously conducted NFHS were designed to produce indicators at state and national levels, as well as for urban and rural areas only.

**TABLE 1. NATIONAL FAMILY HEALTH SURVEY CHARACTERISTICS**

| Survey Characteristics | NFHS -2 | NFHS -3 | NFHS -4 |
|---|---|---|---|
| Survey reference period | 1998-99 | 2005-06 | 2015-16 |
| Number of states covered | 26 states | 29 states | 29 + 6 UTs |
| Number of households interviewed | 91,196 | 1,09,041 | 6,01,509 |
| Number of eligible women (15-49) interviewed | 89,199 | 1,24,385 | 6,99,686 |
| Eligible woman criteria | All Ever-Married Women 15-49 | All Women 15-49 | All Women 15-49 |
| Most indicators estimated at: | State & national level | State & national level | District, state/UT & national level |
| Modern CPR at national level (%) | 42.8 | 48.5 | 47.8 |
| Unmet need at national level (%) | 16.1 | 13.9 | 12.9 |

## 2.2 Analytical framework

In 1978, John Bongaarts proposed a simple framework to analyze differentials and changes in fertility based on the proximate or direct determinants, that is, those elements which, if changed, would causally result in a change in overall fertility levels, all else being equal. The P-D model originally envisaged very little occurrence of fertility outside marriage; hence, all the calculations were based only on currently married women of reproductive age (Alazbih, Tewabe, and Demissie 2017). A later revision incorporates sexual activity outside of marriage, but this is rare in India.

Most applications of the P-D model consider the 15-49 population as a single group. However, Bongaarts and Potter (1983) proposed an age-specific version of the P-D framework. Several researchers have pointed out clear advantages of the age-specific model over the simple aggregate models as it takes account of variation in the age structures of populations (Casterline, Singh, Cleland, et al. 1984; Hobcraft and Little 1985; Singh, Casterline, and Cleland 1985). Different states in India are at different fertility trajectories and hence show variation in age structures. In this paper, we apply both the aggregate and age-specific P-D models for select states and India.

## 2.3 P-D model equations

The multiplicative model expresses the TFR as a product of four indices (marriage, contraception, PPI, and induced abortion) and TF (Bongaarts 1978; Bongaarts and Potter 1983; Bongaarts 2015). It can be expressed as:

$$\boldsymbol{TFR = Cm \times Cc \times Ci \times Ca \times TF}$$

Where, TFR is the total fertility rate, $C_m$ is the index of marriage, $C_c$ is the index of contraception, $C_i$ is the index of PPI, $C_a$ is the index of induced abortion, and $TF$ is the total fecundity.

The value of these indices is allowed to vary between 0 and about 1. When the value of an index is close to 1, the P-D has a minimal inhibiting effect on fertility, whereas, if the index value is close to 0, it has maximum inhibiting effect on fertility.

### 1. Marriage index

The index of marriage calculated as the proportion of women who are married.

Thus, age-specific index of marriage is:

$C_m$(a) = $m$(a), where, $m(a)$ is proportion currently married in age group 'a'

The aggregate index is a weighted sum of the age-specific indices.

$$\boldsymbol{C_m = \sum C_m(a) \times w_m(a)}$$

The weights are
$$\boldsymbol{w_m(a) = \frac{f_m(a)}{\sum f_m(a)}}$$

Where, $f_m$(a) is the marital fertility rate and 'a' is age

### 2. Index of contraception

The index of contraception is calculated as one minus the proportion of fecund women who are effectively protected from pregnancy through the use of contraception. The equation is:

$$C_m(a) = 1 - r(a) \times CPR(a) \times e(a)$$

Where 'r' is the fecundity adjustment, CPR is the proportion of women using contraception, and 'e' is the weighted average effectiveness across all family planning methods. The full equation also includes a factor for the overlap of contraception with postpartum infecundability, but we have not included that in this analysis.

In the analysis, we incorporated age-specific method effectiveness based on an analysis of Demographic and Health Survey data (Bradley, Polis, Bankole, et al. 2017).

The age aggregate index is calculated as: $$C_c = \Sigma\, C_c(a) \times w_c(a)$$

Where, $w_c(a) = f_n(a) / \Sigma f_n(a)$, where $f_n(a)$ is the natural exposed fertility rate and 'a' is age

## 3. Index of PPI

The equation used to calculate this index is:

$$C_i(a) = \frac{20}{(18.5 + i(a))}$$

Where, i(a) is average duration in months of postpartum infecundability for age 'a'

## 4. Index of abortion $C_a(a)$

The abortion index is a function of the number of births averted by an abortion.
The modified formula is:

$C(a) = \frac{f(a)}{f(a) + b \times ab(a)}$, where, $f(a)$ is fertility rates for age 'a', $ab(a)$ is abortion rate for age 'a' and

$b = \frac{14}{18.5 + i(a)}$, where $i(a)$ is average duration in months of PPI for age 'a' (see above equation).

In this study, ab(a), the age-specific abortion rate, is indirectly estimated by taking abortion values for India from a recently published *Lancet* paper (Singh, Shekar, Archarya, et al. 2018) and weighted for age-specific unmet need for family planning services.

Note that $C_a$ values are calculated only for modelling at the national level, not for state levels due to lack of abortion-related data at state levels.

From the values of TFR and the main P-Ds, we can estimate the TF, as the TFR divided by the product of the four indices, $C_m$, $C_c$, $C_i$, $C_a$. and TF is a measure of fertility in the absence these four factors that normally act to restrict fertility. It is determined by unmeasured biological, genetic, and cultural factors. Generally, these factors are not expected to change substantially over short periods. Therefore, we expect that TF will remain constant. We assessed how well the P-D model works in India by calculating TF for each survey and evaluating whether the assumption of constant TF holds true.

Assuming that TF does remain constant, we can predict the TFR at some future period if we know the values of the four indices. This prediction can be compared with the actual TFR to see how well the P-D model works.

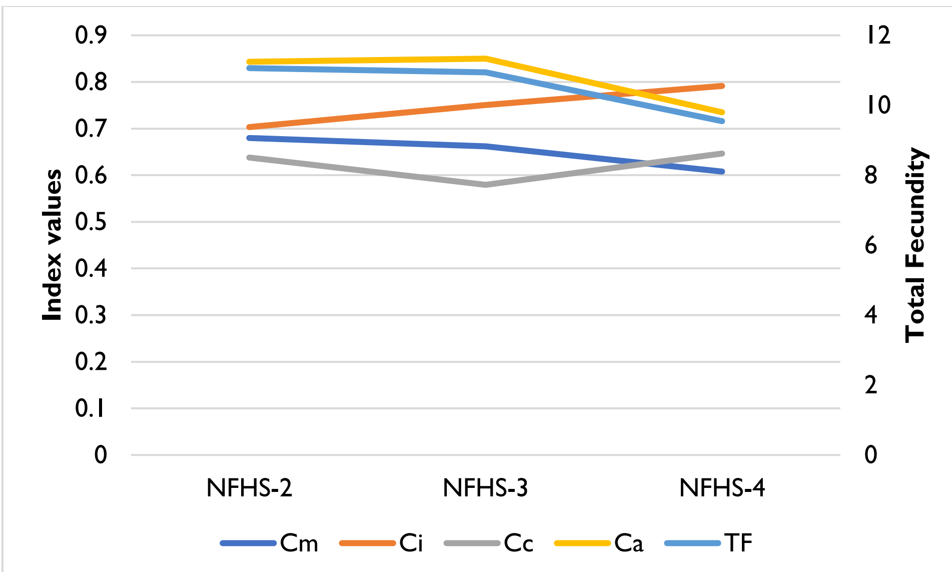
Using the P-D model, the change in TFR can be explained by changes in each of the indices. In other words, we can describe how much of the decline in TFR is due to each P-D.

# 3. RESULTS

## 3.1 Aggregate national-level results

For the aggregate national model, the values of four P-D indices and TF are shown for the three survey rounds in the Figure 1. The index of marriage ($C_m$) decreased marginally from 0.70 in NFHS-2 to 0.66 at NFHS-3 and more substantially to 0.61 by NFHS-4. Thus, the rising age at marriage between NFSH-3 and NFHS-4 made a substantial contribution to declining fertility.

**FIGURE 1. TRENDS IN LEVELS OF FOUR P-D INDICES, INDIA, 1998-99, 2005-06, AND 2015-16**




The index of PPI ($C_i$) increased during the survey period from 0.70 to 0.79 as a result of a decline in the median duration of PPI from 9.2 months in 1998-99 to 6.6 months in 2015-16. The shorter period of PPI would have increased fertility, all other factors being equal.

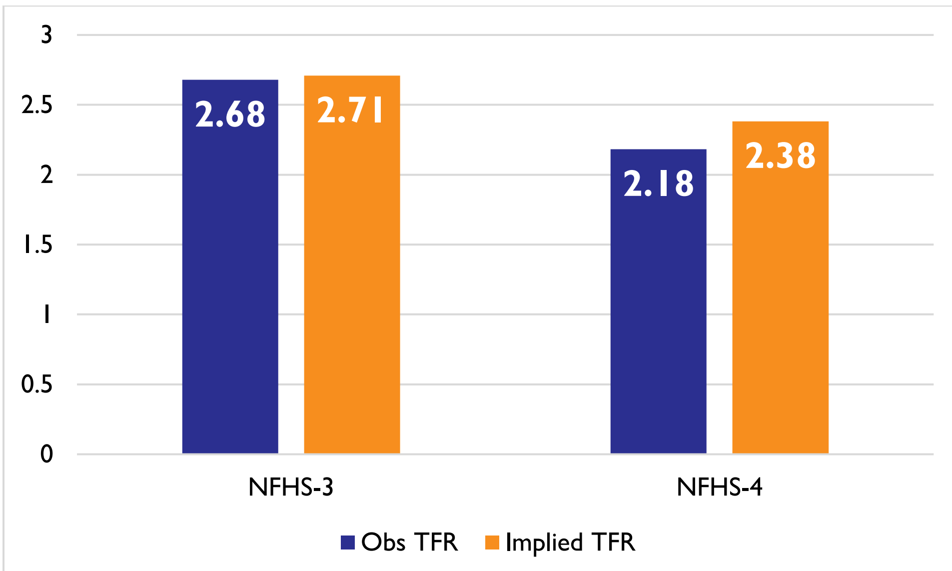
The index of contraception ($C_c$) declined from 0.63 at NFHS-2 to 0.58 level at NFHS-3, contributing to the fertility decline during that period. However, the index rose between NFHS-3 and NFHS-4 due to a decline in CPR. This change would have led to a rise in TFR if all other factors had remained equal. It is worth noting that overall contraceptive use was the most important factor determining fertility at the time of NFHS-2 and NFHS-3 and is the second most important factor (after marriage) at NFHS-4. However, changes in CPR have had only a small influence on changes in TFR in recent years (*see* Annex A).

The index of abortion ($C_a$) did not change significantly between NFHS-2 (0.83) and NFHS-3 (0.85) but decreased significantly by NFHS-4 (0.71) due to the increasing use of medical abortion. The increase in abortion made a major contribution to the decline in fertility from NFHS-3 to NFHS-4.

The estimated TF was essentially constant from NFHS-2 (11.1) to NFHS-3 (10.9) indicating that the P-D model works well because changes in the four indices fully explain the change in TFR. However, from NFHS-3 to NFHS-4, the estimated TF declined significantly to 9.6. This indicates that changes in the four indices do not fully explain the changes in TFR. This could be due to changes in unmeasured factors or to errors in measuring the true changes in these four factors or TFR. One possible explanation is that the CPR is underestimated in NFHS-4. If CPR actually remained constant between NFHS-3 and NFHS-4, then TF would be unchanging.

Figure 2 plots both observed TFRs estimated by NFHS-3 and 4 and implied TFR values obtained using the P-D model. Implied TFRs are estimated using assuming TF values estimated in previous rounds remain constant. To predict TFR at the NFHS-3 level, all the P-D indices at NFHS-3 level are used along with the TF value at the NFHS-2 level. Similarly, TFR is predicted at NFHS-4 using all indices at NFHS-4 and TF value at NFH-3.

**FIGURE 2. OBSERVED AND IMPLIED TFRS, INDIA, 2005-06 AND 2015-16**



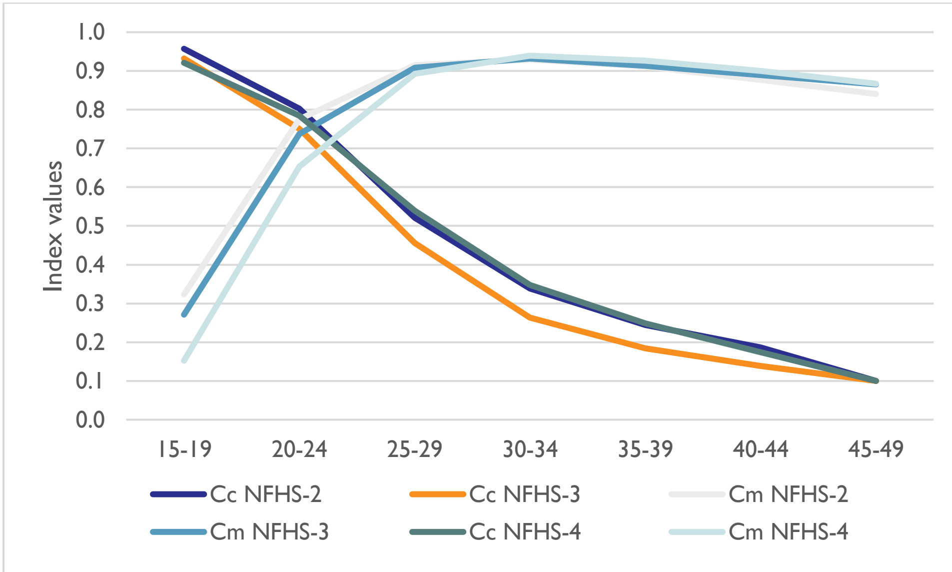

At NFHS-3, the model-predicted TFR value (2.71) is very close to the observed TFR value of 2.68. When the P-D model is extended to predict TFR at NFHS- 4, the predicted value of TFR (2.38) is higher than the observed TFR (2.18). If CPR remained unchanged from NFHS-3 to NFHS-4, then the predicted TFR for NFHS-4 would be 2.24.

## 3.2 Age-specific national-level results

Results for the age-specific P-D model applied nationally are plotted in Figure 3. The index of marriage shows very little change for older ages but significant change for the 15-19 and 20-24 age groups, especially between NFHS-3 and NFHS-4. This change (i.e., rising age at marriage) contributed to reduced fertility among younger women.

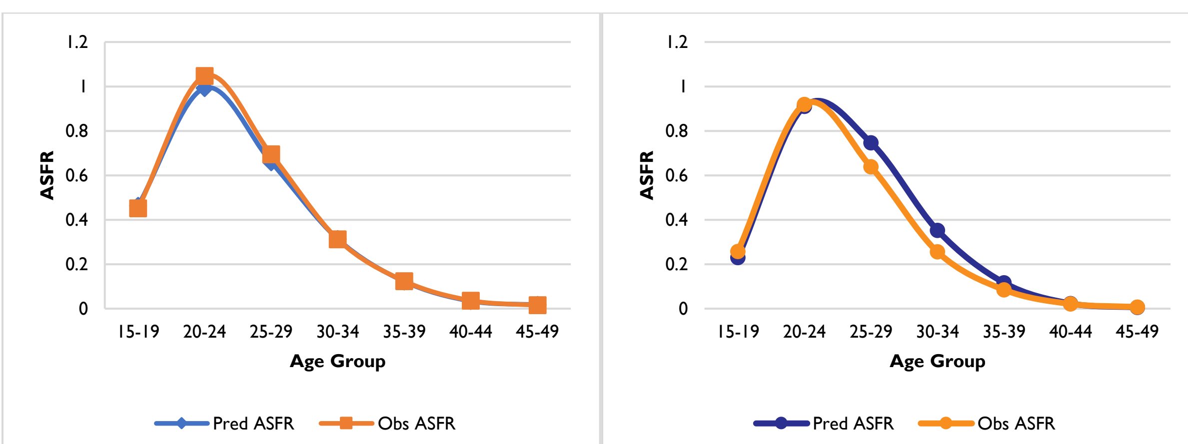
Figure 3 also shows that the index of contraception dropped, due to increasing CPR, from NFHS-2 to NFHS-3, especially for ages 25-39. The NFHS-4 based $C_c$ index rose for ages 25-39 due to decreasing in levels of CPR in this age group reported by NFHS-4.

### FIGURE 3. TRENDS IN AGE-SPECIFIC $C_M$ AND $C_C$ INDICES, INDIA, 1998-99, 2005-06, AND 2015-16




In order to check whether the age pattern of fertility is captured by the P-D model, we calculated Age-Specific Fertility Rates (ASFRs) using the age-specific P-D model for India under two reference points. Figure 4 depicts the two sets of ASFRs plotted for predicted and observed ASFRs. The first graph refers to NFHS-3 and the second to NFHS-4. The model-predicted ASFRs are perfectly blended with the survey-based ASFRs for NFHS-3 (first graph in Figure 4). This increases our confidence in input data and the model. For 2015-16, ASFRs plotted on the second graph suggest a subtle displacement of model-based predicted fertility in three age groups: 25-29, 30-34, and 35-39. For the other four age groups, the model-drawn fertility pattern is closely followed by the observed fertility pattern for India.

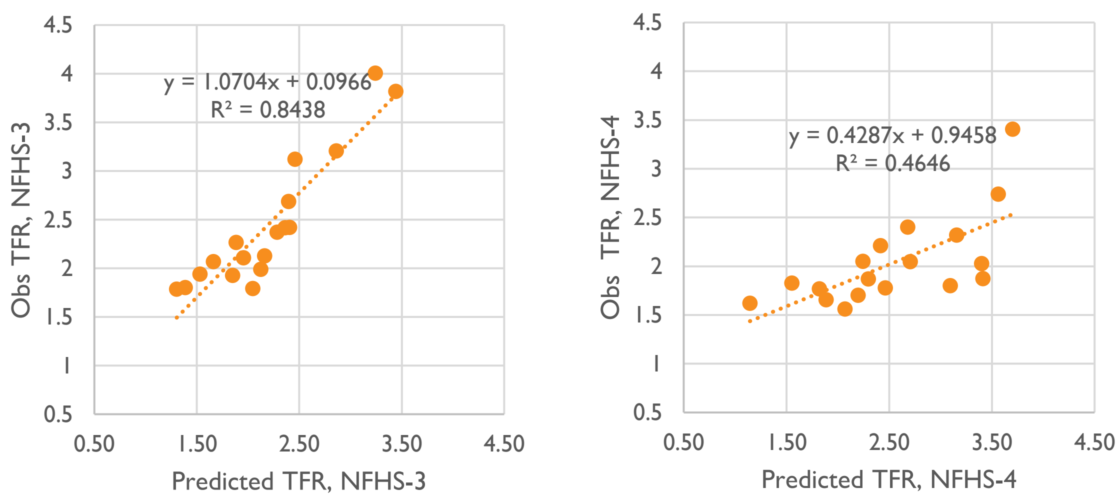
### FIGURE 4. OBSERVED AND PREDICTED ASFRS, INDIA, 2005-06 AND 2015-16



## 3.3 Aggregate state-level results

We also extended the P-D model at the aggregate level for 18 states (see Annex B for list of states). The *abbreviated* P-D model used only two set of index values ($C_c$ and $C_m$) and TF values from the previous survey round. The two sets of predicted and observed TFRs for 18 states are plotted in Figure 5. The graph on the left shows predictions for NFHS-3 and the one on the right represents predictions for NFHS-4. The $R^2$ value (0.84) between observed TFRs and model-implied TFRs for 18 states at NFHS-3 in the first graph suggests high degree of correlation between two sets of TFRs. The model is able to predict state-level TFRs with a high degree of precision. However, the graph on the right shows that the model does not predict TFRs at NFHS-4 very well. The $R^2$ drops to just 0.46. This means that the excluded parameters ($C_a$ or $C_i$) played a major role in impacting fertility. This is not surprising since the national model highlighted the significance of changes in abortion.

**FIGURE 5. PREDICTED AND OBSERVED TFRS FOR 18 STATES AT NFHS-3 AND NFHS-4 SURVEY POINTS**




To assess the predictive power of three indices (abortion index excluded) at three data points, we plotted a set of graphs with correlation values. Table 2 contains correlation values derived between each index value and TFRs at three different data points. Correlation values have been compiled from the graphs in Annex C. The correlation between the marriage index and TFR for 18 states is increased from 0.40 estimated at NFHS-2 to 0.79 in NFHS-3 and 0.74 at the time of NFHS-4. This indicates that variations across the states in the proportion married are more important in explaining variation in TFR now than they were at the time of NFHS-2. The other two indices show relatively poor correlation with TFR when analyzed for 18 states and for all three data reference periods.

#### TABLE 2. CORRELATION VALUES BETWEEN P-D INDEX VALUES AND TFRS FOR 18 STATES, 1998-99, 2005-06, AND 2015-16

| Corr. between | Reference point | | |
|---|---|---|---|
| | NFHS-2 | NFHS-3 | NFHS-4 |
| $C_m$ v/s TFR | 0.4024 | 0.795 | 0.7421 |
| $C_c$ v/s TFR | 0.0355 | 0.3812 | 0.185 |
| $C_i$ v/s TFR | 0.005 | 0.0762 | 0.0079 |

## 3.4 Age-specific state-level results

The age-specific P-D model was fitted for 18 large states and used to predict ASFRs and TFRs. Full results are in Annex D. Figure 6 shows the comparison between predicted ASFRs and observed ASFRs from the 18 states for NFHS-4. The predicted ASFRs at NFHS-4 are based on the TF values calculated at NFHS-3 and changes in only marriage ($C_m$) and contraception ($C_c$). The high $R^2$ value (0.897) suggests that the model works relatively well at the state level.

#### FIGURE 6. PREDICTED ASFRS AND OBSERVED ASFRS FOR 18 STATES, NFHS-4

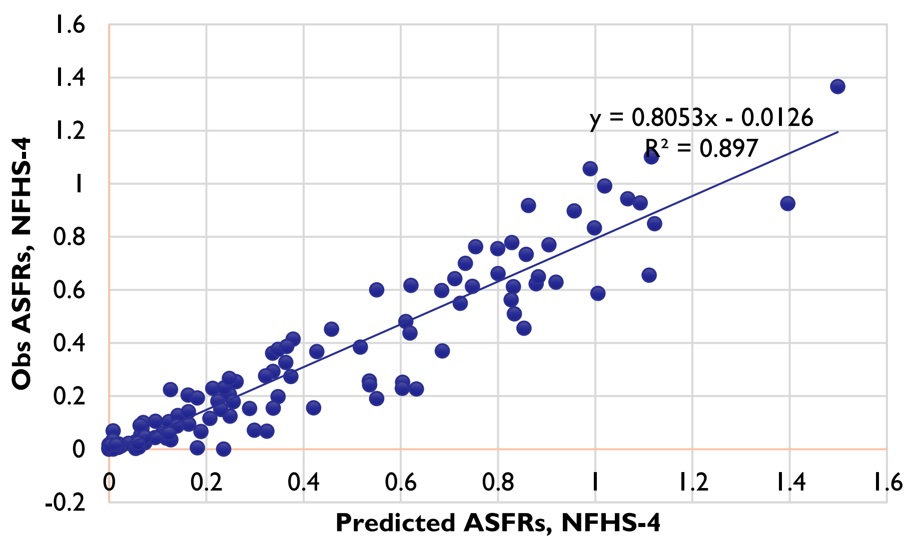


Table 3 shows those states where the predicted ASFRs matched well with the actual values (Matched) and those where it did not (Not matched). See Annex B for the list of state names and their abbreviations used in the table.

### TABLE 3. LIST OF STATES WITH MATCHING RESULT BASED ON OBSERVED AND PREDICTED ASFRS, NFHS-3 AND NFHS-4

| | NFHS-3 | | NFHS-4 | |
|---|---|---|---|---|
| | Matched | Not matched | Matched | Not matched |
| States | AP*, DL*, GJ, HR, KA, KE, MH, MP*, OD*, RJ, TN, WB* | AS, BH, GO, HP, PJ, UP | AP*, AS, HR, MH, OD, PJ, RJ, UP | BH, DL, GJ, GO, HP, KA, KE, MP, TN, WB |

*Note:* * denotes these states have shown very minimal distortion while matching.

Table 3 indicates that pattern between predicted ASFRs and observed ASFRs for a majority of 12 states is matched either perfectly or with minimum distortion under the NFHS-3 data point. The pattern for six states does not match well. For NFHS-4, the number of states in the matching group is reduced to eight, implying that the quality of input data used in the P-D model is likely to have been impacted.

# 4. DISCUSSION

The P-D model works reasonably well for India. At the national level, TFR declined by 5.9 percent from NFHS-2 to NFHS-3. Most of the decline (78 percent) was due to increasing contraceptive use and the rest (22 percent) was due to rising age at marriage (see Annex A). The period of PPI decreased during this interval, which kept fertility from declining further. Changes in abortion had little influence during this period.

From NFHS-3 to NFHS-4, TFR declined even more, by 18.5 percent. The decline was due to increases in abortion (62 percent) and in the age at marriage (38 percent). The declining period of PPI (due to decline in breastfeeding period reported in NFHS-4) exerted upward pressure (32 percent) on fertility. According the NFHS-4, CPR decreased during this period, which would have led to an 11 percent increase in TFR if not offset by changes in abortion and marriage. However, the P-D model does not fully explain the change in TFR. It may be that CPR is underestimated by NFHS-4, in which case contraceptive use may have had little effect on TFR or possibly contributed slightly to the decline. In any case, the major influences on TFR during this period were clearly abortion and marriage rates.

A recent study in Nepal (Miller and Valente 2016) demonstrated that expansion of abortion supply was associated with a 2 percentage point decline in the use of contraceptives. The study further proved that the decline is in the use of modern methods rather than in traditional methods and showed evidence of true substitution between use of modern contraceptives and abortion.

These results are supported by the age-specific version of the model, which accurately explains the changes in ASFR from NFHS-2 to NFHS-3 but similarly underestimates change from NFHS-3 to NFHS-4. Changes in marriage rates occur mainly among young women 15-24, while changes in CPR occur mainly among older women. The P-D model matches the age pattern of fertility very closely for NFHS-3 but deviates from the NFHS-4 results for ages 25-39, which could indicate changes in the age distribution of abortion or problems with the estimates of prevalence by age in NFHS-4.

At the state level, the model correctly predicts changes in ASFR from NFHS-2 to NFHS-3 for most states but does less well for the period from NFHS-3 to NFHS-4. For as many 12 states, age models with two of the P-D indices ($C_m$ and $C_c$) have not sufficiently captured the causes of fertility changes especially during NFHS-3 to NFHS-4 period. In all deviant cases during NFHS-3 to NFHS-4 period, model-predicted ASFRs are found to be higher than survey-based ASFRs (see Annex D). This implies that unobserved factors like abortions might have played key roles in restricting fertility, which turned out to be a major factor associated with fertility decline at the aggregate level. There could be underestimation of contraceptive prevalence in many states with female sterilization being misreported among higher age groups, viz., 35 and above, as reported in NFHS-4.

It is hoped that the recent addition of new methods (injectables and centchroman) to the government-sponsored family welfare program will help to address some of this remaining need.

Unsafe abortion is the third leading cause of maternal deaths in India, contributing to 8 percent of all maternal deaths annually (IPAS 2017). Also, unmet need for family planning in the post-abortion period is likely to be very high, which needs to be filled to save many mothers from morbidity and mortality related to abortions and ease the burden from the health system.

In conclusion, this study analyzes the impact of four important P-Ds on fertility change using Bongaarts' modified (2015) P-D model with data from three NFHS survey waves. The model was found to fit well to data from NFHS-2 and 3, but not well to NFHS-4 data. The results suggest three clear messages:

- The decline in fertility during NFHS-2 to NFHS-3 period in India and states is largely explained by increase in contraceptive use with a small contribution from rising age at marriage.
- The fertility decline during NFHS-3 to NFHS-4 period is due to increases in abortion and rising age at marriage. Change in use of contraception probably had only a small effect on changes in TFR.
- While CPR is a powerful determinant of fertility it is not the only determinant. Changes in other determinants, especially marriage and abortion, also need to be tracked to understand changes in TFR.

According to NFHS-4, the TFR in India is 2.2 children per women, which is close to replacement level. Twenty-four states have a TFR of 2.1 or below. For those states, we may not expect to see further fertility declines. Overall, 80 percent of demand for contraception is satisfied, and 72 percent of demand is satisfied with modern methods. Thus, there is some modest scope for increases in modern CPR in the future to replace less effective traditional methods and abortion. At the subnational level, there are still areas of high fertility, where increases in modern CPR would help couples reach their desired family size.

Unsafe abortion is the third leading cause of maternal deaths in India. Although there is a 72 percent demand satisfied with a modern method of contraception, the significant increase in abortion in the last 10 years indicates an unmet need for modern contraception especially in post-abortion and postpartum periods. In fact, NFHS-4 found 12.9 percent of women have an unmet need for contraception and another 5.7 percent are using traditional methods that have higher failure rates than modern contraception. A return to fertility (RTF) can occur as soon as one week following an abortion, resulting in repeat unintended pregnancy and repeat abortion. For postpartum women, RTF can occur within three weeks if not breastfeeding and six weeks if breastfeeding partially. RTF is at six months if exclusively breastfeeding. That is why counseling on lactational amenorrhea method, i.e., exclusive breastfeeding as a method of postpartum FP, is important in the postpartum period. Women may not know about RTF and, in many cases, health care workers may also not be familiar with RTF, leading to unintended pregnancies. The increase in abortion and unintended pregnancies calls for increased capacity building of health care workers in RTF and post-abortion care. Similarly, strengthening the health care worker capacity in postpartum family planning, including lactational amenorrhea method and immediate postpartum family planning, should be considered to reduce both unintended pregnancies and pregnancies that are closely spaced.

# ANNEX A. FERTILITY DECOMPOSITION RESULTS

Fertility decomposition results arranged separately for those set of determinants impacting fertility reductions and fertility increasing, India

| Determinants | Fertility reducing factors | | Fertility increasing factors | |
|---|---|---|---|---|
| | NFHS-2 to NFHS-3 | NFHS-3 to NFHS-4 | NFHS-2 to NFHS-3 | NFHS-3 to NFHS-4 |
| Marriage index $(C_m)$ | 22.1% | 37.8% | | |
| Postpartum insusceptibility *(PPI)* index $(C_i)$ | | | 89.7% | 31.9% |
| Contraception index $(C_c)$ | 77.9% | | | 68.1% |
| Induced abortion index $(C_a)$ | | 62.2% | 10.3% | |

# ANNEX B. STATES INCLUDED IN ANALYSIS

List of 18 states included in the analysis

1. Andhra Pradesh [AP]
2. Assam [AS]
3. Bihar [BH]
4. Delhi [DL]
5. Gujarat [GJ]
6. Goa [GO]
7. Himachal Pradesh [HP]
8. Haryana [HR]
9. Karnataka [KA]
10. Kerala [KE]
11. Maharashtra [MH]
12. Madhya Pradesh [MP]
13. Odisha [OD]
14. Punjab [PJ]
15. Rajasthan [RJ]
16. Tamil Nadu [TN]
17. Uttar Pradesh [UP]
18. West Bengal [WB]

# ANNEX C. CORRELATION BETWEEN P-D INDICES AND TFR FOR DIFFERENT NFHS WAVES

**FIGURE C.1 MARRIAGE INDEX ($C_m$) AND TOTAL FERTILITY RATE (TFR), NFHS-2**

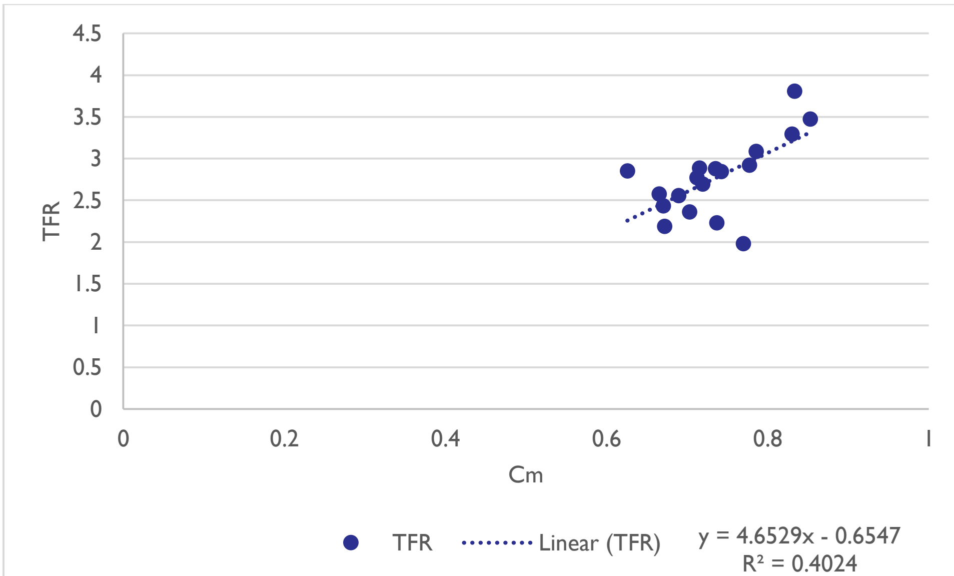



**FIGURE C.2 CONTRACEPTIVE INDEX ($C_c$) AND TOTAL FERTILITY RATE (TFR), NFHS-2**

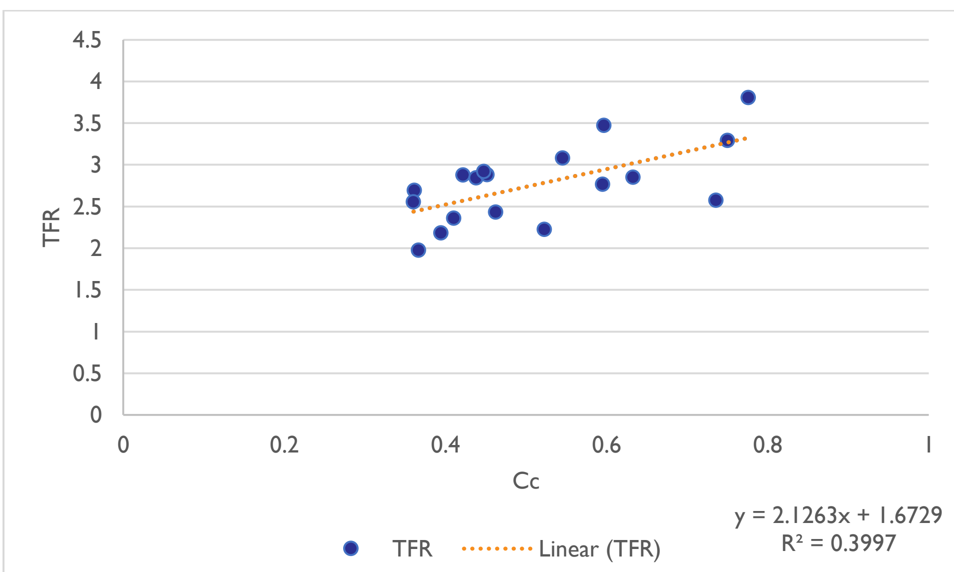


**FIGURE C.3 POSTPARTUM INSUSCEPTIBILITY INDEX ($C_i$) AND TOTAL FERTILITY RATE (TFR), NFHS-2**

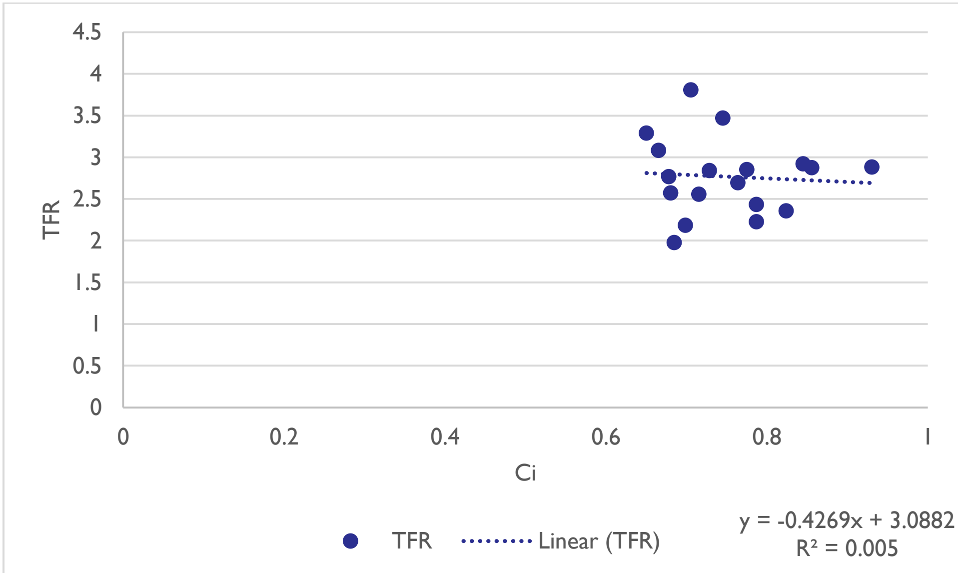
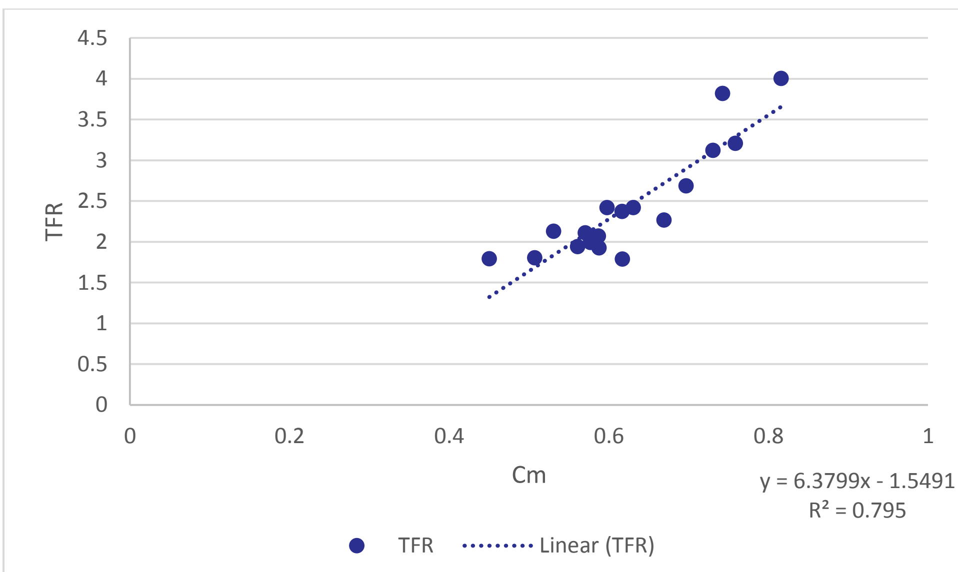
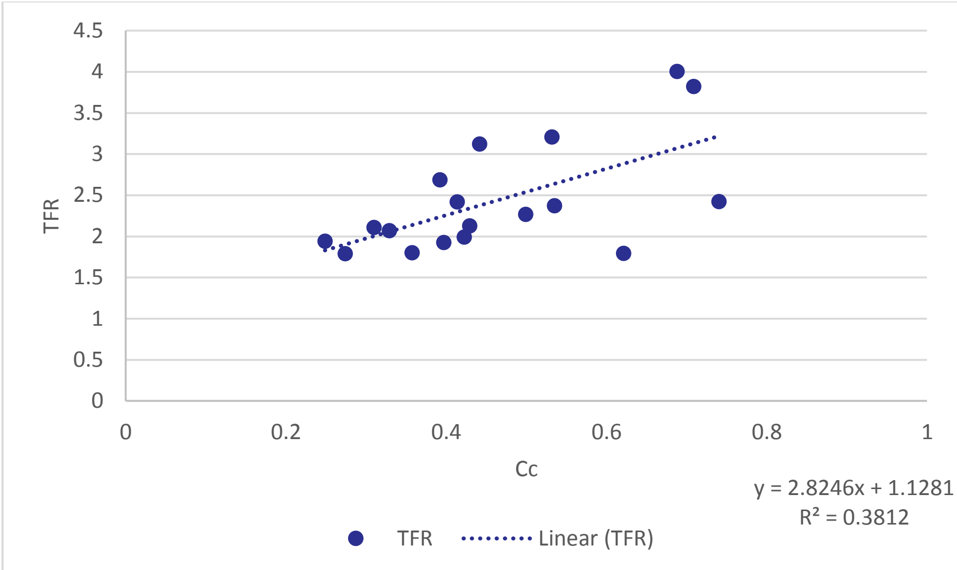


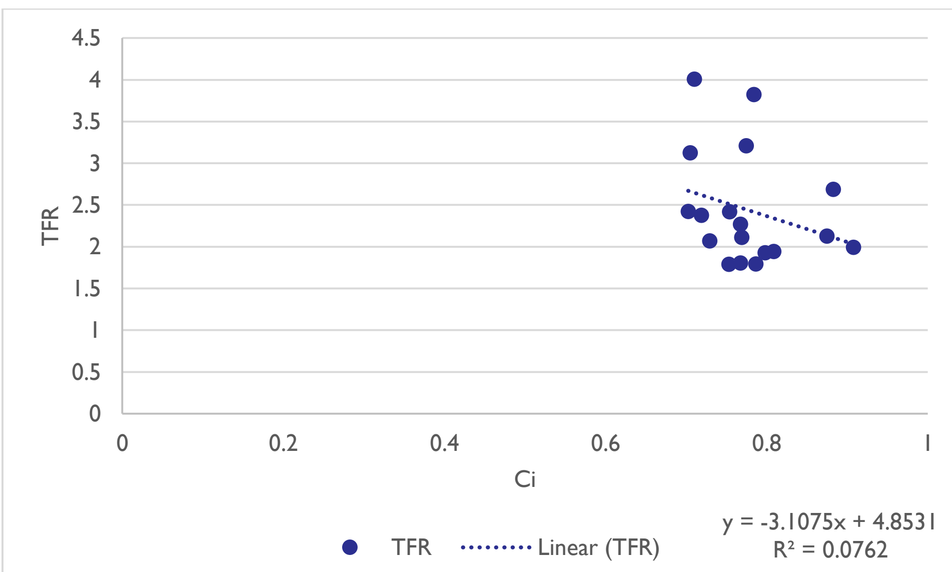

**FIGURE C.4 MARRIAGE INDEX ($C_m$) AND TOTAL FERTILITY RATE (TFR), NFHS-3**



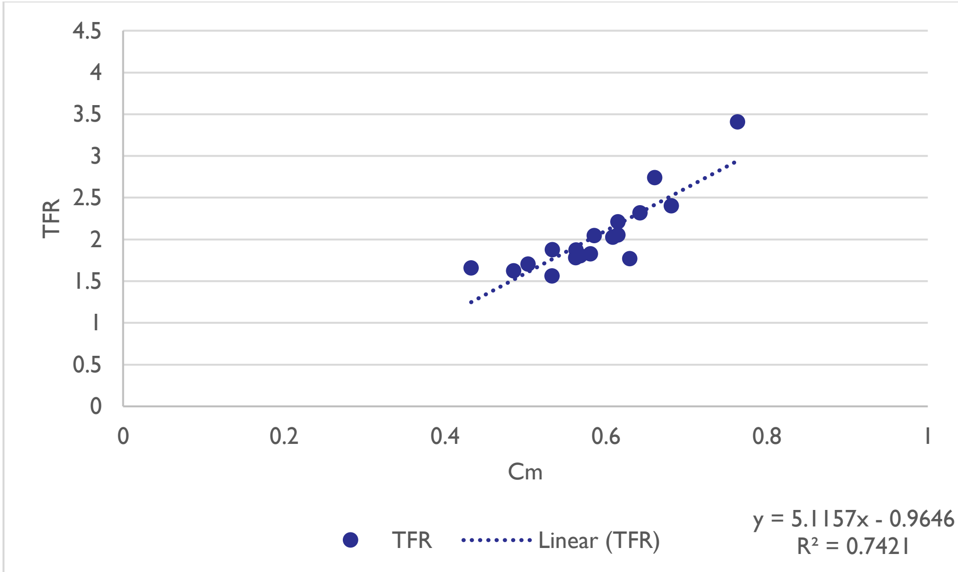
### FIGURE C.5 CONTRACEPTIVE INDEX ($C_c$) AND TOTAL FERTILITY RATE (TFR), NFHS-3




### FIGURE C.6 POSTPARTUM INSUSCEPTIBILITY INDEX ($C_i$) AND TOTAL FERTILITY RATE (TFR), NFHS-3



### FIGURE C.7 MARRIAGE INDEX ($C_m$) AND TOTAL FERTILITY RATE (TFR), NFHS-4




### FIGURE C.8 CONTRACEPTIVE INDEX ($C_c$) AND TOTAL FERTILITY RATE (TFR), NFHS-4

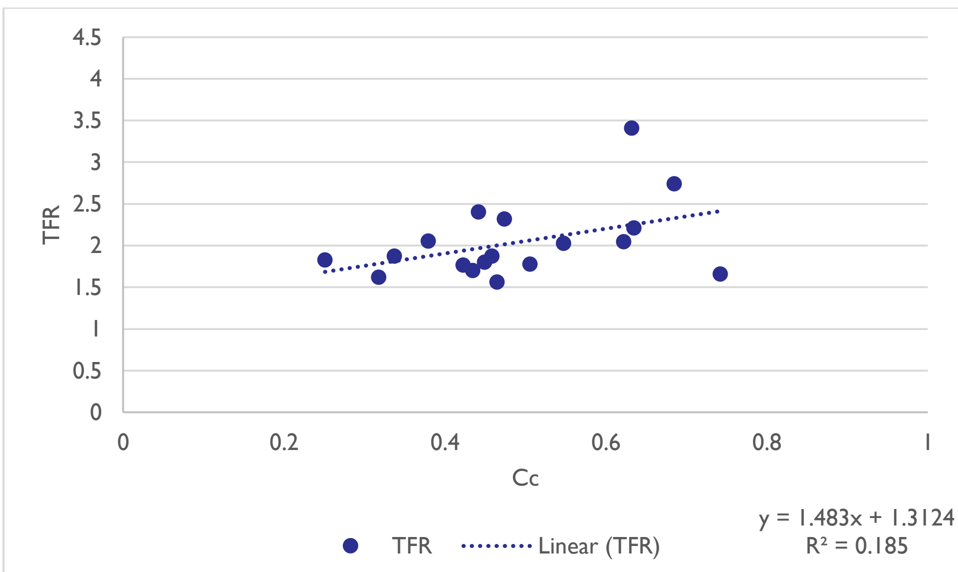
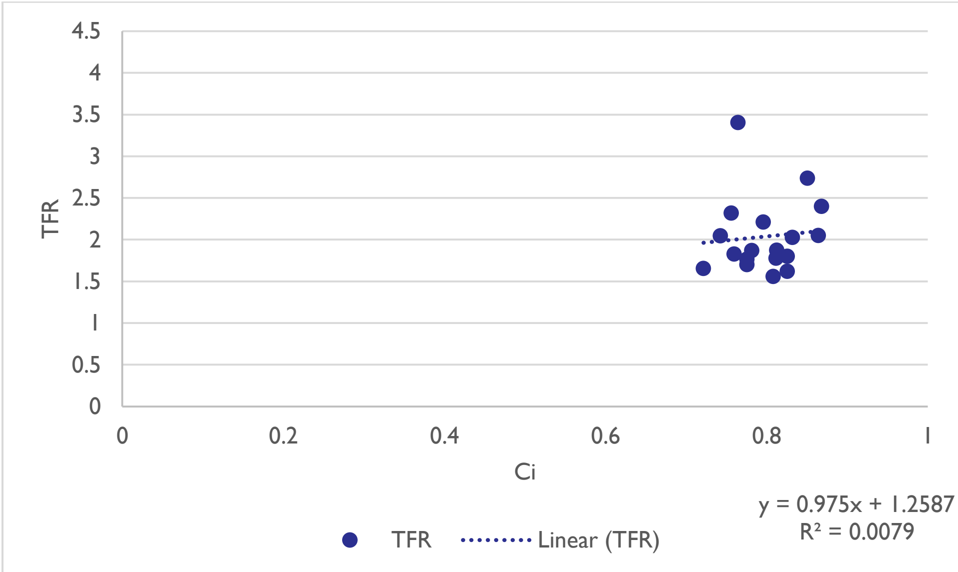


**FIGURE C.9 POSTPARTUM INSUSCEPTIBILITY INDEX ($C_i$) AND TOTAL FERTILITY RATE (TFR), NFHS-4**



# ANNEX D. FULL SET OF AGE-SPECIFIC GRAPHS FOR 18 STATES, NFHS-3 AND NFHS-4

**FIGURE D.1 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), ANDHRA PRADESH, NFHS-3**

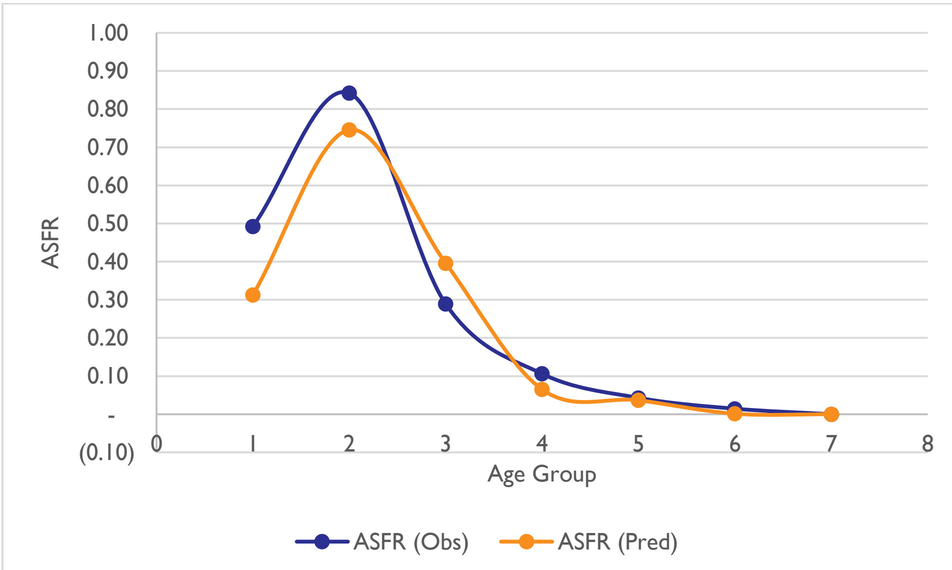



**FIGURE D.2 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), ANDHRA PRADESH, NFHS-4**

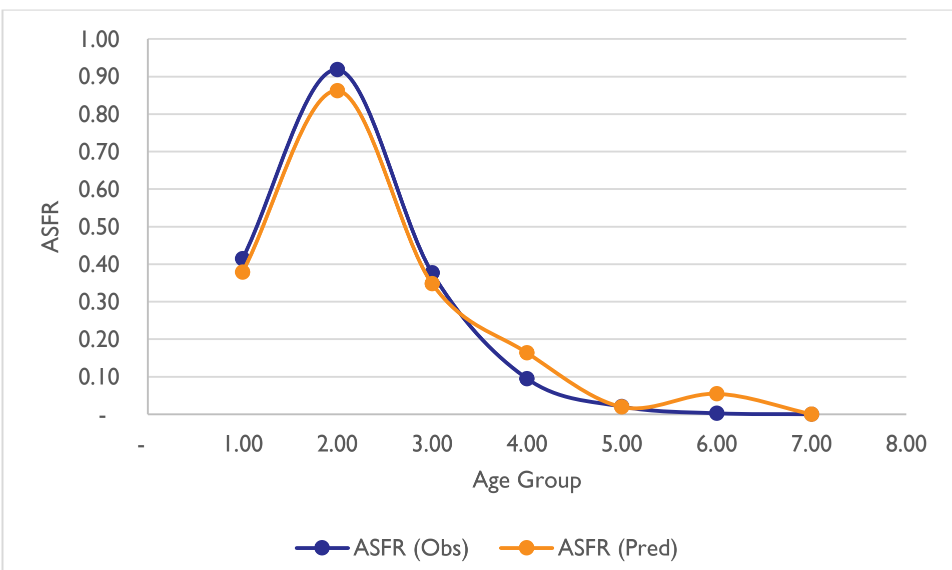


**FIGURE D.3 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), ASSAM, NFHS-3**

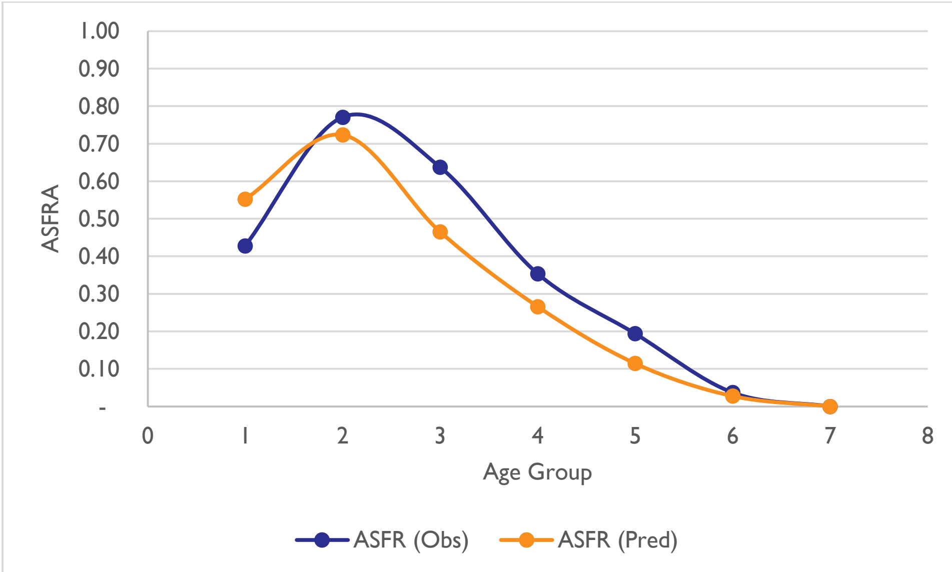



**FIGURE D.4 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), ASSAM, NFHS-4**

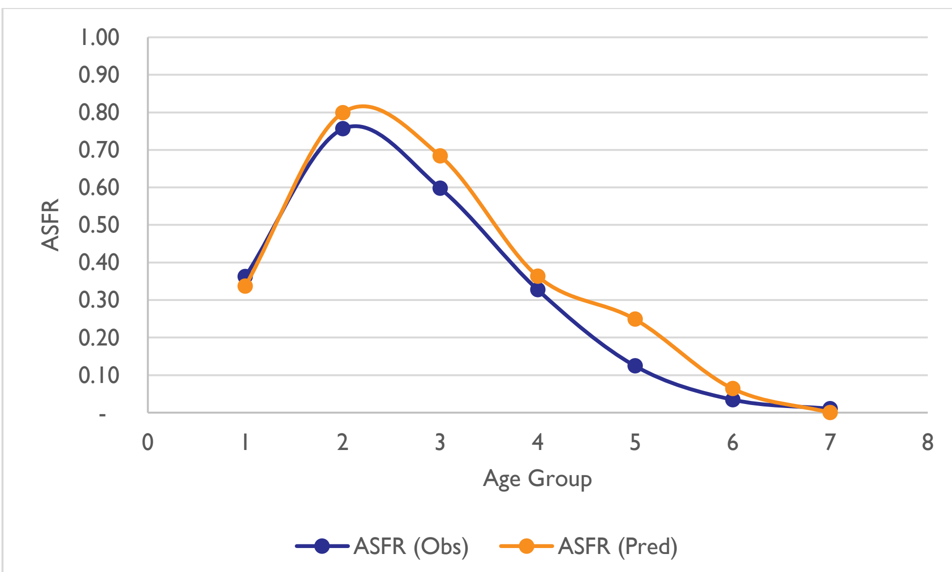


**FIGURE D.5 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), BIHAR, NFHS-3**

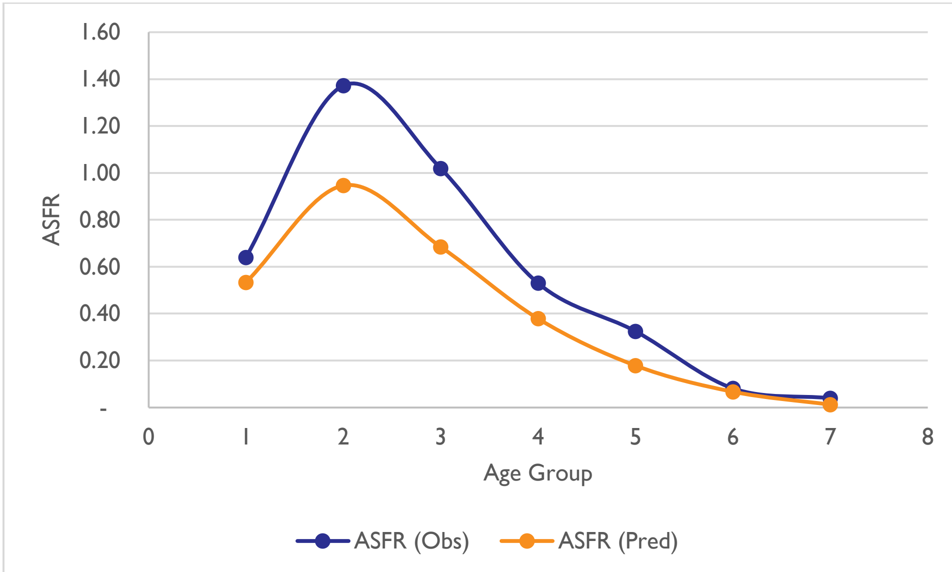



**FIGURE D.6 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), BIHAR, NFHS-4**

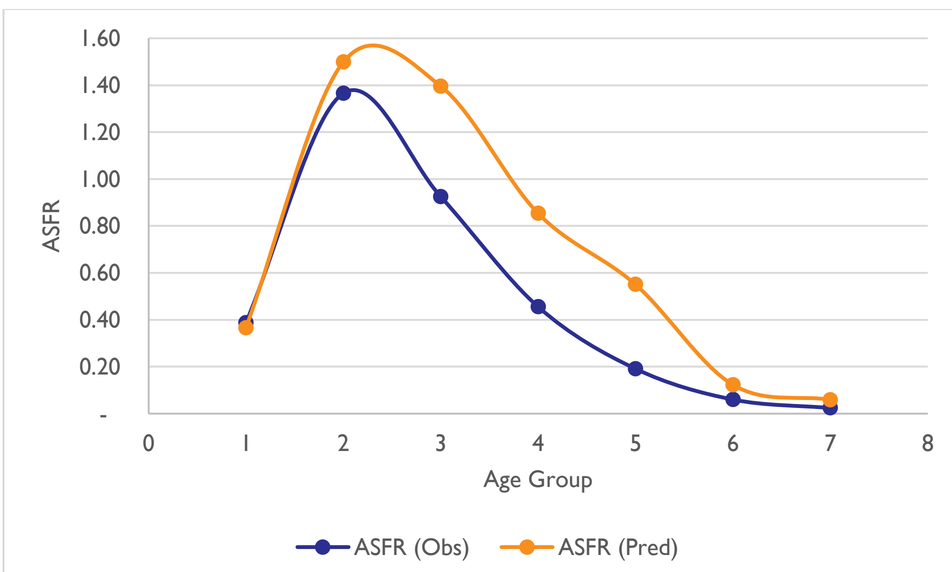


**FIGURE D.7 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), DELHI, NFHS-3**

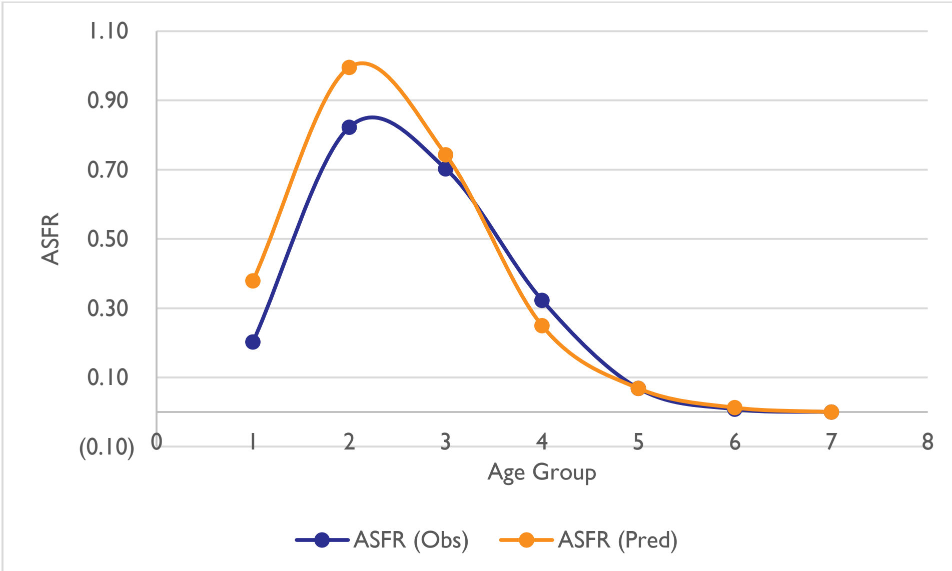



**FIGURE D.8 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), DELHI, NFHS-4**

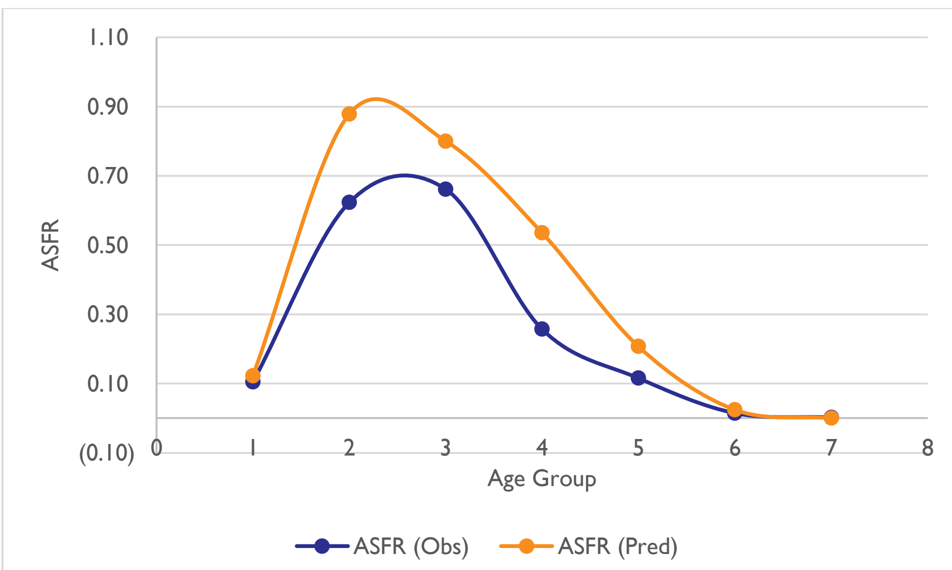


**FIGURE D.9 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), GUJARAT, NFHS-3**

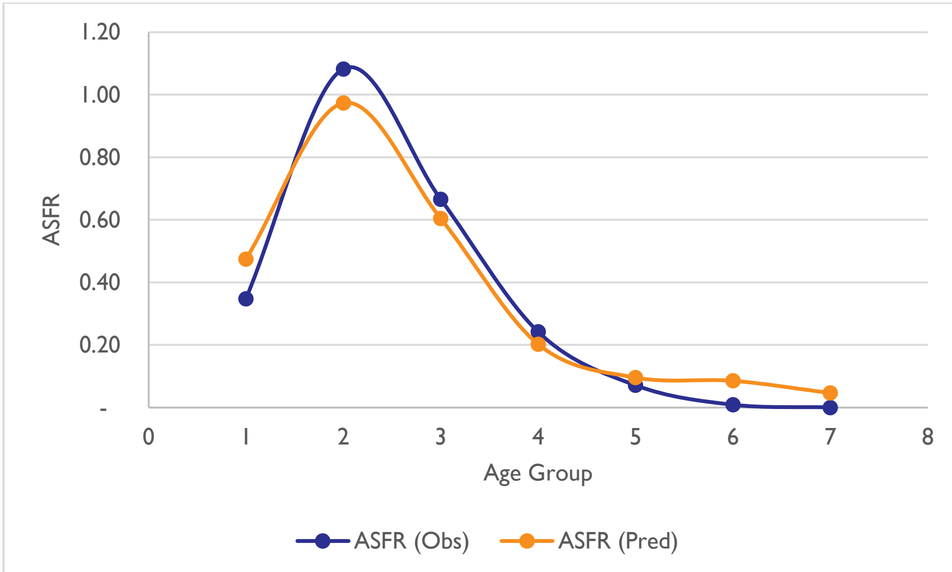



**FIGURE D.10 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), GUJARAT, NFHS-4**

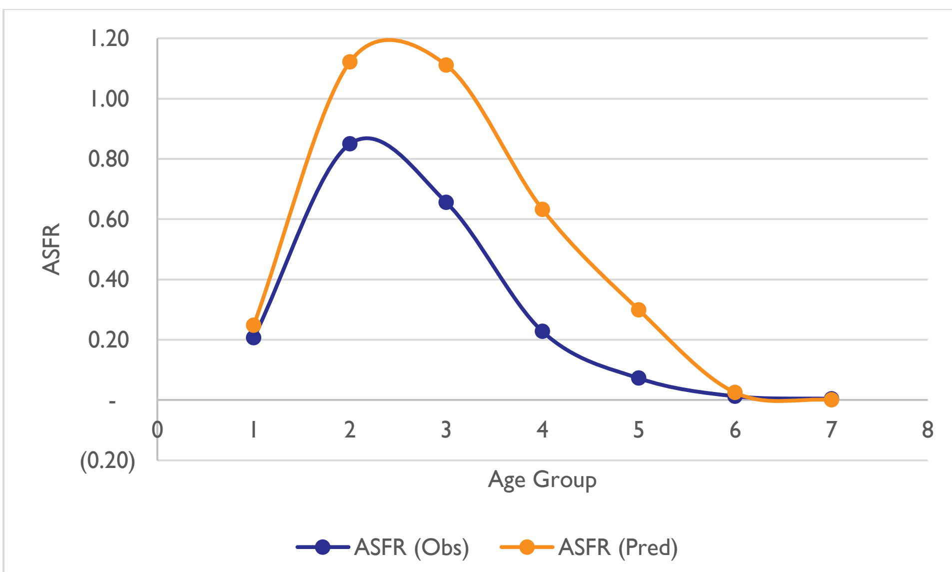


**FIGURE D.11 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), GOA, NFHS-3**

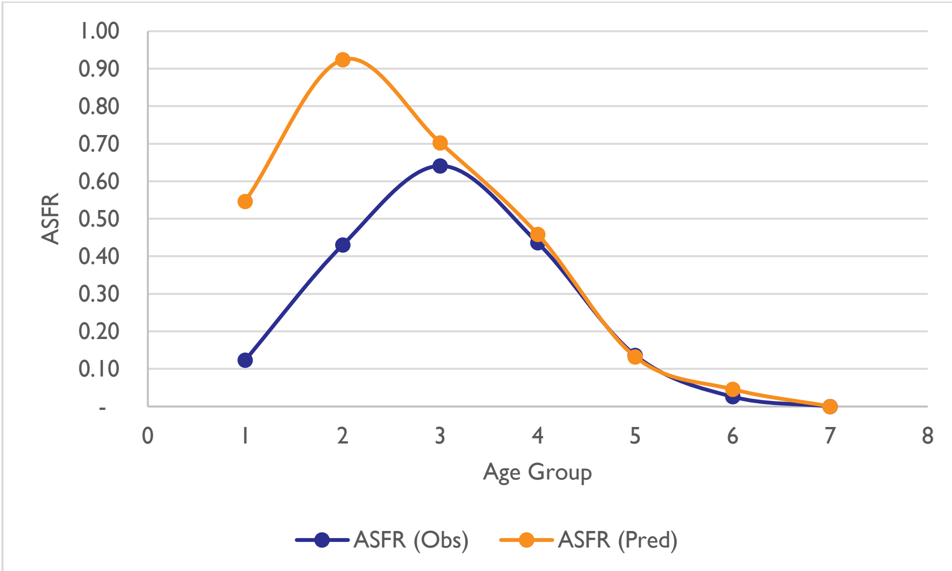



**FIGURE D.12 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), GOA, NFHS-4**

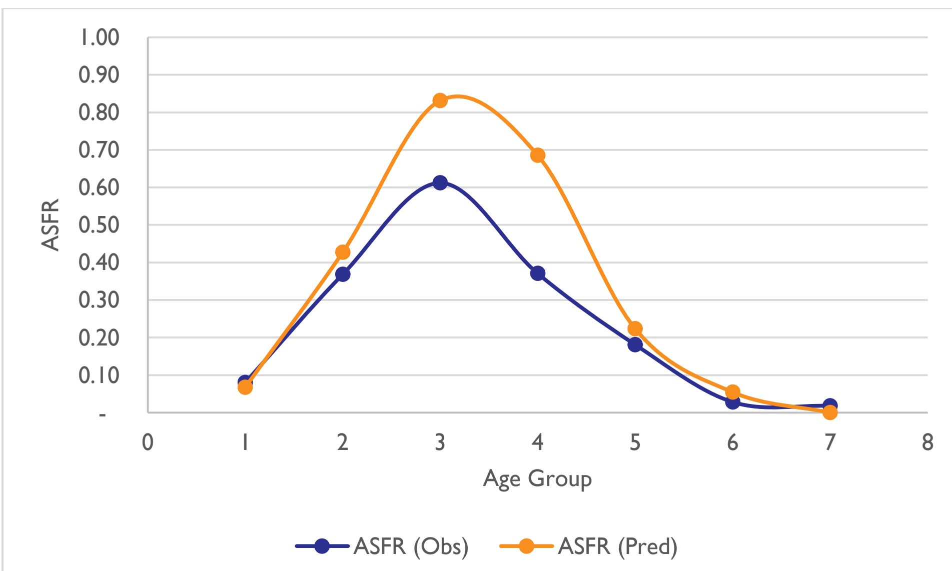
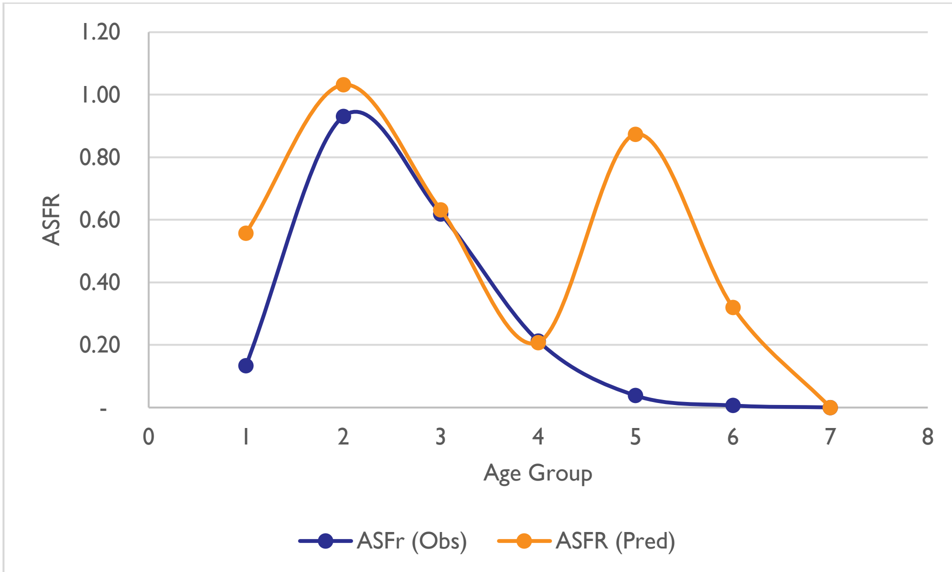


**FIGURE D.13 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), HIMACHAL PRADESH, NFHS-3**




Spike in TF values for age group 35-39 in NFHS2; perhaps due to quite high CPR in this age group.

**FIGURE D.14 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), HIMACHAL PRADESH, NFHS-4**

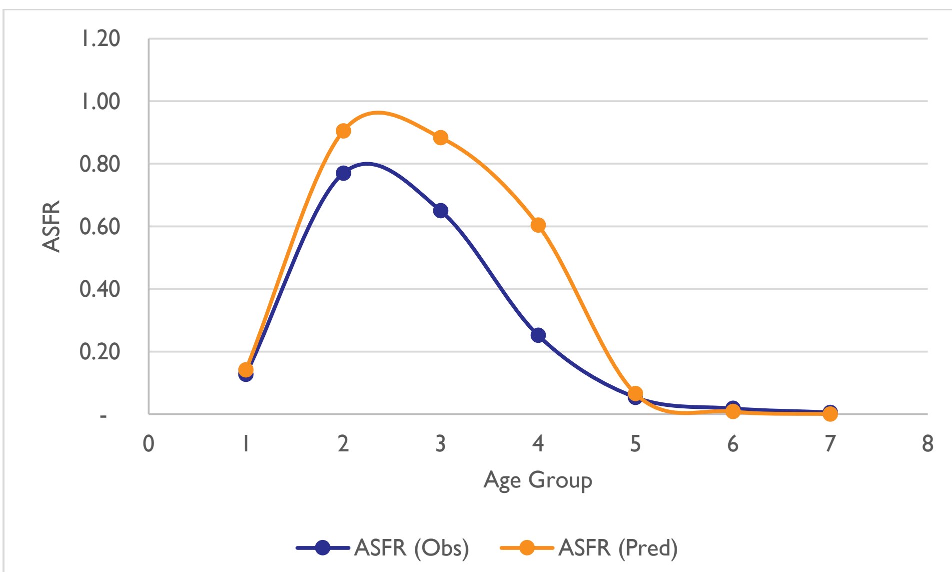


FIGURE D.15 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), HARYANA, NFHS-3

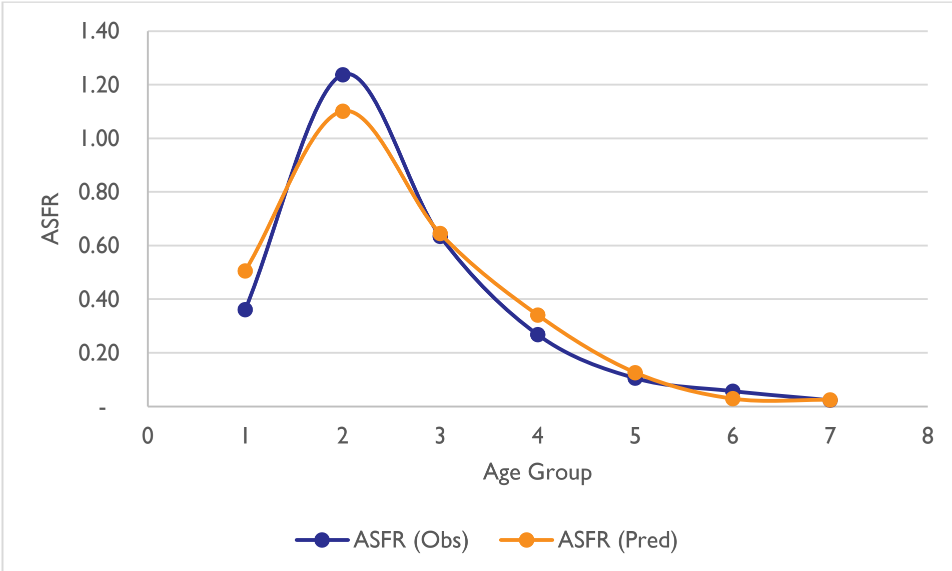



FIGURE D.16 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), HARYANA, NFHS-4

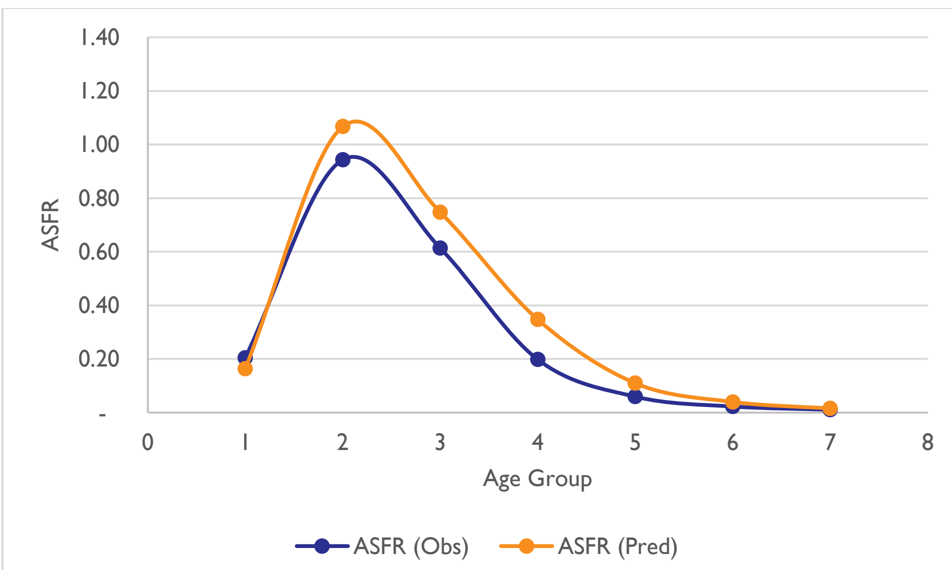


**FIGURE D.17 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), KARNATAKA, NFHS-3**

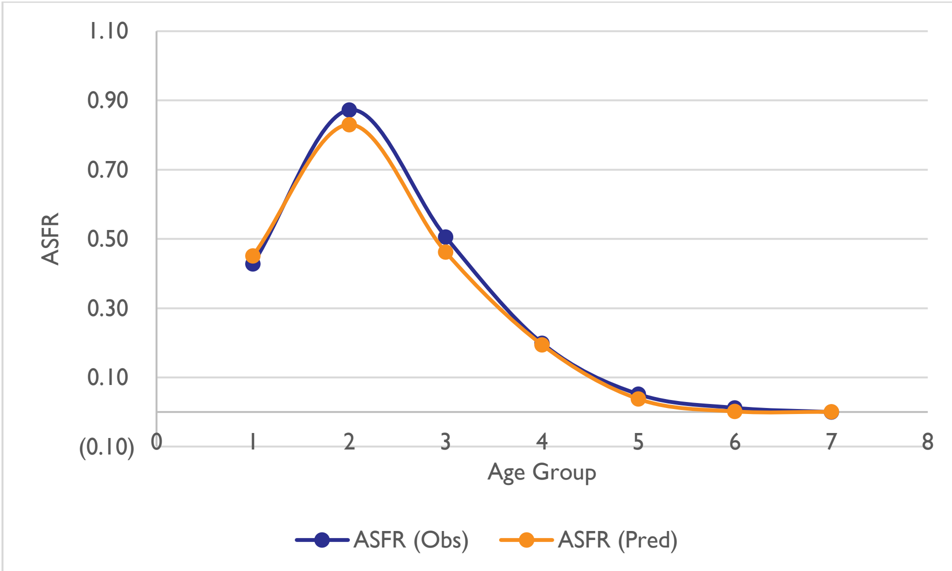
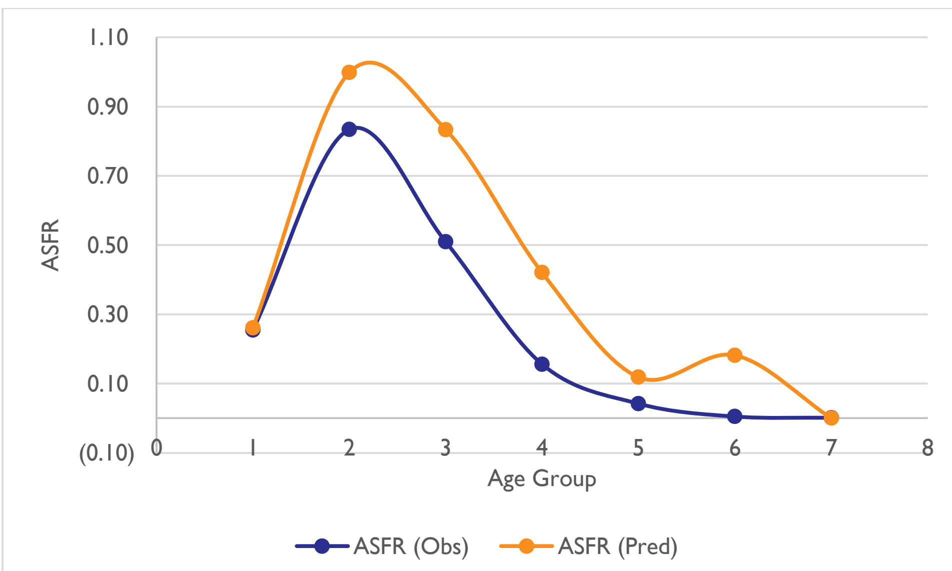
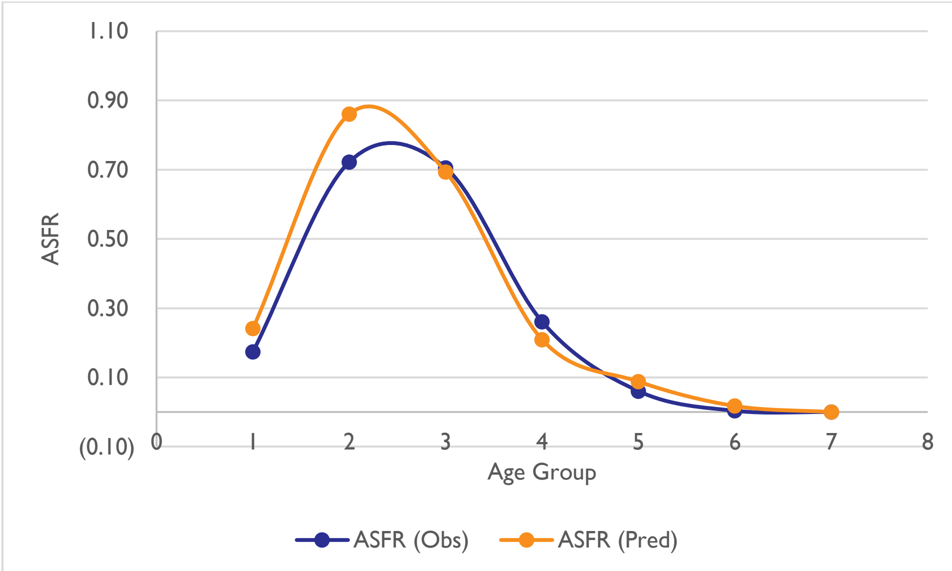



**FIGURE D.18 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), KARNATAKA, NFHS-4**



### FIGURE D.19 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), KERALA, NFHS-3




### FIGURE D.20 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), KERALA, NFHS-4

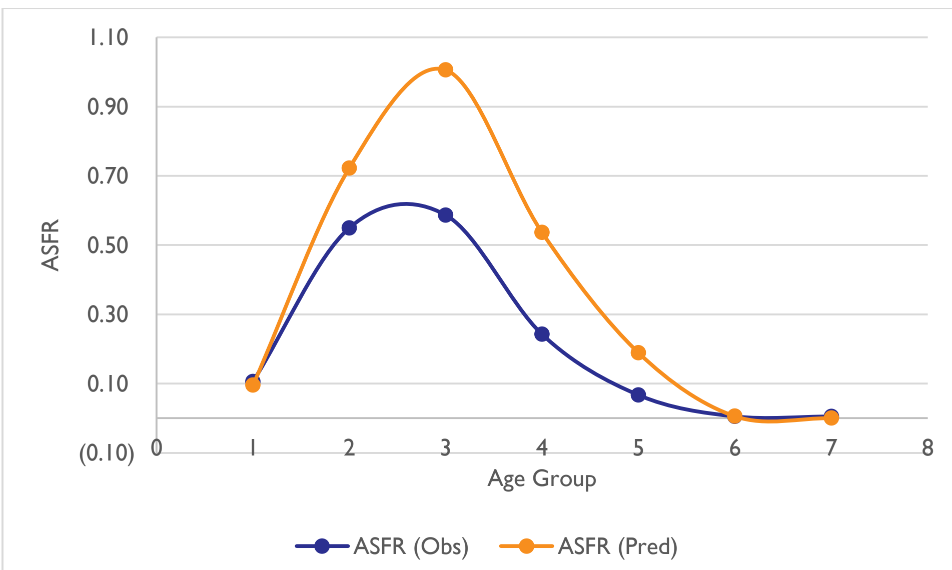


**FIGURE D.21 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), MAHARASHTRA, NFHS-3**

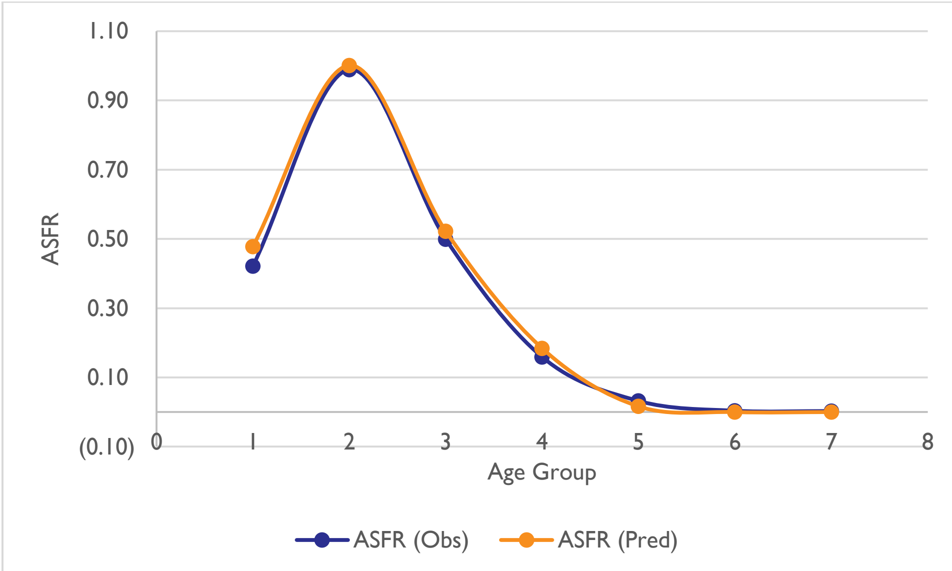



**FIGURE D.22 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), MAHARASHTRA, NFHS-4**

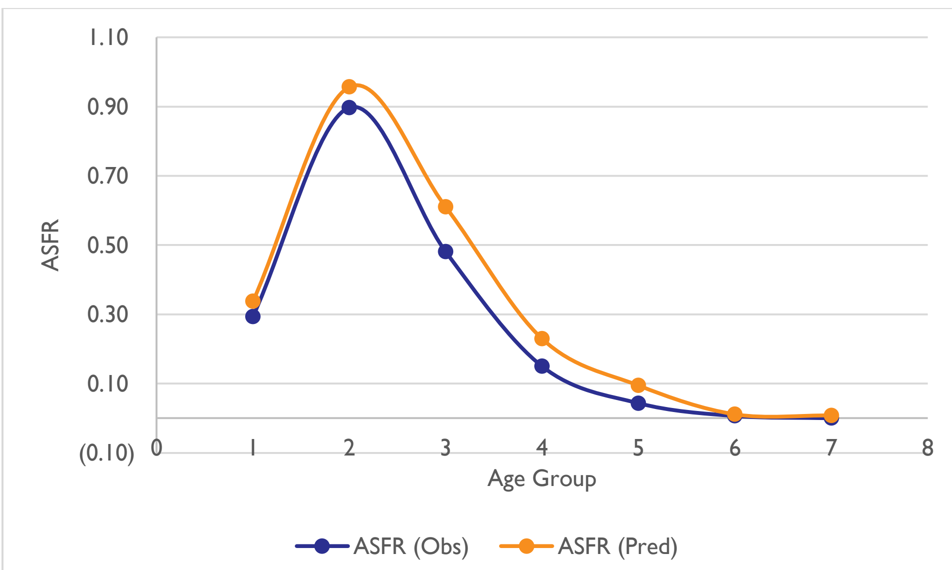


**FIGURE D.23 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), MADHYA PRADESH, NFHS-3**

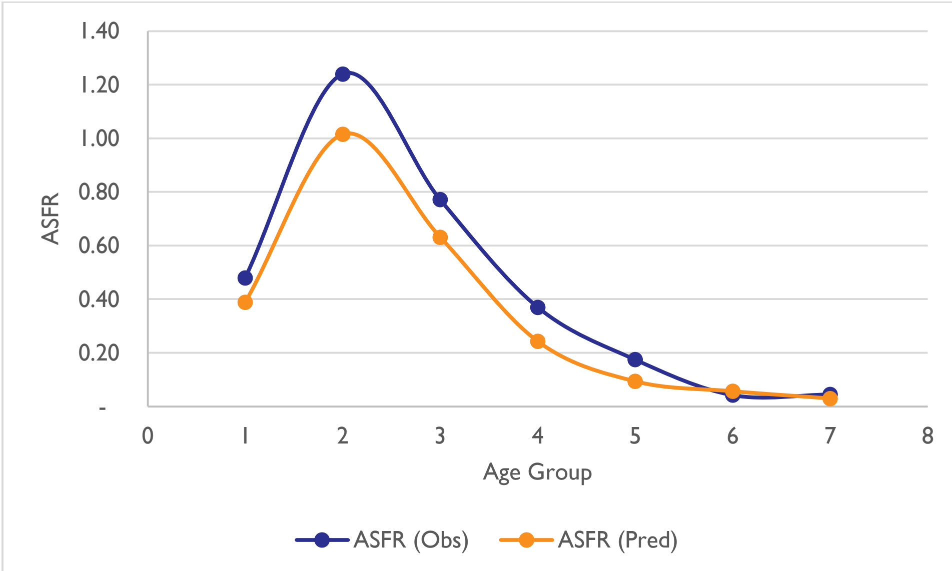



**FIGURE D.24 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), MADHYA PRADESH, NFHS-4**

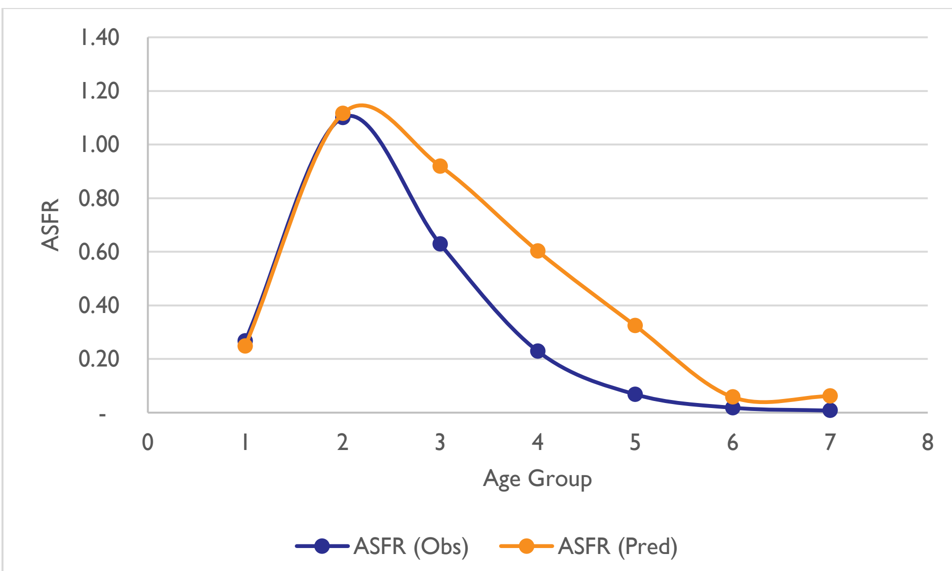


**FIGURE D.25 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), ODISHA, NFHS-3**

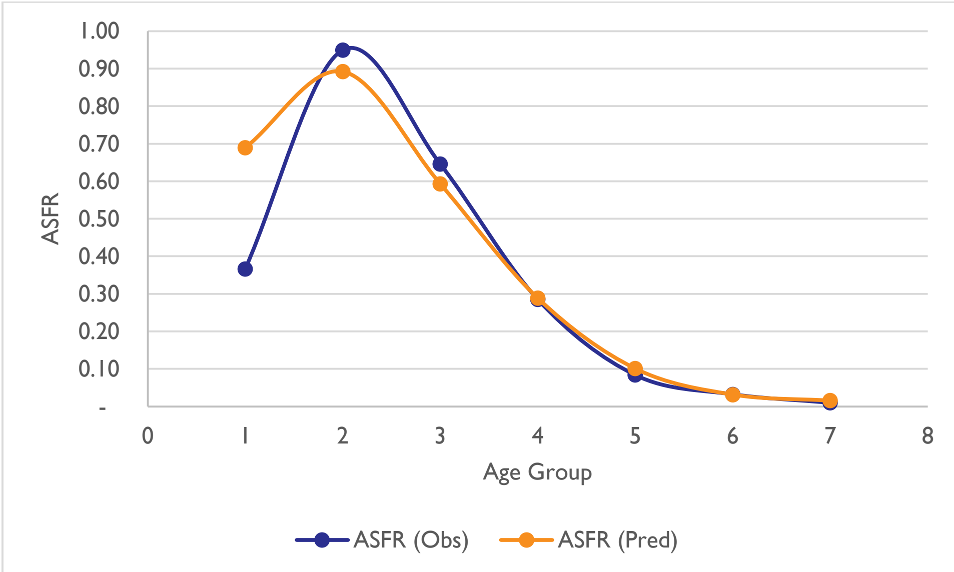



**FIGURE D.26 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), ODISHA, NFHS-4**

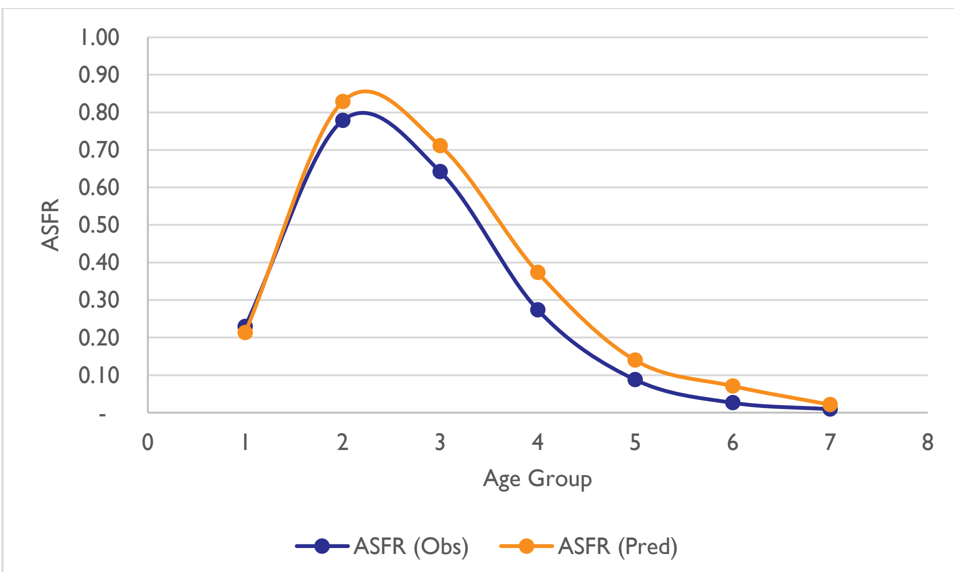


**FIGURE D.27 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), PUNJAB, NFHS-3**

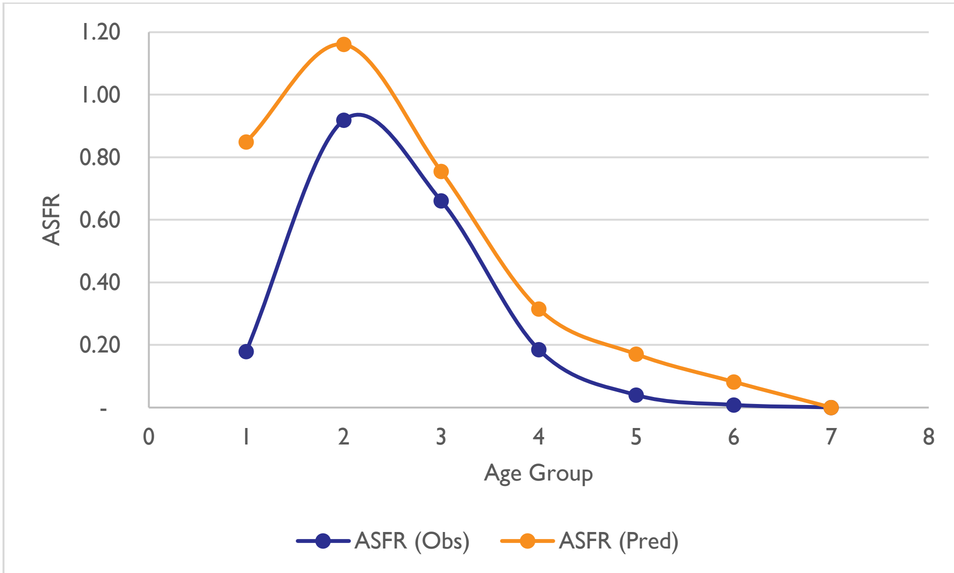



**FIGURE D.28 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), PUNJAB, NFHS-4**

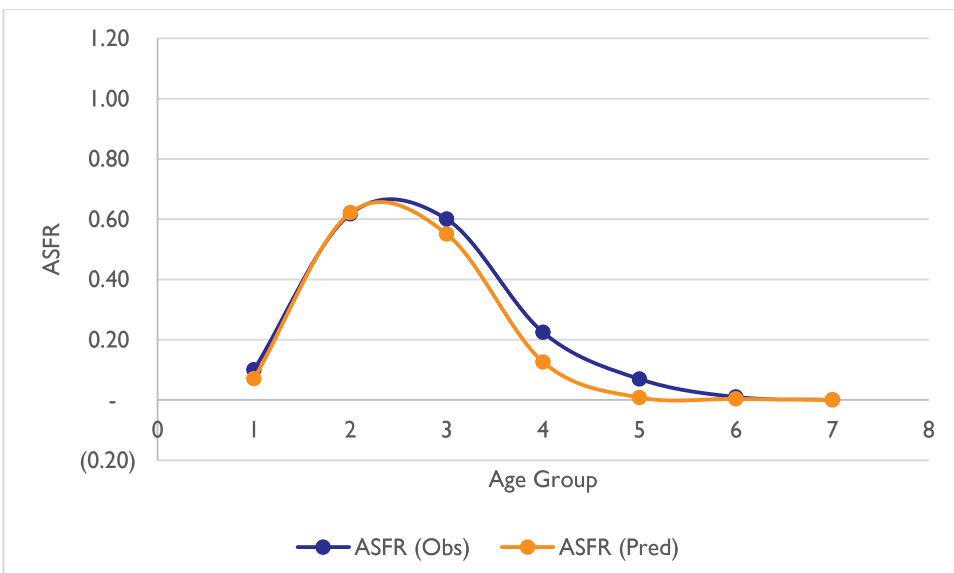


**FIGURE D.29 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), RAJASTHAN, NFHS-3**

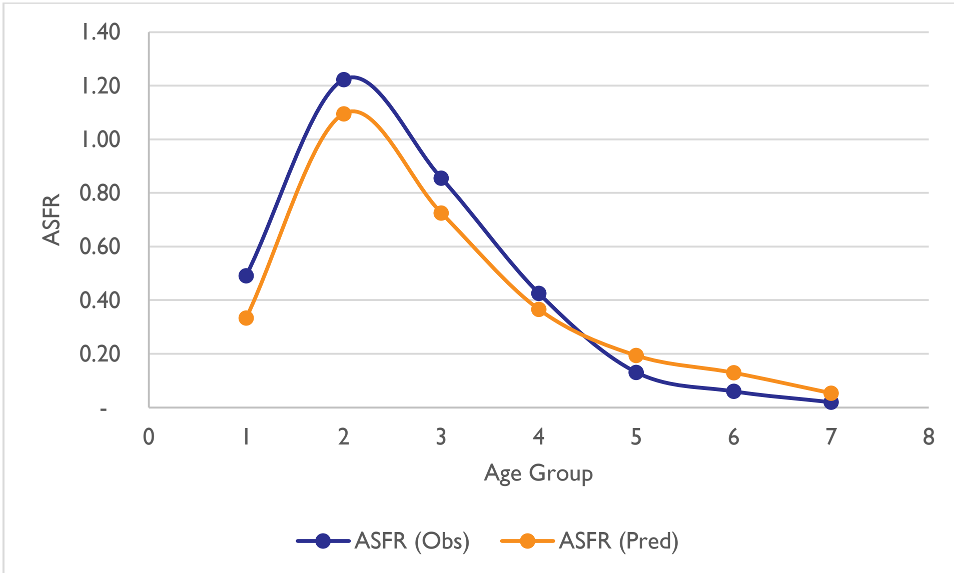
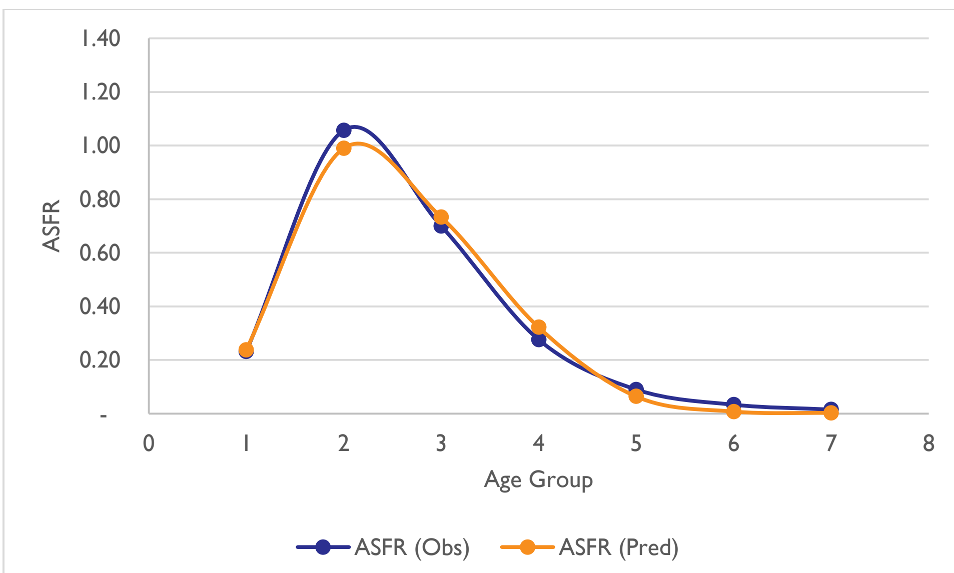
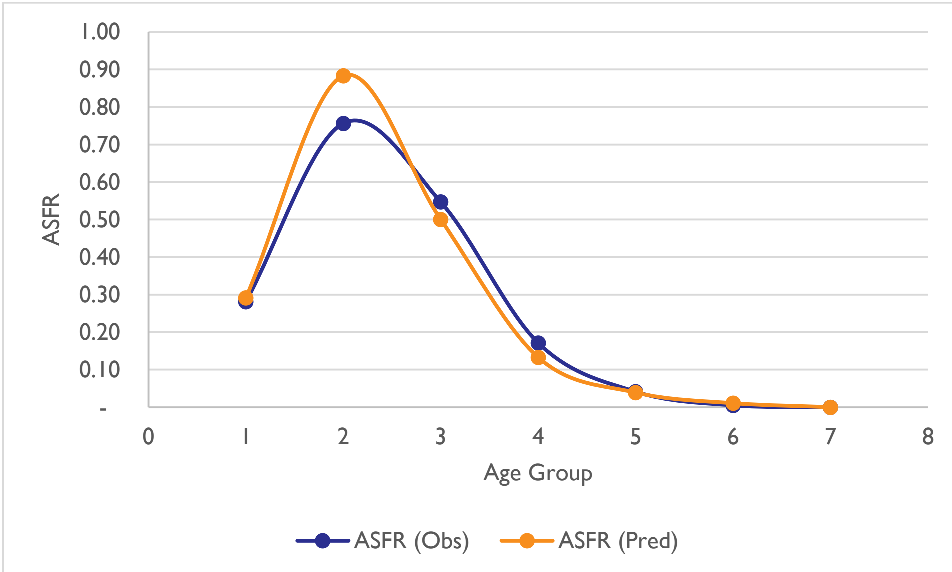



**FIGURE D.30 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), RAJASTHAN, NFHS-4**



### FIGURE D.31 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), TAMIL NADU, NFHS-3




### FIGURE D.32 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), TAMIL NADU, NFHS-4

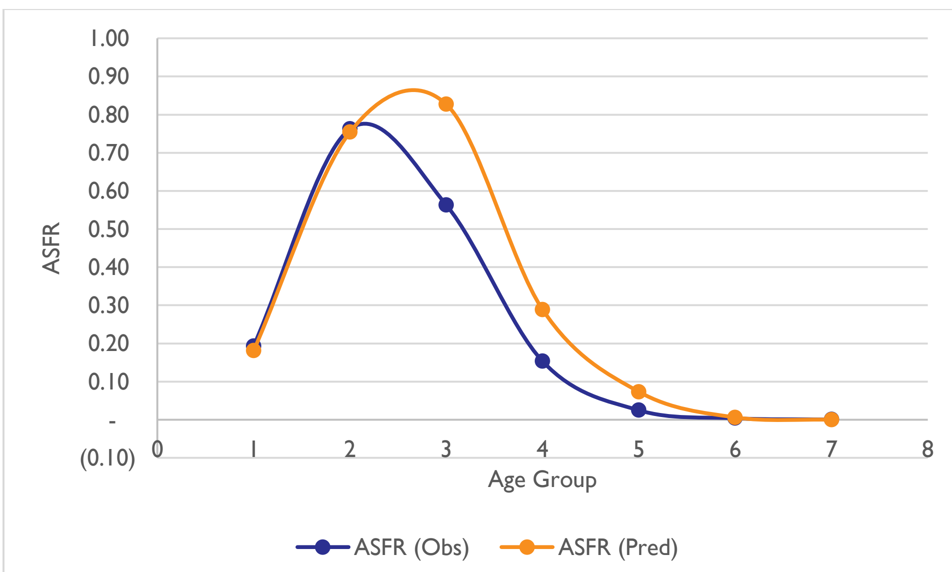


**FIGURE D.33 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), UTTAR PRADESH, NFHS-3**

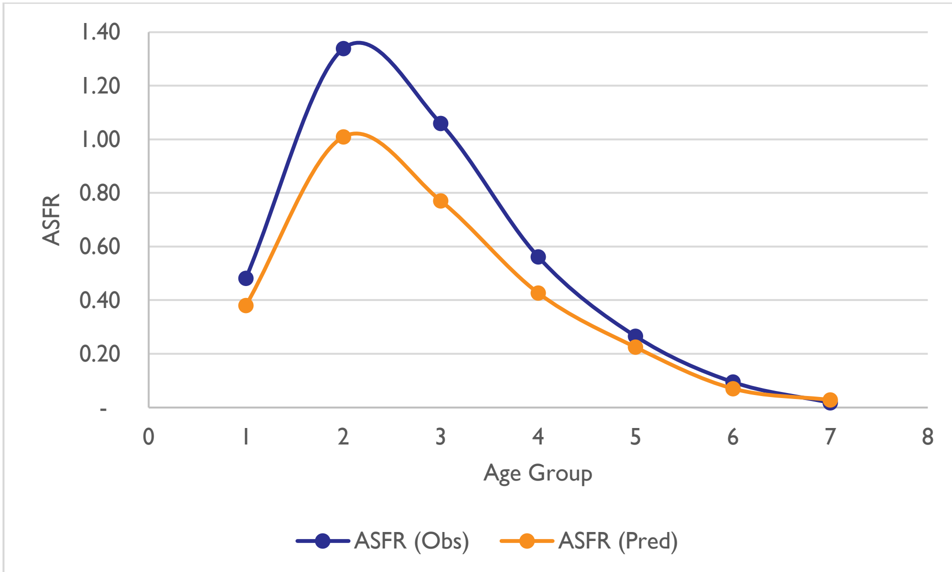
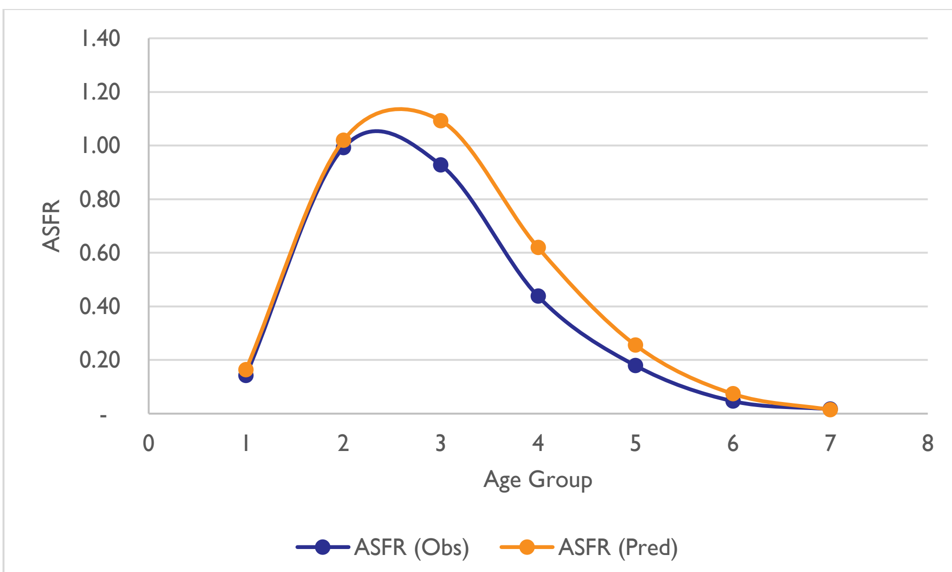
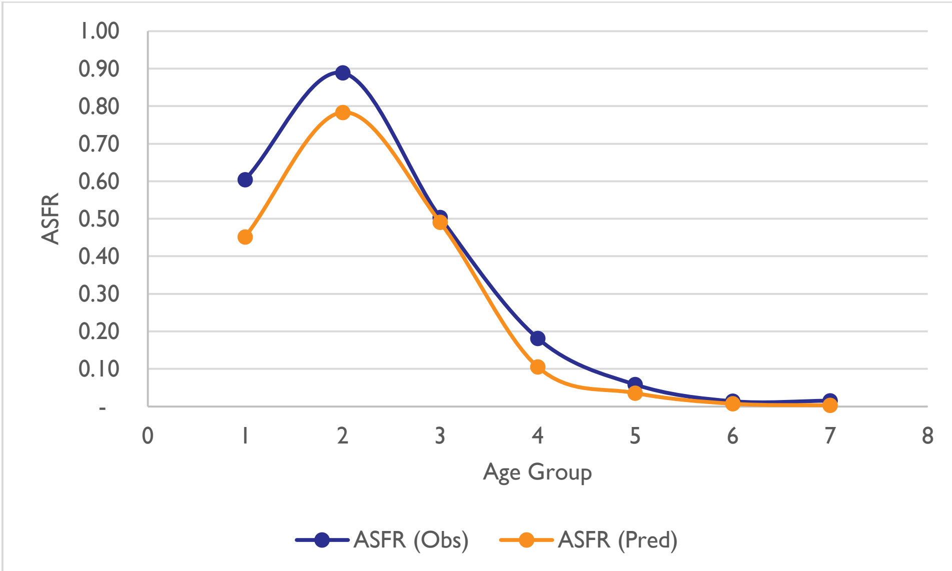


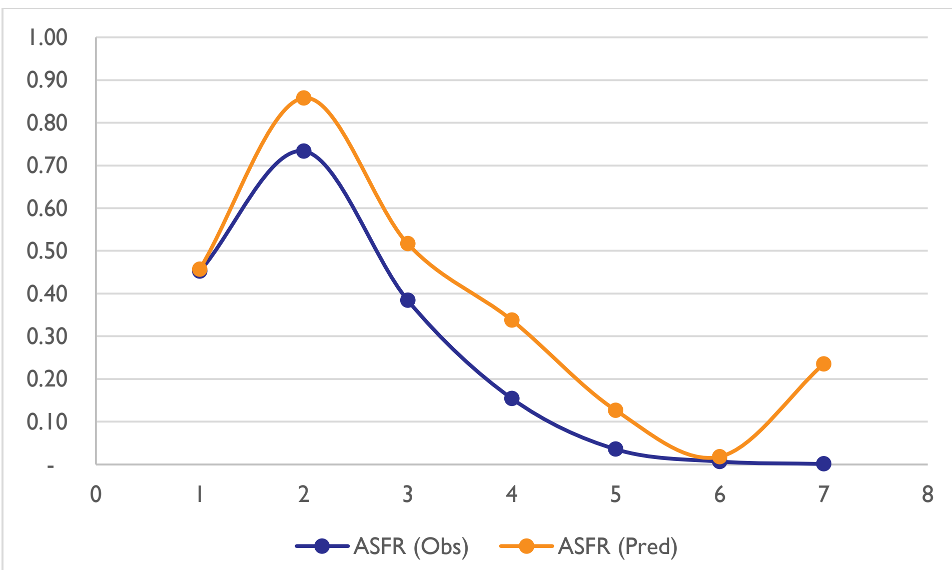

**FIGURE D.34 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), UTTAR PRADESH, NFHS-4**



## FIGURE D.35 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), WEST BENGAL, NFHS-3




## FIGURE D.36 OBSERVED AND MODEL PREDICTED AGE SPECIFIC FERTILITY RATES (ASFR), WEST BENGAL, NFHS-4




A spike in TF value for the age group 45-49 in NFHS3.

# ANNEX E. REFERENCES


Alazbih NM, Tewabe GN, and Demissie TD. 2017. Contraception and fertility transition in AMHARA National Regional State of ETHIOPIA: an application of BONGAARTS' model. *Fertility research and practice* 3(1): 12.

Bongaarts J. 1978. A framework for analyzing the proximate determinants of fertility. *Population and development review* 1: 105-132.

Bongaarts J and Potter R. 1983. *Fertility, biology, and behaviour: An analysis of the proximate determinants*. New York. Academic Press.

Bongaarts J. 2015. Modeling the fertility impact of the proximate determinants: Time for a tune-up. *Demographic Research* 33(19): 535-560.

Bradley S, Polis C, Bankole A, and Croft A. 2017. Global Contraceptive Failure Rates: Who Is Most at Risk? Paper presented at 2017 Annual Meeting of Population Association of America, Chicago, USA, April 27-29, 2017.

Casterline J, Singh S, Cleland J, and Ashurst H. 1984. The proximate determinants of fertility. *WFS Comparative Studies* no. 39. Voorburg, Netherlands: International Statistics Institute.

Davis K and Blake J. 1956. Social structure and fertility: An analytical framework. *Economic development and cultural change* 4(3): 211-235.

Hobcraft J and Little RJA. 1985. Fertility Exposure Analysis: A New Method for Assessing the Contribution of Proximate Determinants to Fertility Differentials. *Population Studies* 38(1): 21–45.

IPAS Press release, 2017. Accessed on April 2018. https://www.ipasdevelopmentfoundation.org/Press_Release_CAC_Conclave_IDF_11_7_17.pdf

International Institute for Population Sciences (IIPS) and ORC Macro. 2000. *National Family Health Survey (NFHS-2), 1998-99: India*. Mumbai: IIPS.

International Institute for Population Sciences (IIPS) and Macro International. 2007. *National Family Health Survey (NFHS-3), 2005-06: India*. Mumbai: IIPS.

International Institute for Population Sciences (IIPS) and ICF. 2017. *National Family Health Survey (NFHS-4), 2015-16: India*. Mumbai: IIPS.

Miller G and Valente C. 2016. Population policy: Abortion and modern contraception are substitutes. *Demography* 53(4): 979-1009.

Singh S, Casterline J, and Cleland J. 1985. The proximate determinants of fertility: Sub-national variations. *Population Studies* 39(1): 113-135.

Singh S, Shekar C, Acharya R, et al. 2018. The incidence of abortion and unintended pregnancy in India, 2015. *The Lancet Global Health* 6(1): e111-e120.

Stover J. 1998. Revising the proximate determinants of fertility framework: What have we learned in the past 20 years? *Studies in family planning* 29(3): 255-267.