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# Inequalities in Household Wealth in India: Evidence from National Family Health Survey, 2019-2021

Aalok Ranjan Chaurasia

## Abstract

This paper analyses the variation in the household wealth within India using data on selected household assets collected during the latest round of the National Family Health Survey, 2019-2021. The household wealth has been measured in terms of a composite household asset index that has been constructed based on the availability of selected assets in the household at the time of the survey. The analysis reveals that the distribution of the household wealth is different in different states and Union Territories of the country. The analysis also reveals that within-state and within-district inequality in the household wealth is very high in some districts of the country and many of these districts are those districts where the composite household asset index is high, on average. The paper calls for a household entitlement approach for the creation of household wealth.

## Introduction

It is universally recognised that gross domestic product (GDP) per capita is not an appropriate indicator to measure household material living standards (Stiglitz, 2009; Balestra and Tonkin, 2018). Alternatively, household income and household consumption expenditures have been suggested to measure household standard of living. A common problem with both these measures is their volatility. Income, for example, may change randomly or on a seasonal basis. Households also try to maintain core and nondiscretionary consumption expenditures in periods when household income is depleted, but not the discretionary expenditures. It is, therefore, argued that even the household income provides only a partial view of the economic resources available in a household to support individual consumption. In this context, it has been emphasised that household wealth should be considered as a measure of household living standard. Households can use wealth to consume more than their income or may consume less than their income and add to household wealth. Household wealth also allows individuals to smooth consumption over time and to protect them from unexpected changes in income. Households with reserves of wealth can also use them to generate capital income and to support higher standard of living. It is also argued that although, some wealth may be held as household assets that may not be easily converted into money, yet household assets allow household to borrow to meet financial expenditures and investments. As a measure of the household material well-being, household wealth has several advantages. It represents a more permanent status as compared to either household income or household consumption expenditures.

Household wealth can easily be measured and requires far fewer questions than either household consumption expenditures or household income (Rutstein and Johnson, 2004).

In addition to an alternative measure of household standard of living, the inequality or disparity in the wealth across households has now become a subject of increasing focus among the policymakers, the media, and the people. The reason is that wealth is very unequally distributed across households and all evidence suggests that the inequality in household wealth across households is increasing over time. The reduction in household wealth inequality matters in the context of sustainable development. The United Nations sustainable development agenda has called for eliminating inequality in all forms to make sure that no one is left behind (United Nations, 2015). Efforts to reduce household wealth inequality are directed towards increasing the financial resilience of vulnerable households, and to limit the increasing concentration of wealth at the top end of the distribution.

In this paper, we explore the regional perspective of the variation in household wealth in India. We measure household wealth in terms of a household asset index based on the availability or ownership of selected household assets by the household. The analysis has been carried out at national, state/Union Territory and district levels. The household asset index used in the present analysis also serves as an alternative measure of household standard of living which is not based on either the household income or the household consumption expenditures and, therefore, is a non-monetary measure of household standard of living. The household asset index has also been used to define asset poverty as the proportion of households which are asset-poor. The asset poverty presents a new perspective of household poverty which is different from the conventional income or consumption-based poverty rate which, as is well-known, has many limitations.

The rest of the paper is organised as follows. The next section of the paper describes the data used in the analysis and details on the construction of the household asset index. The analysis is based on the data available from the latest round of the National Family Health Survey 2019-2021 which covered 636699 households throughout the country selected in a statistically representative manner. The third section of the paper analyses the distribution of households in terms of the household asset index in the country, in its constituent states and Union Territories and in its 707 districts as they existed in the year 2017 – the reference year for the National Family Health Survey 2019-2021. The fourth section of the paper analyses the within-district inequality in the household standard of living as reflected in terms of the distribution of households in the district by the household asset index. The findings of the analysis are discussed in the fifth section of the paper from the regional perspective. The sixth and the last section of the paper summarises the main findings of the analysis and their development implications.

## Data and Methods

The analysis is based on the data available from the latest round of the National Family Health Survey, 2019-2021 (Government of India, 2022). The survey covered all states and Union Territories and the 707 districts of the country that existed at the time of the survey. The survey covered 636699 households in the country which were distributed across all the 707 districts. In each district, 900-1000 households were covered under the survey. The households in a district were selected through a statistically representative sampling procedure to provide statistically reliable estimates of selected health related indicators at the district level. Details about the selection of the sample households in the district and other aspects of the National Family Health Survey 2019-2021 are given elsewhere and not repeated here (Government of India, 2022).

The National Family Health Survey 2019-2021 has collected information about the availability of several household assets from every household covered during the survey. The information on the availability of a set of 12 household assets has been used in the present analysis to construct the household asset index. These include: 1) refrigerator, 2) Air conditioner, 3) washing machine, 4) sewing machine, 5) mobile phone, 6) watch, 7) electric fan, 8) colour television, 9) scooter/motorcycle/moped, 10) car/truck, 11) computer, and 12) landline telephone. Each household asset was given a value 1 if the asset was available in the household at the time of the survey and 0 otherwise. A household asset index was constructed based on the availability of the 12 household assets in for every house covered under the survey. At the first step the exploratory factor analysis procedure was used to combine the 12 household assets into mutually exclusive but independent factors based on the correlation of the availability of different household assets in the household. The factor analysis revealed that the 12 household assets can be combined into three factors which accounted for more than 50 per cent of the total variation in the original data set. The KMO measure was found to be 0.874 while the Bartlett's test of sphericity was found to be statistically significant. This means that factor analysis solution was adequate for grouping 12 household assets into three factors. The first factor had high loadings in the availability of refrigerator, air-conditioner, washing machine and sewing machine which means that the availability of these four household assets in a household is highly correlated. This factor accounted for almost 21 per cent of the total variation in the original data set. The second factor had high loadings in the availability of mobile phone, watch, electric fan, colour television and scooter/motorcycle/moped in the household and accounted for almost 17 per cent of the total variation in the original dataset. Finally, the third factor had high loadings in the availability of car/truck, computer and landline telephone in the household and accounted for almost 13 per cent of the total variation in the original dataset. The three factors identified through the exploratory factor analysis were retained for the construction of the composite household asset index.

The construction of the composite household asset index required estimation of weights for each of the 12 household assets. The estimation of weights for each of the 12 indicators was done following a statistical approach (Nardo et al, 2005; Nicoletti et al, 2000). The weights so estimated reflect the contribution of each of the 12 household assets to the composite household asset index which is the weighted sum of household assets available in the household. The household asset index varies from the lowest possible value of 0 to the highest possible value of 1. If $a$ denotes the household asset and $w$ denotes the weight of the household asset, then the composite household asset index, $ai$, was calculated as

$$ai = \sum_{j=1}^{12} a_j \times w_j$$

The composite household asset index ranges from the minimum possible value of 0 to the maximum possible value of 1. When, a household has none of the 12 household assets, then

$ai$=0 for that household. On the other hand, when a household has all the 12 household assets, then $ai$=1 for 1 for the household. The household asset index $ai$ has been taken as the proxy for household wealth – the higher the composite household asset index, $ai$, the higher the household wealth and vice versa. Based on the index $ai$, households can be grouped into five categories in terms of their wealth status: poor ($ai<0.2$); below average ($0.2\leq ai<0.4$); average ($0.4\leq ai<0.6$); above average ($0.6\leq ai<0.8$); and rich ($ai\geq 0.8$).

It is well-known that the distribution of households by the availability of household assets in the household, measured in terms of the composite household asset, $ai$, is not statistically normal but is skewed. As such, the commonly used summary statistics of inequality such as the coefficient of variation cannot be used to measure the inequality in the availability of household assets across households because of the lack of robustness to outliers of the arithmetic mean and the standard deviation which are moment-based measures of the distribution. Alternative summary statistics of inequality for skewed distributions have, therefore, been suggested including coefficient of variability (Lovitt and Holtzclaw, 1929) or coefficient of quartile variation (Bonett, 2006) and median absolute deviation (MAD). In the present analysis, we measure the inequality across households in the composite household asset index, $ai$, in terms of the index of variation, $IV$, which is defined as

$$IV = \sqrt{\frac{\sum_h \left(\frac{ai_h}{ai_m} - 1\right)^2}{n}}$$

where $ai_h$ is the household asset index for the household $h$ and $ai_m$ is the median household asset index for all households. It may be noticed that when the distribution is statistically normal median of the distribution is the same as the arithmetic mean of the distribution and the index of variation is the same as the coefficient of variation. It may also be noticed than when $ai$ is the same for all households, $IV$=0 and the higher the $IV$ the higher the inequality in household wealth across households.

## Availability of Household Assets

The availability of the 12 household assets varies across the 636699 households covered during the National Family Health Survey, 2019-2021. The mobile telephone was nearly universally available in the households (Table 1). The second most commonly available household asset was electric fan. The availability of the watch and the colour television was also quite common in the households whereas car/truck was available in only about 7 per cent of the households and a computer was available in only around 9 per cent of the households. Motorcycle/Scooter was also available in almost half of the households at the time of the National Family Health Survey, 2019-2021. The rural urban divide in the availability of different household assets is also evident from the table. The availability of all the 12 household assets is relatively more common in the urban households as compared to the rural households of the country. This difference is particularly marked in case of the availability of the refrigerator and the computer in the household. If the availability of the 12 household assets is any indication, then household wealth in the urban areas of the country is substantially higher than the household wealth in the rural areas.

Table 1 also suggests that in approximately 2 per cent households, none of the 12 household assets was available at the time of the survey. This proportion was almost 7 times higher in rural households as compared to household urban households. Similarly, there were more than 5 per cent households in which any one of the 12 household assets was available at the time of the survey and the rural urban difference was again quite marked. On the other hand, there were only a small proportion of households in which all the 12 household assets were available at the time of the survey and the proportion of the urban households having all the 12 household assets was seven times higher than the proportion of rural households having all the 12 household assets. Table 1 highlights very high degree of disparity in the availability of selected household assets in the rural and urban areas of the country.

Table 1: Availability of selected household assets in the households in India, 2019-2021.

| Household asset | Total | Rural | Urban | Assets per household | Total | Rural | Urban |
|---|---|---|---|---|---|---|---|
| Refrigerator | 37.9 | 25.2 | 63.4 | No asset | 1.9 | 2.7 | 0.4 |
| Motorcycle/scooter | 49.7 | 44.3 | 60.6 | Only one | 5.2 | 7.1 | 1.3 |
| Car/truck | 7.5 | 4.4 | 13.8 | Any two | 9.7 | 12.9 | 3.2 |
| Telephone (land line) | 2.3 | 1.1 | 4.6 | Any three | 13.3 | 16.6 | 6.6 |
| Mobile telephone | 93.3 | 91.5 | 96.7 | Any four | 15.6 | 17.4 | 11.8 |
| Watch | 77.2 | 70.7 | 90.3 | Any five | 14.8 | 15.2 | 13.9 |
| Computer | 9.3 | 4.4 | 19.3 | Any six | 12.5 | 11.3 | 14.9 |
| Electric fan | 88.3 | 84.3 | 96.4 | Any seven | 9.4 | 7.1 | 14.0 |
| Colour television | 66.7 | 57.1 | 86.0 | Any eight | 7.1 | 4.6 | 12.1 |
| Sewing machine | 26.4 | 22.7 | 34.0 | Any nine | 5.5 | 3.0 | 10.5 |
| Air conditioner/cooler | 23.7 | 15.8 | 39.5 | Any ten | 3.2 | 1.4 | 6.8 |
| Washing machine | 18.0 | 9.0 | 36.1 | Any eleven | 1.6 | 0.5 | 3.7 |
| | | | | All twelve | 0.3 | 0.1 | 0.7 |
| N | 636699 | 476561 | 160138 | | 636699 | 476561 | 160138 |

Source: Author

## Composite Household Asset Index

The composite household asset index, *ai*, is calculated for all the households covered during the National Family Health Survey, 2019-2021. The distribution of households by the composite household asset index, *ai*, is depicted in figure 1 while summary measures of the distribution are presented in table 2. The household asset index ranges from 0 to 1 across the 636699 households and the median household asset index is 0.332. The range of the household asset index is more than three times the inter-quartile range which means that the household asset index of 50 per cent of the households varies in a narrow range whereas the asset index of the remaining 50 per cent of the households varies widely. The kernel density plot shows that the distribution of the households by household asset index, *ai*, is positively skewed with the skewness of 0.540 (Figure 1). The skewed distribution of households by household wealth is also reflected in the positive difference between mean household asset index (0.385) and median household asset index (0.332). Wide variation in household asset index is also revealed through the negative value of excess kurtosis which means that the distribution of the households in terms of household asset index is platykurtic in shape. The centre of the distribution is shorter than the centre of the corresponding statistical normal distribution while the tails of the distribution are lighter than those of the normal distribution.

Based on the household asset index, *ai*, households may be categories into eight wealth categories. The household wealth may be termed as low if $ai<0.20$. The household wealth may be termed as below average if $0.20\leq ai<0.40$ while the household wealth may be termed as average if $0.40\leq ai<0.60$. On the other hand, household wealth may be termed as above average if $0.60\leq ai<0.80$ and high if $ai\geq 0.80$. The household asset index, *ai*, of a household is equal to 0 if the household has none of the 12 household assets that have been used for the construction of the household asset index whereas the household asset index, *ai*, is equal to 1 if the household has all the 12 household assets. There are almost 19 per cent households in which the household wealth is low as $ai<0.20$ in these household. On the other hand, there are only around 5 per cent households in which the household wealth is high as $ai\geq 0.80$ in these households. The household wealth may be termed as average in around one fourth of the households but below average in almost 38 per cent of the households. This leaves only around 13 per cent of the households in which household wealth may be termed as above average. In other words, only around 18 per cent of the households had either above average or high household wealth

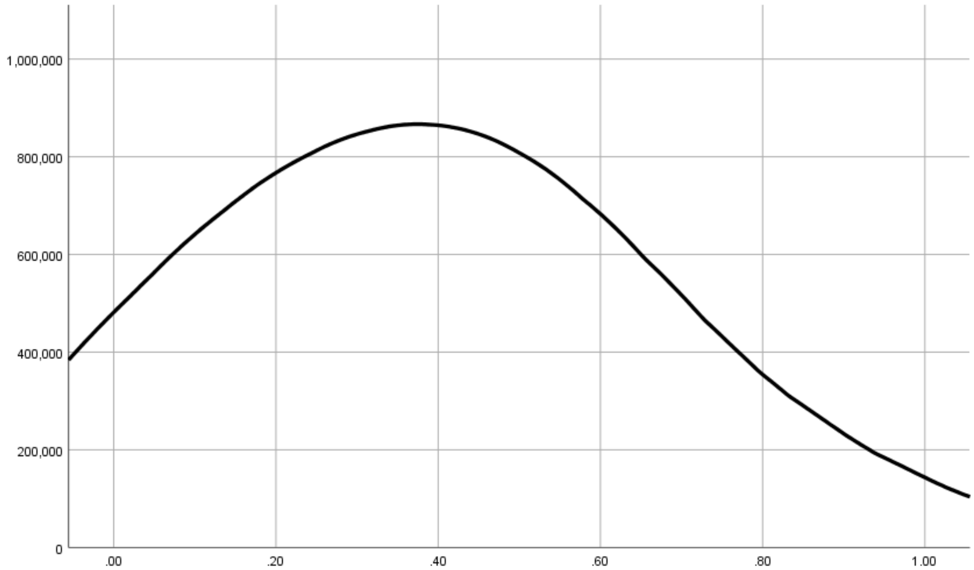


Figure 1: Kernal density plot of the distribution of households by composite household asset index across 636699 households in India, 2019-2021.
Source: Author, based on the data from the National Family Health Survey, 2019-2021.

Table 1 also highlights marked difference in the distribution of household wealth in rural as compared to urban households. Household wealth, as reflected through the composite household asset index, is estimated to be low in more than one fourth of the rural households whereas this proportion is only around 5 per cent in the urban households.

Similarly, less than 2 per cent of the rural households had high household wealth but this proportion was almost 11 per cent in the urban households, In rural households, household wealth was very low in more than two-third of the households, but this proportion was only 30 per cent in the urban households. The skewness in the distribution of households by the composite household asset index is very high in the rural households as compared to that in the urban households. The composite household asset index is found to be more than the average in more than 35 per cent of the urban households but in only less than 10 per cent of the rural households.

Table 1: Distribution of households (per cent) by the household wealth as measured by the household asset index in India, 2019-2021.

| Household wealth | Household asset index | Total | Rural | Urban |
|---|---|---|---|---|
| | | | Frequencies | |
| Low | (<0.20) | 18.7 | 25.3 | 5.3 |
| Lower middle | (0.20-0.40) | 37.7 | 43.6 | 25.9 |
| Middle | (0.40-0.60) | 25.7 | 21.6 | 34.1 |
| Upper middle | (0.60-0.80) | 13.0 | 7.7 | 23.7 |
| High | (≥0.80) | 4.8 | 1.8 | 10.9 |
| | | Summary measures of distribution | | |
| Minimum | | 0 | 0 | 0 |
| First quartile | | 0.229 | 0.194 | 0.332 |
| Median | | 0.332 | 0.295 | 0.507 |
| Third quartile | | 0.526 | 0.439 | 0.657 |
| Maximum | | 1 | 1 | 1 |
| IQR | | 0.297 | 0.245 | 0.325 |
| Mean | | 0.385 | 0.325 | 0.505 |
| Standard deviation | | 0.210 | 0.184 | 0.208 |
| Skewness | | 0.540 | 0.738 | 0.121 |
| Excess kurtosis | | - | 0.329 | - |
| | | 0.334 | | 0.749 |
| N | | 636699 | 476561 | 160138 |

Source: Author

The distribution of households by the composite household asset index, *ai*, has been found to be different in different states and Union Territories which implies that household standard of living varies widely even with a state or Union Territory of the country (Table 2). In Meghalaya, Bihar and Jharkhand, the household wealth had been found to be low in more than 40 per cent of the households ($ai<0.200$) whereas this proportion was just around 1 per cent in Goa. In 11 states/Union Territories of the country, the household wealth had been found to be low in at least one fifth of the households. On the other hand, Chandigarh is the only state/Union Territory of the country in which more than 35 per cent of the households had high household wealth ($ai\geq0.80$). Besides Chandigarh, there are only 6 states/Union Territories in which at least 10 per cent of the households had high household wealth at the time of the survey. In 20 states/Union Territories, less than 5 per cent of the households had high household wealth. This proportion was the lowest in Tripura where the composite household asset index was at least 0.80 in only 0.3 per cent households (Table 2).

Table 2: Distribution of households by the composite household asset index, *ai*, in states/Union Territories, 2019-2021.

| State/Union Territory | Composite household asset index | | | | | | |
|---|---|---|---|---|---|---|---|
| | <0.2 | 0.2-0.4 | 0.4-0.6 | 0.6-0.8 | ≥0.8 | Median | Skewness |
| Jammu & Kashmir | 12.0 | 25.4 | 34.6 | 21.2 | 6.8 | 0.489 | 0.055 |
| Himachal Pradesh | 8.9 | 24.1 | 37.6 | 23.5 | 6.0 | 0.489 | -0.110 |
| Punjab | 2.5 | 9.5 | 22.3 | 41.9 | 23.7 | 0.708 | -0.806 |
| Chandigarh | 2.0 | 9.8 | 17.2 | 35.0 | 36.0 | 0.745 | -0.775 |
| Uttarakhand | 13.6 | 30.8 | 25.2 | 20.7 | 9.7 | 0.423 | 0.195 |
| Haryana | 4.8 | 17.1 | 23.2 | 38.7 | 16.2 | 0.636 | -0.524 |
| NCT of Delhi | 3.1 | 13.9 | 20.6 | 39.1 | 23.4 | 0.657 | -0.593 |
| Rajasthan | 12.1 | 29.9 | 29.0 | 22.0 | 7.0 | 0.443 | 0.135 |
| Uttar Pradesh | 26.3 | 36.6 | 17.5 | 14.5 | 5.0 | 0.317 | 0.623 |
| Bihar | 40.6 | 45.0 | 9.5 | 3.6 | 1.2 | 0.229 | 1.436 |
| Sikkim | 23.7 | 47.7 | 22.6 | 5.2 | 0.8 | 0.287 | 0.861 |
| Arunachal Pradesh | 27.9 | 45.2 | 21.0 | 5.0 | 0.9 | 0.295 | 0.699 |
| Nagaland | 37.2 | 35.9 | 19.2 | 6.7 | 1.0 | 0.229 | 0.841 |
| Manipur | 26.3 | 37.6 | 22.4 | 12.7 | 0.9 | 0.295 | 0.536 |
| Mizoram | 13.0 | 20.1 | 37.0 | 26.9 | 2.9 | 0.510 | -0.206 |
| Tripura | 15.2 | 55.3 | 27.6 | 1.7 | 0.3 | 0.295 | 0.349 |
| Meghalaya | 42.2 | 43.0 | 11.3 | 3.0 | 0.5 | 0.218 | 1.037 |
| Assam | 28.1 | 53.6 | 13.7 | 3.7 | 1.0 | 0.245 | 1.119 |
| West Bengal | 19.2 | 56.1 | 19.5 | 3.9 | 1.4 | 0.295 | 1.143 |
| Jharkhand | 40.3 | 40.6 | 11.7 | 4.8 | 2.6 | 0.229 | 1.220 |
| Odisha | 27.2 | 45.5 | 19.3 | 6.1 | 1.9 | 0.295 | 0.760 |
| Chhattisgarh | 23.4 | 33.9 | 27.8 | 11.3 | 3.6 | 0.332 | 0.410 |
| Madhya Pradesh | 28.1 | 34.3 | 22.5 | 11.5 | 3.7 | 0.317 | 0.551 |
| Gujarat | 13.1 | 35.5 | 36.9 | 10.2 | 4.3 | 0.402 | 0.457 |
| Dadra & Nagar Haveli and Daman & Diu | 16.2 | 41.1 | 31.7 | 7.9 | 3.0 | 0.332 | 0.702 |
| Maharashtra | 11.6 | 33.2 | 35.6 | 14.2 | 5.4 | 0.406 | 0.328 |
| Andhra Pradesh | 11.9 | 43.7 | 32.1 | 10.2 | 2.1 | 0.335 | 0.536 |
| Karnataka | 10.1 | 46.1 | 30.4 | 9.7 | 3.7 | 0.332 | 0.692 |
| Goa | 1.1 | 9.9 | 34.9 | 29.9 | 24.2 | 0.616 | -0.042 |
| Lakshadweep | 3.0 | 18.2 | 48.5 | 24.2 | 6.1 | 0.521 | 0.177 |
| Kerala | 2.9 | 21.3 | 45.2 | 21.5 | 9.1 | 0.507 | 0.281 |
| Tamil Nadu | 6.3 | 35.9 | 39.7 | 14.2 | 4.0 | 0.420 | 0.376 |
| Puducherry | 2.8 | 18.5 | 41.3 | 25.4 | 12.1 | 0.526 | 0.071 |
| Andaman & Nicobar Islands | 6.6 | 27.0 | 47.4 | 15.2 | 3.8 | 0.439 | 0.252 |
| Telangana | 11.3 | 38.9 | 34.1 | 13.0 | 2.8 | 0.383 | 0.354 |
| Ladakh | 15.2 | 47.8 | 28.3 | 7.6 | 1.1 | 0.330 | 0.574 |

Source: Author

The prosperity of a state/Union Territory may be measured in terms of the median of the distribution of households by the composite household asset index *ai* – the higher the median the more prosperous state/Union Territory. The median of the distribution of households by the composite household asset index, *ai*, is found to be the highest in Chandigarh, followed by Punjab. Chandigarh and Punjab are the only two states/Union Territories of the country in which the median of the composite household asset index, *ai*, is estimated to be more than 0.700. In addition, there are only three states/Union Territories in which median of the composite household asset index, *ai*, ranges between 0.600-0.700. On the other hand, the median of the composite household asset index is found to be the lowest in Meghalaya followed by Bihar, Nagaland and Jharkhand. There are 11 states/Union Territories in the country in which the median of the distribution of households by the composite household asset index, *ai*, is estimated to be less than 0.300. followed by Nagaland (0.246), Meghalaya (0.249) and Assam (0.249). These are the only five states/Union Territories in the country in which the median of the distribution of the households by the household asset index is found to be less than 0.250. These states/Union Territories may be termed as the most poor states/Union Territories of the country in the context of the household wealth as measured through the composite household asset index, *ai*. Table 2 also suggests that there is very substantial gap in the average household wealth between the most prosperous state/Union Territory and the least prosperous state/Union Territory.

The asymmetry in the distribution of households by composite household asset index, *ai*, or the skewness in the distribution is also found to be different in different states and Union Territories of the country. In majority of the states/Union Territories, the skewness in the distribution of the composite household asset index, *ai*, is found to be positive which means that the right tail of the distribution is longer than its left tail. There are, however, seven states/Union Territories in which the skewness of the distribution is negative or the left tail of the distribution of household by the composite household asset index, *ai*, is longer than its right tale. The positive skewness in the distribution is found to be the highest in Bihar followed by Jharkhand, West Bengal, Assam and Meghalaya. In Bihar and Meghalaya, the composite household asset index, *ai*, is less than 0.400 in more than 85 per cent of the households. This proportion is around 80 per cent in Assam and Jharkhand and around 75 per cent in West Bengal. On the other hand, the negative skewness is found to be the highest in Punjab followed by Chandigarh, National Capital Territory of Delhi and Haryana. In Chandigarh, the composite household asset index is at least 0.600 in more than 70 per cent households. This proportion is found to be around 66 per cent in Punjab; around 63 per cent in National Capital Territory of Delhi, and around 55 per cent in Haryana.

The distribution of households by household asset index in 707 districts of the country is presented in the appendix table. The proportion of households having composite household asset index less than 0.200 is found to be the highest (71 per cent) in district West Jaintia Hills of Meghalaya. There are 49 districts in which household asset index is found to be less than 0.200 in more than 50 per cent households in the district. In another 49 districts, the household asset index is found to be less than 0.200 in 40-50 per cent households in the district. This means that in 98 districts of the country, at least 40 per cent of the households have composite household asset index of less than 0.200 per cent. These districts may be termed as the hotspot districts of the country as regards household wealth. On the other hand, there are 208 districts in which the composite household asset index is found to be less than 0.200 in less than 10 per cent of the households and, in another 190 districts, in 10-20 per cent households (Figure 4). District Mahe in the Union Territory of Puducherry is the only district in the country where there is no household in which the household asset index is found to be less than 0.200 whereas in only 10 per cent of the households of the district, the composite household asset index ranges between 0.200-0.400 (Figure 2).

On the other hand, there are 76 districts in which there is no household in which composite household asset index is found to be at least 0.800 whereas in 136 districts, the composite household asset index is at least 0.800 in less than 1 per cent of the households and in 323 districts, between 1-5 per cent of the households. This leaves only 172 districts in which the composite household asset index is found to be at least 0.800 in more than 5 per cent of the households. There are, however, only 36 districts in which the composite household asset index is found to be at least 0.800 in at least 20 per cent of the households. The proportion of households in which the composite household asset index was at least 0.800 is found to be the highest (36 per cent) in district South-West of the National Capital Territory of Delhi. In addition, there are only two districts in the country – Sahibzada Ajit Singh Nagar in Punjab and Chandigarh in the Union Territory of Chandigarh – in which the composite household asset index was at least 0.800 in more than 30 per cent households in these districts. There are only 88 districts in which the composite household asset index was at least 0.800 in 20-30 per cent households (Figure 3).

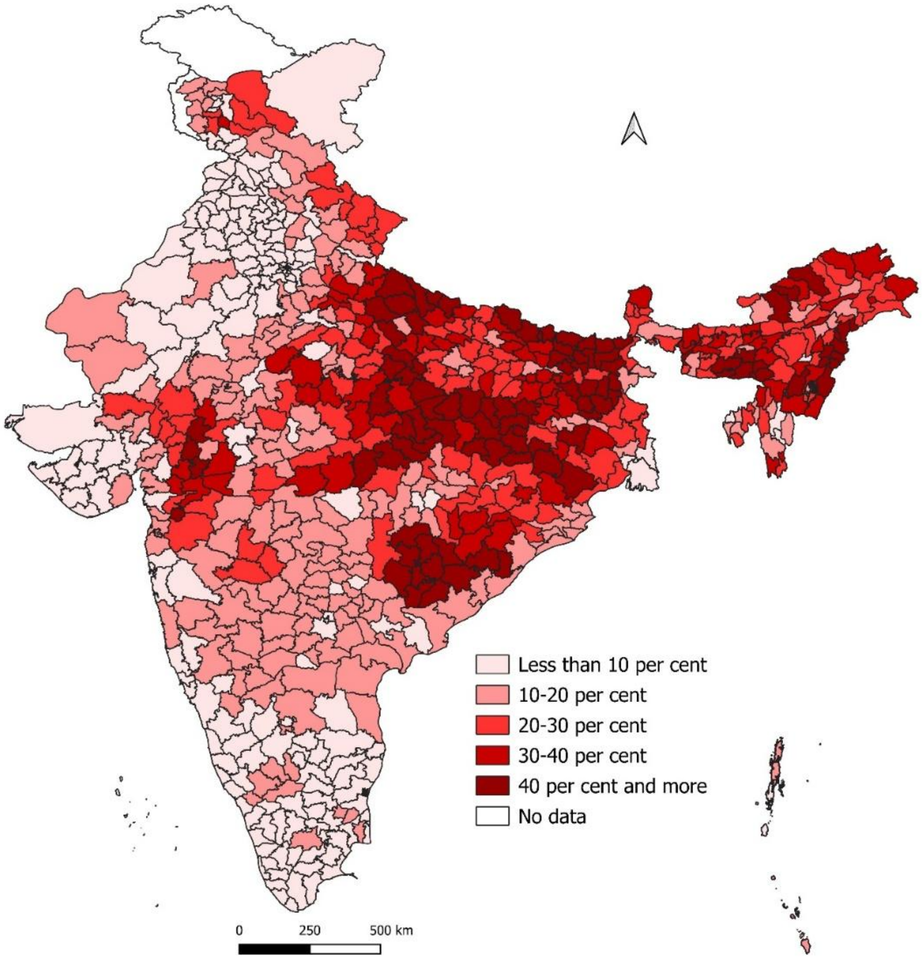


Figure 2: Inter-district variation in the proportion of households in the district having low household wealth (household asset index less than 0.200).
Source: Author

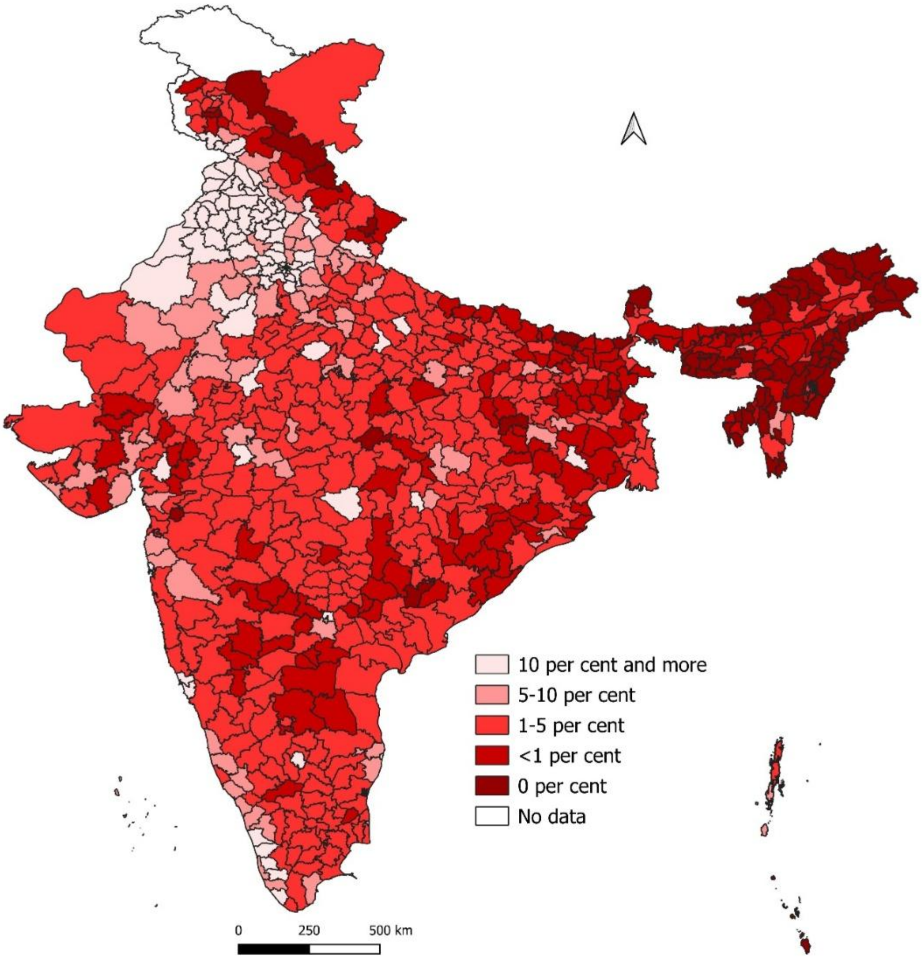


Figure 3: Inter-district variation in the proportion of households in the district having high household wealth (household asset index at least 0.800).
Source: Author.

In terms of prosperity, the least prosperous district in the country is district Bijapur in Chhattisgarh with a composite household asset index, *ai*, of only 0.119. On the other hand, district Kapurthala in Punjab is the most prosperous district of the country with a composite household asset index, *ai*, of 0.745. There are 49 districts in which median of the distribution of households by composite household asset index, *ai*, is found to be less than 0.200. These districts may be termed as the poorest districts in terms of household wealth. The median of the household distribution of the composite household asset index, *ai*, he ranges between 0.200-0.300 in 248 districts; between 0.300-0.400 in 184 districts; and between 0.400-0.500 in 116 districts. There are only 111 districts in which median is at least 0.500 (Figure 4). The uneven distribution of districts in terms of prosperity as measured by the composite household asset index, *ai* is very much evident.

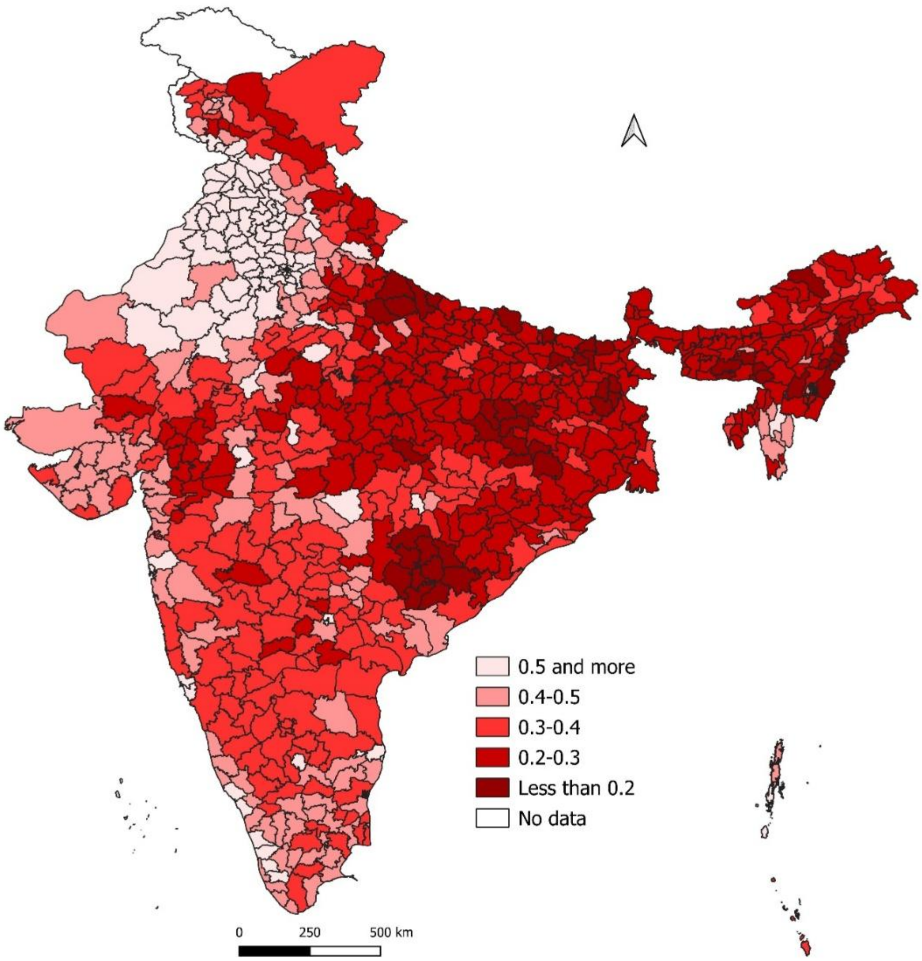


Figure 4: Inter-district variation in the median of the distribution of the households by the composite household asset index.
Source: Author

In 676 districts, the lowest value of the composite household asset index, *ai*, is found to be 0. In these districts, there is at least one household in which none of the 10 household assets were available at the time of the survey. There are only 31 districts in which at least one of the 10 household assets was available. Almost half of these districts are in Punjab, National Capital Territory of Delhi and Haryana. On the other hand, there are 401 districts in which there was at least one household in which all the 10 household assets were available. In the remaining 303 districts, there was at least one household in which all the 10 household assets were not available so that highest value of the composite household asset index, *ai*, in these districts is less than 1. In district Anjaw of Arunachal Pradesh, the maximum value of the composite household asset index is found to be 0.691 which is the lowest in the country.

## Inequality in Household Wealth

The inequality in household wealth is measured in terms of the index of variation (*IV*). When the composite household asset index, *ai*, is the same for all households in the district, the index of variation (*IV*) is 0 which means that there is no inequality in the distribution of household wealth. On the other hand, the higher the index of variation (*IV*) the higher the inequality in household wealth. A high value of the index of variation (*IV*) is an indication of the concentration of household wealth in a small proportion of households while a low value indicates more even distribution.

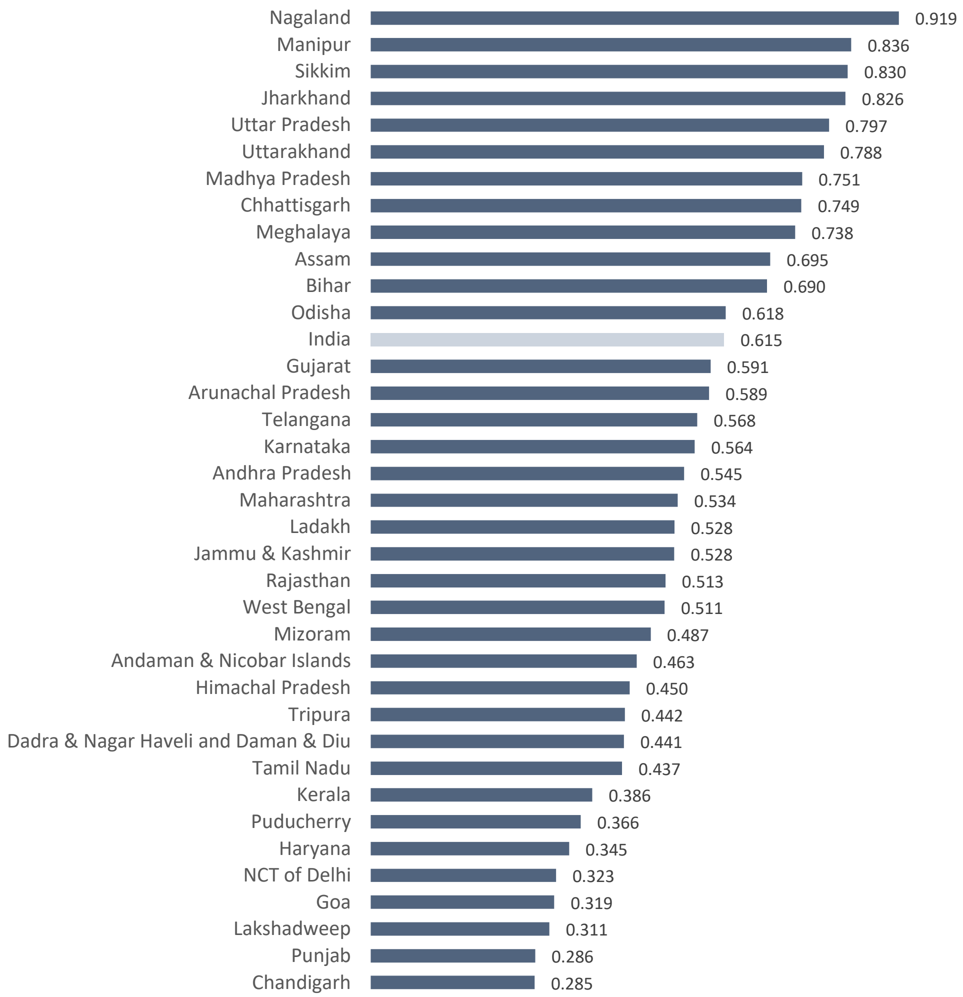


Figure 5: Inequality in household wealth (index of variation IV in composite household asset index) in states and Union Territories of India, 2019-2021.
Source: Author

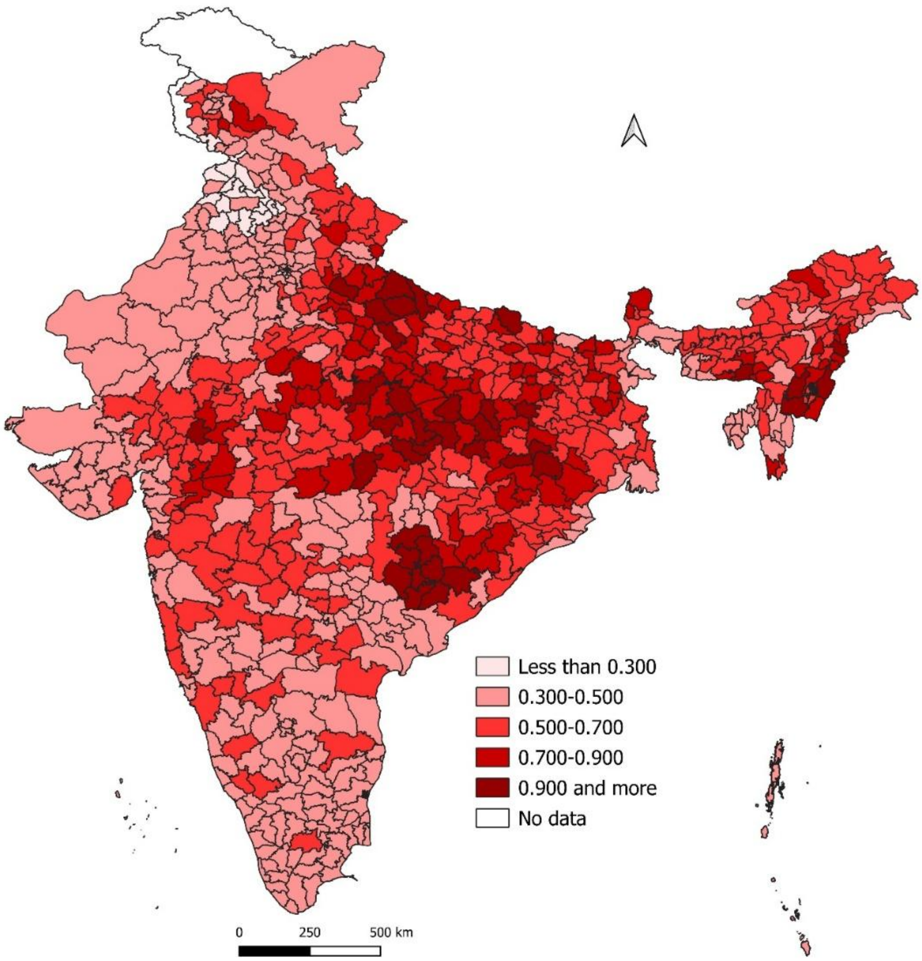


Figure 6: Inter-district variation in the within-district inequality in household wealth.
Source: Author

The index of variation (*IV*) in the composite household asset index is found to be 0.615. There are 1`2 states/Union Territories in which the inequality in household wealth is found to be higher than the inequality in household wealth in the country as the index of variation (*IV*) in the composite household asset index in these states and Union Territories is found to be higher than that in India. The inequality in household wealth is found to be the lowest in the Union Territory of Chandigarh but the highest in Nagaland (Figure 5). The index of variation (*IV*) in the composite household asset index in Nagaland is found to be more than three times higher than that in Chandigarh. The inequality in household wealth is also found to be low in Punjab. Chandigarh and Punjab are the only two states and Union Territories in the country in which the index of variation (*IV*) in the composite household asset index is found to be less than 0.300. The inequality in household wealth has also been found to be low in Lakshadweep, Goa, National Capital Territory of Delhi, Haryana, Puducherry and Kerala. In these states and Union Territories, the index of variation (*IV*) in the composite household asset index is found to range between 0.300-0.400. On the other hand, Nagaland is the only state/Union Territory in the country in which the index of variation (*IV*) in the composite household asset index is found to be more than 0.900. The inequality in household wealth is also found to be high in Manipur, Sikkim and Jharkhand. In these states, the index of variation (*IV*) in the composite household asset index is found to range between 0.800-0.900 and well above the average in Uttar Pradesh, Uttarakhand, Madhya Pradesh, Chhattisgarh and Meghalaya.

The index of variation (*IV*) in the composite household asset index in 707 districts of the country is presented in the appendix table. The index of variation (*IV*) in the composite household asset index is found to be the lowest in district Sangrur of Punjab (0.249) but the highest in district Narayanpur in Chhattisgarh (1.395). There are only 23 districts in which the inequality in household wealth is found to be very low ($IV<0.300$). Sixteen of these 23 districts are in Punjab, three in the National Capital Territory of Delhi and one each in Jammu & Kashmir, Chandigarh, Haryana and Puducherry. On the other hand, there are 38 districts in which inequality in household wealth is found to be very high ($IV\geq0.900$). Twenty nine of these 38 districts are in Chhattisgarh, Madhya Pradesh, Uttar Pradesh and Jharkhand. In Rajasthan, Bihar, Manipur, Meghalaya and Odisha, there is at least one district in which the inequality in household wealth is found to be very high. In majority of the districts, however, the inequality in household wealth is not found to be large as the index of variation (*IV*) in the composite household asset index ranges between 0.300-0.600 in these districts. There are only 97 districts in which the inequality in household wealth is substantial as the index of variation (*IV*) in the composite household asset index in these districts ranges between 0.070-0.900 (Figure 6).

## Discussions and Conclusions

Measurement of household well-being has always been a challenge in the development research. The traditional approach to measure household well-being has been based on either the household income or the household consumption expenditures. This approach has many limitations which have been highlighted in the literature. In recent years, household wealth-based measures have been advocated to measure household well-being to address many of the limitations associated with income-based measures of household standard of living (OECD, 2015; 2017). Household level data on wealth can help to understand how assets are distributed across households or the ways in which different households respond to financial shocks and other economic developments. This information is important not only for developing and evaluating policies designed to address the disadvantage of certain groups of households, but also in identifying areas of risk, such as high levels of debt in certain households (Balestra and Tonkin, 2018).

In this paper, we have constructed a composite household asset index based on the availability of a set of household assets as measure of household wealth. The application of the composite household asset index to the data from India reveals that in almost around 20 per cent of the households in the country, the household wealth is low and there is marked variation in this proportion across states/Union Territories and districts of the country. The household prosperity, measured in terms of the composite household asset index is found to be much better in the north-western region of the country. In Punjab, Chandigarh, Haryana, and National Capital Territory of Delhi, the composite household asset index is high in at least 50 per cent of the households. Besides the north-western region, there are only two states/Union Territory – Goa and Puducherry – where the composite household asset index is found to be high in at least 50 per cent of the households. On the other hand, the household wealth is low in at least 30 per cent of the households in the central region of the country comprising of Bihar, Jharkhand, Odisha, Chhattisgarh, and Madhya Pradesh. Another region where household wealth is low is the north-east region of the country. In Nagaland, Manipur, Meghalaya, Tripura and Assam, the composite household asset index is found to be low or in 20-30 per cent households. In Uttar Pradesh and West Bengal also, household wealth is low in 20-30 per cent households.

The analysis also reveals that the inequality in household wealth also varies widely across states/Union Territories and districts. The inequality in the household wealth is the lowest in Chandigarh and Punjab where the composite household asset index is the highest. On the other hand, the inequality in household wealth is very high in Nagaland, Manipur and Sikkim. All these states and Union Territories are in the north-eastern region of the country. The highly uneven distribution of household wealth indicates a high degree of concentration of household wealth.

The present analysis the need of identifying factors that contribute to household wealth formation. One argument is that there is a certain minimum threshold of household income that is necessary to create household assets and accumulate household wealth. Identification of this minimum threshold of household income is challenging as it depends upon many factors including household capability to earn additional income and the opportunities available in the economy. One possible option is to ensure a minimum set of entitlements to every household that leads to the minimum household income necessary to create household wealth.

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Table 3: Distribution of household wealth score within districts.

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| Jammu & Kashmir | Kupwara | 13.6 | 0.383 | 0.7 | 0.453 |
| | Badgam | 11.3 | 0.471 | 2.5 | 0.412 |
| | Punch | 19.7 | 0.383 | 1.3 | 0.509 |
| | Rajouri | 14.0 | 0.402 | 2.9 | 0.491 |
| | Kathua | 6.6 | 0.598 | 12.2 | 0.371 |
| | Baramula | 18.5 | 0.353 | 4.0 | 0.632 |
| | Bandipore | 19.7 | 0.314 | 1.4 | 0.668 |
| | Srinagar | 2.9 | 0.547 | 8.4 | 0.323 |
| | Ganderbal | 17.9 | 0.379 | 1.8 | 0.487 |
| | Pulwama | 7.8 | 0.482 | 1.0 | 0.349 |
| | Shupiyan | 7.3 | 0.441 | 0.9 | 0.357 |
| | Anantnag | 8.2 | 0.465 | 2.9 | 0.417 |
| | Kulgam | 21.3 | 0.324 | 0.0 | 0.560 |
| | Doda | 25.4 | 0.295 | 1.1 | 0.651 |
| | Ramban | 38.6 | 0.229 | 0.7 | 0.891 |
| | Kishtwar | 26.7 | 0.314 | 2.6 | 0.786 |
| | Udhampur | 9.2 | 0.489 | 6.7 | 0.441 |
| | Reasi | 27.5 | 0.295 | 0.7 | 0.647 |
| | Jammu | 2.2 | 0.657 | 22.5 | 0.289 |
| | Samba | 5.3 | 0.620 | 14.0 | 0.327 |
| Himachal Pradesh | Chamba | 13.1 | 0.383 | 0.4 | 0.489 |
| | Kangra | 3.8 | 0.526 | 7.4 | 0.345 |
| | Lahul & Spiti | 13.3 | 0.289 | 0.0 | 0.459 |
| | Kullu | 19.6 | 0.340 | 0.9 | 0.615 |
| | Mandi | 8.9 | 0.459 | 3.6 | 0.465 |
| | Hamirpur | 4.8 | 0.564 | 7.8 | 0.337 |
| | Una | 5.5 | 0.635 | 18.6 | 0.329 |
| | Bilaspur | 4.5 | 0.526 | 6.5 | 0.342 |
| | Solan | 10.2 | 0.526 | 7.7 | 0.408 |
| | Sirmaur | 10.5 | 0.482 | 7.7 | 0.480 |
| | Shimla | 13.4 | 0.432 | 2.1 | 0.494 |
| | Kinnaur | 24.0 | 0.306 | 0.0 | 0.574 |
| Punjab | Kapurthala | 1.8 | 0.745 | 24.5 | 0.273 |
| | Jalandhar | 1.4 | 0.708 | 23.4 | 0.264 |
| | Hoshiarpur | 2.3 | 0.745 | 27.9 | 0.266 |
| | Shahid Bhagat Singh Nagar | 1.3 | 0.708 | 21.1 | 0.254 |
| | Fatehgarh Sahib | 4.2 | 0.726 | 26.1 | 0.294 |
| | Ludhiana | 2.9 | 0.703 | 24.2 | 0.300 |
| | Moga | 1.7 | 0.708 | 21.9 | 0.267 |
| | Muktsar | 3.1 | 0.637 | 18.2 | 0.307 |
| | Faridkot | 2.7 | 0.657 | 21.5 | 0.307 |
| | Bathinda | 1.8 | 0.657 | 25.0 | 0.298 |
| | Mansa | 3.5 | 0.637 | 16.5 | 0.308 |
| | Patiala | 2.5 | 0.727 | 26.0 | 0.271 |
| | Amritsar | 2.0 | 0.708 | 24.9 | 0.286 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Tarn Taran | 3.9 | 0.635 | 15.0 | 0.324 |
| | Rupnagar | 1.8 | 0.745 | 24.8 | 0.268 |
| | Sahibzada Ajit Singh Nagar | 4.5 | 0.745 | 34.9 | 0.294 |
| | Sangrur | 1.4 | 0.745 | 26.8 | 0.249 |
| | Barnala | 2.1 | 0.679 | 21.9 | 0.279 |
| | Fazilka | 3.6 | 0.600 | 16.4 | 0.332 |
| | Firozpur | 2.3 | 0.657 | 24.8 | 0.285 |
| | Gurdaspur | 4.2 | 0.708 | 23.3 | 0.297 |
| | Pathankot | 1.6 | 0.669 | 18.8 | 0.273 |
| Chandigarh | Chandigarh | 2.0 | 0.745 | 36.0 | 0.285 |
| Uttarakhand | Uttarkashi | 27.7 | 0.294 | 0.7 | 0.689 |
| | Chamoli | 26.4 | 0.295 | 1.4 | 0.649 |
| | Rudraprayag | 21.7 | 0.305 | 1.6 | 0.633 |
| | Tehri Garhwal | 19.6 | 0.306 | 1.8 | 0.630 |
| | Dehradun | 3.4 | 0.635 | 22.9 | 0.330 |
| | Garhwal | 19.5 | 0.306 | 4.8 | 0.767 |
| | Pithoragarh | 21.1 | 0.306 | 0.7 | 0.611 |
| | Bageshwar | 24.3 | 0.295 | 0.0 | 0.581 |
| | Almora | 23.5 | 0.295 | 0.6 | 0.592 |
| | Champawat | 28.9 | 0.295 | 3.1 | 0.753 |
| | Nainital | 10.5 | 0.514 | 10.9 | 0.444 |
| | Udham Singh Nagar | 9.1 | 0.460 | 9.1 | 0.482 |
| | Hardwar | 9.6 | 0.526 | 13.8 | 0.442 |
| Haryana | Panchkula | 2.7 | 0.708 | 26.5 | 0.297 |
| | Ambala | 3.2 | 0.637 | 21.7 | 0.330 |
| | Yamunanagar | 4.2 | 0.635 | 17.9 | 0.345 |
| | Kurukshetra | 4.0 | 0.635 | 17.7 | 0.336 |
| | Kaithal | 2.7 | 0.635 | 14.7 | 0.323 |
| | Karnal | 5.2 | 0.637 | 16.4 | 0.342 |
| | Panipat | 3.8 | 0.635 | 17.3 | 0.351 |
| | Sonipat | 7.7 | 0.637 | 18.0 | 0.365 |
| | Jind | 4.6 | 0.620 | 7.9 | 0.333 |
| | Fatehabad | 5.6 | 0.635 | 13.8 | 0.352 |
| | Sirsa | 3.9 | 0.637 | 15.9 | 0.330 |
| | Hisar | 2.4 | 0.637 | 11.7 | 0.305 |
| | Rohtak | 3.6 | 0.657 | 19.2 | 0.319 |
| | Jhajjar | 3.2 | 0.679 | 19.1 | 0.307 |
| | Mahendragarh | 6.1 | 0.572 | 9.4 | 0.358 |
| | Rewari | 4.2 | 0.637 | 14.2 | 0.332 |
| | Gurgaon | 5.0 | 0.689 | 26.0 | 0.341 |
| | Mewat | 17.9 | 0.420 | 4.5 | 0.527 |
| | Faridabad | 3.4 | 0.657 | 23.8 | 0.341 |
| | Palwal | 7.6 | 0.548 | 12.2 | 0.410 |
| | Bhiwani | 3.6 | 0.634 | 9.1 | 0.336 |
| | Charkhi Dadri | 3.7 | 0.657 | 13.2 | 0.312 |
| Delhi | Central | 2.6 | 0.637 | 17.5 | 0.313 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | East | 2.7 | 0.657 | 25.5 | 0.338 |
| | New Delhi | 5.3 | 0.620 | 16.4 | 0.370 |
| | North | 5.9 | 0.619 | 21.0 | 0.386 |
| | North East | 1.6 | 0.708 | 25.5 | 0.275 |
| | North West | 2.0 | 0.689 | 24.8 | 0.317 |
| | Shahdara | 3.1 | 0.679 | 21.9 | 0.306 |
| | South | 1.8 | 0.708 | 22.2 | 0.271 |
| | South East | 3.2 | 0.689 | 27.4 | 0.317 |
| | South West | 3.2 | 0.745 | 36.0 | 0.288 |
| | West | 3.3 | 0.657 | 19.4 | 0.336 |
| Rajasthan | Ganganagar | 4.7 | 0.570 | 10.5 | 0.374 |
| | Hanumangarh | 2.9 | 0.549 | 10.3 | 0.365 |
| | Bikaner | 7.1 | 0.531 | 11.6 | 0.416 |
| | Churu | 11.8 | 0.446 | 5.9 | 0.447 |
| | Jhunjhunun | 3.9 | 0.533 | 8.3 | 0.359 |
| | Alwar | 9.8 | 0.512 | 8.9 | 0.436 |
| | Bharatpur | 14.7 | 0.420 | 4.4 | 0.488 |
| | Dhaulpur | 19.9 | 0.335 | 2.7 | 0.643 |
| | Karauli | 17.7 | 0.354 | 1.9 | 0.564 |
| | Sawai Madhopur | 17.8 | 0.383 | 2.3 | 0.522 |
| | Dausa | 13.2 | 0.420 | 2.6 | 0.458 |
| | Jaipur | 6.3 | 0.549 | 15.1 | 0.389 |
| | Sikar | 7.1 | 0.531 | 10.1 | 0.390 |
| | Nagaur | 7.3 | 0.526 | 5.0 | 0.375 |
| | Jodhpur | 6.9 | 0.526 | 8.7 | 0.390 |
| | Jaisalmer | 11.1 | 0.420 | 2.9 | 0.441 |
| | Barmer | 13.8 | 0.376 | 1.9 | 0.464 |
| | Jalor | 9.4 | 0.383 | 2.9 | 0.487 |
| | Sirohi | 19.6 | 0.335 | 4.9 | 0.658 |
| | Pali | 4.8 | 0.479 | 3.5 | 0.359 |
| | Ajmer | 4.7 | 0.531 | 9.8 | 0.375 |
| | Tonk | 14.2 | 0.411 | 3.9 | 0.475 |
| | Bundi | 15.3 | 0.420 | 6.0 | 0.511 |
| | Bhilwara | 14.2 | 0.376 | 5.6 | 0.522 |
| | Rajsamand | 10.8 | 0.420 | 5.0 | 0.472 |
| | Dungarpur | 23.2 | 0.266 | 1.3 | 0.558 |
| | Banswara | 43.8 | 0.229 | 4.2 | 0.946 |
| | Chittaurgarh | 17.7 | 0.371 | 4.2 | 0.546 |
| | Kota | 4.6 | 0.624 | 16.9 | 0.341 |
| | Baran | 14.9 | 0.426 | 3.8 | 0.464 |
| | Jhalawar | 16.4 | 0.348 | 2.5 | 0.552 |
| | Udaipur | 20.3 | 0.332 | 5.3 | 0.639 |
| | Pratapgarh | 39.5 | 0.260 | 1.7 | 0.702 |
| Uttar Pradesh | Saharanpur | 11.2 | 0.443 | 7.3 | 0.533 |
| | Bijnor | 12.7 | 0.420 | 6.2 | 0.530 |
| | Rampur | 15.2 | 0.349 | 5.1 | 0.603 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Jyotiba Phule Nagar | 18.1 | 0.420 | 5.5 | 0.561 |
| | Meerut | 4.8 | 0.635 | 15.5 | 0.361 |
| | Baghpat | 7.3 | 0.526 | 8.0 | 0.424 |
| | Gautam Buddha Nagar | 6.2 | 0.657 | 24.7 | 0.372 |
| | Bulandshahr | 14.1 | 0.420 | 7.6 | 0.528 |
| | Aligarh | 15.3 | 0.420 | 8.8 | 0.562 |
| | Mahamaya Nagar | 22.2 | 0.332 | 4.6 | 0.680 |
| | Mathura | 13.3 | 0.420 | 6.6 | 0.524 |
| | Agra | 9.1 | 0.510 | 9.5 | 0.500 |
| | Firozabad | 17.4 | 0.374 | 4.7 | 0.589 |
| | Mainpuri | 24.8 | 0.311 | 5.1 | 0.772 |
| | Bareilly | 17.2 | 0.354 | 4.0 | 0.703 |
| | Pilibhit | 33.9 | 0.266 | 2.8 | 0.815 |
| | Shahjahanpur | 31.0 | 0.295 | 5.5 | 0.788 |
| | Kheri | 51.2 | 0.194 | 1.5 | 1.015 |
| | Sitapur | 56.7 | 0.167 | 1.0 | 1.114 |
| | Hardoi | 51.2 | 0.194 | 1.0 | 0.906 |
| | Unnao | 40.1 | 0.239 | 2.6 | 0.930 |
| | Lucknow | 12.4 | 0.489 | 12.8 | 0.559 |
| | Farrukhabad | 22.6 | 0.317 | 3.9 | 0.696 |
| | Kannauj | 33.0 | 0.266 | 2.0 | 0.725 |
| | Etawah | 16.2 | 0.400 | 6.3 | 0.594 |
| | Auraiya | 29.7 | 0.295 | 2.0 | 0.738 |
| | Kanpur Dehat | 39.0 | 0.239 | 1.5 | 0.801 |
| | Kanpur Nagar | 20.3 | 0.420 | 12.1 | 0.600 |
| | Jalaun | 26.4 | 0.317 | 4.3 | 0.751 |
| | Jhansi | 19.3 | 0.365 | 7.2 | 0.603 |
| | Lalitpur | 37.6 | 0.260 | 1.2 | 0.709 |
| | Hamirpur | 25.4 | 0.295 | 1.3 | 0.628 |
| | Mahoba | 29.8 | 0.266 | 1.9 | 0.741 |
| | Banda | 41.8 | 0.229 | 2.5 | 0.837 |
| | Chitrakoot | 40.7 | 0.229 | 2.2 | 0.817 |
| | Fatehpur | 47.3 | 0.229 | 1.4 | 0.858 |
| | Pratapgarh | 28.7 | 0.295 | 1.6 | 0.675 |
| | Kaushambi | 46.1 | 0.229 | 1.9 | 0.865 |
| | Allahabad | 29.6 | 0.295 | 5.3 | 0.870 |
| | Bara Banki | 48.6 | 0.223 | 1.8 | 0.851 |
| | Faizabad | 28.2 | 0.295 | 3.9 | 0.691 |
| | Ambedkar Nagar | 31.0 | 0.266 | 1.0 | 0.635 |
| | Bahraich | 52.8 | 0.188 | 1.6 | 0.913 |
| | Shrawasti | 55.4 | 0.188 | 1.1 | 0.832 |
| | Balrampur | 45.5 | 0.229 | 0.9 | 0.725 |
| | Gonda | 31.1 | 0.266 | 1.9 | 0.674 |
| | Siddharthnagar | 32.0 | 0.266 | 0.6 | 0.581 |
| | Basti | 23.7 | 0.295 | 3.8 | 0.641 |
| | Sant Kabir Nagar | 29.5 | 0.266 | 1.1 | 0.620 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Mahrajganj | 29.6 | 0.266 | 0.7 | 0.597 |
| | Gorakhpur | 21.5 | 0.299 | 4.1 | 0.667 |
| | Kushinagar | 31.5 | 0.266 | 3.2 | 0.747 |
| | Deoria | 19.7 | 0.317 | 4.6 | 0.620 |
| | Azamgarh | 22.2 | 0.317 | 1.5 | 0.594 |
| | Mau | 20.4 | 0.295 | 3.2 | 0.657 |
| | Ballia | 26.5 | 0.295 | 3.0 | 0.631 |
| | Jaunpur | 11.4 | 0.332 | 3.5 | 0.543 |
| | Ghazipur | 25.5 | 0.295 | 2.6 | 0.620 |
| | Chandauli | 30.0 | 0.295 | 2.9 | 0.820 |
| | Varanasi | 12.2 | 0.383 | 6.2 | 0.639 |
| | Sant Ravidas Nagar (Bhadohi) | 28.9 | 0.290 | 1.0 | 0.654 |
| | Mirzapur | 27.5 | 0.295 | 3.6 | 0.815 |
| | Sonbhadra | 46.2 | 0.229 | 2.2 | 0.846 |
| | Etah | 32.2 | 0.266 | 4.8 | 0.894 |
| | Kanshiram Nagar | 30.4 | 0.282 | 2.2 | 0.741 |
| | Amethi | 30.6 | 0.266 | 1.1 | 0.670 |
| | Budaun | 36.1 | 0.260 | 4.4 | 0.944 |
| | Ghaziabad | 4.3 | 0.657 | 18.7 | 0.314 |
| | Hapur | 6.3 | 0.627 | 10.9 | 0.380 |
| | Moradabad | 13.3 | 0.420 | 6.4 | 0.542 |
| | Muzaffarnagar | 9.8 | 0.489 | 7.2 | 0.455 |
| | Rae Bareli | 37.7 | 0.242 | 2.3 | 0.835 |
| | Sambhal | 29.9 | 0.295 | 3.3 | 0.771 |
| | Shamli | 11.4 | 0.460 | 8.2 | 0.508 |
| | Sultanpur | 30.6 | 0.266 | 3.5 | 0.769 |
| Bihar | Pashchim Champaran | 58.2 | 0.157 | 0.4 | 0.924 |
| | Purba Champaran | 48.3 | 0.223 | 0.3 | 0.565 |
| | Sheohar | 46.1 | 0.229 | 0.5 | 0.563 |
| | Sitamarhi | 55.0 | 0.157 | 0.1 | 0.815 |
| | Madhubani | 48.3 | 0.223 | 0.0 | 0.498 |
| | Supaul | 63.6 | 0.157 | 0.3 | 0.711 |
| | Araria | 59.2 | 0.157 | 0.1 | 0.765 |
| | Kishanganj | 43.6 | 0.229 | 0.0 | 0.485 |
| | Purnia | 49.7 | 0.223 | 0.5 | 0.616 |
| | Katihar | 49.5 | 0.223 | 0.2 | 0.567 |
| | Madhepura | 64.9 | 0.157 | 0.2 | 0.716 |
| | Saharsa | 50.9 | 0.194 | 0.7 | 0.651 |
| | Darbhanga | 43.0 | 0.229 | 0.3 | 0.558 |
| | Muzaffarpur | 40.0 | 0.229 | 2.9 | 0.788 |
| | Gopalganj | 37.5 | 0.229 | 1.3 | 0.633 |
| | Siwan | 34.0 | 0.229 | 1.1 | 0.765 |
| | Saran | 31.4 | 0.229 | 0.6 | 0.654 |
| | Vaishali | 38.9 | 0.229 | 0.4 | 0.639 |
| | Samastipur | 52.2 | 0.194 | 0.2 | 0.619 |
| | Begusarai | 40.6 | 0.229 | 0.1 | 0.534 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Khagaria | 40.7 | 0.229 | 1.1 | 0.632 |
| | Bhagalpur | 28.8 | 0.229 | 1.1 | 0.764 |
| | Banka | 42.6 | 0.229 | 0.3 | 0.593 |
| | Munger | 20.3 | 0.295 | 1.9 | 0.599 |
| | Lakhisarai | 32.4 | 0.229 | 1.3 | 0.689 |
| | Sheikhpura | 34.1 | 0.229 | 1.0 | 0.670 |
| | Nalanda | 31.5 | 0.229 | 1.0 | 0.675 |
| | Patna | 15.0 | 0.332 | 9.1 | 0.856 |
| | Bhojpur | 22.8 | 0.295 | 2.6 | 0.709 |
| | Buxar | 21.8 | 0.295 | 0.9 | 0.632 |
| | Kaimur (Bhabua) | 34.9 | 0.229 | 0.4 | 0.691 |
| | Rohtas | 20.9 | 0.295 | 2.4 | 0.622 |
| | Aurangabad | 28.0 | 0.245 | 1.2 | 0.680 |
| | Gaya | 37.5 | 0.229 | 1.1 | 0.709 |
| | Nawada | 38.3 | 0.229 | 1.5 | 0.776 |
| | Jamui | 43.5 | 0.229 | 0.5 | 0.628 |
| | Jehanabad | 31.7 | 0.229 | 1.4 | 0.720 |
| | Arwal | 35.4 | 0.229 | 0.3 | 0.596 |
| Sikkim | North District | 31.6 | 0.218 | 0.0 | 0.716 |
| | West District | 29.2 | 0.218 | 0.0 | 0.758 |
| | South District | 22.1 | 0.291 | 1.2 | 0.669 |
| | East District | 21.4 | 0.295 | 1.0 | 0.611 |
| Arunachal Pradesh | Tawang | 23.8 | 0.295 | 0.0 | 0.473 |
| | West Kameng | 12.5 | 0.324 | 0.0 | 0.505 |
| | East Kameng | 40.7 | 0.228 | 0.0 | 0.657 |
| | Papum Pare | 14.9 | 0.366 | 2.1 | 0.457 |
| | Upper Subansiri | 55.9 | 0.181 | 0.0 | 0.767 |
| | Upper Siang | 30.8 | 0.259 | 0.0 | 0.580 |
| | Changlang | 23.1 | 0.295 | 0.0 | 0.475 |
| | Lower Subansiri | 24.2 | 0.295 | 0.0 | 0.593 |
| | Dibang Valley | 33.3 | 0.255 | 0.0 | 0.595 |
| | Lower Dibang Valley | 26.7 | 0.331 | 0.0 | 0.550 |
| | Anjaw | 36.4 | 0.218 | 0.0 | 0.512 |
| | East Siang | 14.3 | 0.366 | 2.9 | 0.499 |
| | Kra Daadi | 30.8 | 0.254 | 0.0 | 0.574 |
| | Kurung Kumey | 40.9 | 0.226 | 0.0 | 0.528 |
| | Lohit | 21.1 | 0.327 | 0.0 | 0.602 |
| | Longding | 47.1 | 0.218 | 0.0 | 0.576 |
| | Namsai | 34.0 | 0.250 | 0.0 | 0.532 |
| | Siang | 30.0 | 0.256 | 0.0 | 0.595 |
| | Tirap | 26.9 | 0.295 | 0.0 | 0.483 |
| | West Siang | 22.7 | 0.332 | 2.3 | 0.556 |
| Nagaland | Mon | 65.5 | 0.151 | 0.0 | 0.785 |
| | Mokokchung | 25.9 | 0.306 | 0.0 | 0.632 |
| | Zunheboto | 42.9 | 0.218 | 0.0 | 0.574 |
| | Wokha | 32.0 | 0.229 | 0.0 | 0.747 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Dimapur | 4.2 | 0.438 | 4.8 | 0.432 |
| | Phek | 59.4 | 0.151 | 0.0 | 0.874 |
| | Tuensang | 58.6 | 0.151 | 0.0 | 0.934 |
| | Longleng | 55.6 | 0.151 | 0.0 | 0.782 |
| | Kiphire | 69.0 | 0.151 | 0.0 | 0.817 |
| | Kohima | 29.8 | 0.287 | 0.0 | 0.684 |
| | Peren | 33.3 | 0.250 | 0.0 | 0.829 |
| Manipur | Senapati | 32.8 | 0.228 | 0.0 | 0.818 |
| | Tamenglong | 53.2 | 0.152 | 0.0 | 0.925 |
| | Churachandpur | 33.0 | 0.255 | 0.0 | 0.954 |
| | Bishnupur | 23.7 | 0.295 | 0.8 | 0.628 |
| | Thoubal | 25.2 | 0.295 | 0.4 | 0.582 |
| | Imphal West | 15.9 | 0.404 | 1.9 | 0.509 |
| | Imphal East | 20.6 | 0.333 | 1.2 | 0.612 |
| | Ukhrul | 59.4 | 0.151 | 0.0 | 0.914 |
| | Chandel | 30.6 | 0.263 | 0.0 | 0.706 |
| Mizoram | Mamit | 20.5 | 0.402 | 0.0 | 0.501 |
| | Kolasib | 10.6 | 0.494 | 0.0 | 0.385 |
| | Aizawl | 6.7 | 0.595 | 5.3 | 0.341 |
| | Champhai | 12.3 | 0.439 | 1.5 | 0.420 |
| | Serchhip | 10.0 | 0.469 | 0.0 | 0.403 |
| | Lunglei | 11.3 | 0.443 | 1.3 | 0.452 |
| | Lawngtlai | 34.4 | 0.295 | 0.0 | 0.742 |
| | Saiha | 22.2 | 0.400 | 0.0 | 0.515 |
| Tripura | Dhalai | 24.1 | 0.295 | 0.0 | 0.422 |
| | Gomati | 13.3 | 0.295 | 0.4 | 0.430 |
| | Khowai | 18.2 | 0.295 | 0.0 | 0.387 |
| | North Tripura | 14.3 | 0.295 | 0.9 | 0.482 |
| | Sepahijala | 13.5 | 0.315 | 0.0 | 0.390 |
| | South Tripura | 20.3 | 0.295 | 0.0 | 0.427 |
| | Unakoti | 26.0 | 0.288 | 0.0 | 0.409 |
| | West Tripura | 7.9 | 0.332 | 0.8 | 0.396 |
| Meghalaya | South Garo Hills | 26.2 | 0.293 | 0.0 | 0.415 |
| | Ribhoi | 52.4 | 0.190 | 0.0 | 0.736 |
| | East Khasi Hills | 41.7 | 0.218 | 1.4 | 0.912 |
| | East Garo Hills | 27.2 | 0.295 | 0.0 | 0.539 |
| | East Jantia Hills | 63.2 | 0.151 | 0.0 | 0.895 |
| | North Garo Hills | 25.7 | 0.295 | 0.0 | 0.461 |
| | South West Garo Hills | 30.0 | 0.264 | 0.0 | 0.442 |
| | South West Khasi Hills | 65.1 | 0.151 | 0.0 | 0.788 |
| | West Garo Hills | 20.0 | 0.295 | 0.0 | 0.452 |
| | West Jaintia Hills | 70.7 | 0.151 | 0.0 | 0.842 |
| | West Khasi Hills | 69.8 | 0.148 | 0.0 | 0.651 |
| Assam | Kokrajhar | 32.1 | 0.229 | 0.4 | 0.615 |
| | Goalpara | 36.9 | 0.229 | 0.8 | 0.618 |
| | Barpeta | 31.6 | 0.229 | 0.5 | 0.638 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Morigaon | 31.1 | 0.229 | 0.8 | 0.603 |
| | Lakhimpur | 25.2 | 0.295 | 0.4 | 0.448 |
| | Dhemaji | 36.8 | 0.229 | 0.3 | 0.585 |
| | Tinsukia | 24.7 | 0.295 | 1.6 | 0.626 |
| | Dibrugarh | 19.8 | 0.295 | 2.2 | 0.647 |
| | Golaghat | 25.0 | 0.295 | 0.9 | 0.475 |
| | Dima Hasao | 23.9 | 0.295 | 0.0 | 0.465 |
| | Cachar | 33.9 | 0.229 | 0.8 | 0.642 |
| | Karimganj | 33.7 | 0.229 | 0.0 | 0.545 |
| | Hailakandi | 29.0 | 0.229 | 0.0 | 0.518 |
| | Bongaigaon | 24.1 | 0.229 | 0.8 | 0.657 |
| | Chirang | 28.0 | 0.229 | 0.4 | 0.519 |
| | Kamrup | 25.4 | 0.295 | 0.7 | 0.546 |
| | Kamrup Metropolitan | 11.4 | 0.402 | 6.4 | 0.510 |
| | Nalbari | 26.6 | 0.266 | 0.0 | 0.534 |
| | Baksa | 28.9 | 0.229 | 0.0 | 0.521 |
| | Darrang | 32.5 | 0.229 | 0.2 | 0.578 |
| | Udalguri | 35.1 | 0.229 | 0.0 | 0.578 |
| | Biswanath | 27.4 | 0.286 | 0.4 | 0.531 |
| | Charaideo | 27.8 | 0.266 | 0.8 | 0.609 |
| | Dhubri | 34.0 | 0.229 | 0.5 | 0.503 |
| | Hojai | 24.2 | 0.266 | 0.8 | 0.519 |
| | Jorhat | 16.1 | 0.314 | 1.1 | 0.593 |
| | Karbi Anglong | 26.1 | 0.295 | 0.6 | 0.513 |
| | Majuli | 31.3 | 0.229 | 0.0 | 0.571 |
| | Nagaon | 30.3 | 0.229 | 0.8 | 0.628 |
| | Sivasagar | 17.5 | 0.317 | 2.6 | 0.578 |
| | Sonitpur | 28.9 | 0.266 | 0.3 | 0.621 |
| | South Salmara Mancachar | 41.2 | 0.229 | 0.0 | 0.454 |
| | West Karbi Anglong | 30.9 | 0.229 | 0.0 | 0.505 |
| West Bengal | Darjiling | 21.4 | 0.295 | 1.5 | 0.527 |
| | Jalpaiguri | 18.5 | 0.295 | 0.6 | 0.493 |
| | Koch Bihar | 26.6 | 0.229 | 0.3 | 0.487 |
| | Uttar Dinajpur | 23.4 | 0.260 | 1.0 | 0.493 |
| | Dakshin Dinajpur | 19.7 | 0.295 | 0.4 | 0.418 |
| | Maldah | 18.1 | 0.295 | 0.4 | 0.395 |
| | Murshidabad | 25.9 | 0.229 | 0.2 | 0.502 |
| | Birbhum | 24.8 | 0.256 | 1.1 | 0.533 |
| | Nadia | 24.8 | 0.266 | 1.3 | 0.510 |
| | North Twenty Four Parganas | 9.8 | 0.332 | 2.5 | 0.516 |
| | Hugli | 12.3 | 0.295 | 2.0 | 0.541 |
| | Bankura | 34.3 | 0.229 | 0.3 | 0.533 |
| | Puruliya | 45.6 | 0.223 | 0.8 | 0.644 |
| | Haora | 9.0 | 0.295 | 1.2 | 0.544 |
| | Kolkata | 5.5 | 0.402 | 7.4 | 0.500 |
| | South Twenty Four Parganas | 9.5 | 0.295 | 1.2 | 0.446 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Paschim Medinipur | 29.8 | 0.229 | 0.5 | 0.556 |
| | Purba Medinipur | 23.0 | 0.229 | 0.1 | 0.490 |
| | Paschim Barddhaman | 11.5 | 0.332 | 3.4 | 0.548 |
| | Purba Barddhaman | 20.1 | 0.295 | 0.1 | 0.414 |
| Jharkhand | Garhwa | 64.1 | 0.151 | 0.8 | 1.106 |
| | Chatra | 61.1 | 0.157 | 1.0 | 0.999 |
| | Kodarma | 31.8 | 0.266 | 0.7 | 0.557 |
| | Giridih | 34.6 | 0.260 | 0.9 | 0.573 |
| | Deoghar | 41.6 | 0.229 | 0.6 | 0.622 |
| | Godda | 50.8 | 0.194 | 0.3 | 0.686 |
| | Sahibganj | 55.8 | 0.157 | 0.3 | 0.876 |
| | Pakur | 55.5 | 0.157 | 0.0 | 0.788 |
| | Dhanbad | 16.5 | 0.332 | 2.8 | 0.551 |
| | Bokaro | 19.2 | 0.317 | 5.5 | 0.617 |
| | Lohardaga | 41.7 | 0.229 | 0.9 | 0.630 |
| | Purbi Singhbhum | 25.2 | 0.332 | 10.3 | 0.761 |
| | Palamu | 52.7 | 0.193 | 0.8 | 0.785 |
| | Latehar | 68.2 | 0.151 | 0.0 | 0.882 |
| | Hazaribagh | 30.8 | 0.266 | 1.1 | 0.626 |
| | Ramgarh | 22.4 | 0.295 | 2.3 | 0.582 |
| | Dumka | 53.5 | 0.188 | 0.6 | 0.784 |
| | Jamtara | 45.7 | 0.229 | 1.5 | 0.678 |
| | Ranchi | 23.6 | 0.295 | 8.4 | 0.729 |
| | Khunti | 56.3 | 0.171 | 0.7 | 0.911 |
| | Gumla | 55.3 | 0.188 | 0.6 | 0.691 |
| | Simdega | 61.0 | 0.157 | 0.7 | 0.916 |
| | Pashchimi Singhbhum | 66.2 | 0.151 | 0.7 | 0.981 |
| | Saraikela-Kharsawan | 38.1 | 0.229 | 2.1 | 0.674 |
| Odisha | Bargarh | 27.6 | 0.295 | 1.6 | 0.605 |
| | Jharsuguda | 18.3 | 0.377 | 3.7 | 0.535 |
| | Sambalpur | 26.6 | 0.295 | 3.0 | 0.705 |
| | Debagarh | 37.7 | 0.229 | 1.2 | 0.795 |
| | Sundargarh | 23.0 | 0.317 | 4.9 | 0.757 |
| | Kendujhar | 38.8 | 0.236 | 1.7 | 0.881 |
| | Mayurbhanj | 47.4 | 0.223 | 0.9 | 0.719 |
| | Baleshwar | 21.2 | 0.295 | 1.4 | 0.536 |
| | Bhadrak | 15.8 | 0.295 | 0.7 | 0.479 |
| | Kendrapara | 16.7 | 0.295 | 0.8 | 0.483 |
| | Jagatsinghapur | 14.2 | 0.332 | 0.7 | 0.464 |
| | Cuttack | 14.1 | 0.332 | 4.6 | 0.579 |
| | Jajapur | 18.3 | 0.295 | 1.3 | 0.536 |
| | Dhenkanal | 25.5 | 0.295 | 0.6 | 0.545 |
| | Anugul | 24.2 | 0.295 | 0.8 | 0.596 |
| | Nayagarh | 20.2 | 0.295 | 0.7 | 0.520 |
| | Khordha | 11.6 | 0.402 | 7.0 | 0.537 |
| | Puri | 14.9 | 0.332 | 1.4 | 0.481 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Ganjam | 15.1 | 0.317 | 1.8 | 0.548 |
| | Gajapati | 45.6 | 0.229 | 0.3 | 0.648 |
| | Kandhamal | 35.8 | 0.229 | 0.9 | 0.707 |
| | Baudh | 34.1 | 0.260 | 0.4 | 0.644 |
| | Subarnapur | 26.9 | 0.295 | 0.8 | 0.580 |
| | Balangir | 30.6 | 0.267 | 1.2 | 0.593 |
| | Nuapada | 38.8 | 0.229 | 0.6 | 0.727 |
| | Kalahandi | 36.7 | 0.229 | 0.4 | 0.729 |
| | Rayagada | 47.9 | 0.223 | 0.7 | 0.809 |
| | Nabarangapur | 54.4 | 0.188 | 0.3 | 0.816 |
| | Koraput | 53.4 | 0.188 | 1.7 | 0.980 |
| | Malkangiri | 53.2 | 0.194 | 0.6 | 0.947 |
| Chhattisgarh | Koriya | 40.8 | 0.260 | 4.3 | 0.919 |
| | Jashpur | 48.2 | 0.218 | 1.4 | 0.862 |
| | Raigarh | 22.7 | 0.332 | 1.4 | 0.574 |
| | Korba | 22.1 | 0.376 | 5.4 | 0.596 |
| | Janjgir - Champa | 13.5 | 0.376 | 2.4 | 0.469 |
| | Kabeerdham | 18.9 | 0.339 | 1.5 | 0.561 |
| | Rajnandgaon | 11.1 | 0.355 | 1.9 | 0.498 |
| | Mahasamund | 22.0 | 0.332 | 2.6 | 0.568 |
| | Dhamtari | 12.7 | 0.383 | 2.8 | 0.489 |
| | Uttar Bastar Kanker | 19.7 | 0.332 | 3.0 | 0.573 |
| | Narayanpur | 56.5 | 0.183 | 1.4 | 1.395 |
| | Bijapur | 65.2 | 0.119 | 0.8 | 1.247 |
| | Balod | 14.2 | 0.383 | 2.4 | 0.491 |
| | Baloda Bazar | 16.8 | 0.335 | 2.8 | 0.579 |
| | Balrampur | 53.9 | 0.188 | 1.4 | 0.970 |
| | Bastar | 51.3 | 0.194 | 2.6 | 1.156 |
| | Bemetara | 15.9 | 0.332 | 1.9 | 0.540 |
| | Bilaspur | 19.0 | 0.355 | 6.3 | 0.684 |
| | Dantewada | 53.8 | 0.188 | 1.3 | 1.030 |
| | Durg | 4.8 | 0.531 | 14.0 | 0.397 |
| | Gariyaband | 27.7 | 0.295 | 1.1 | 0.623 |
| | Kodagaon | 53.3 | 0.188 | 1.0 | 0.949 |
| | Mungeli | 24.5 | 0.295 | 1.0 | 0.600 |
| | Raipur | 7.1 | 0.443 | 5.9 | 0.445 |
| | Sukma | 65.5 | 0.151 | 0.0 | 1.029 |
| | Surajpur | 38.1 | 0.260 | 2.2 | 0.810 |
| | Surguja | 45.0 | 0.229 | 3.3 | 0.971 |
| Madhya Pradesh | Sheopur | 37.2 | 0.256 | 1.6 | 0.779 |
| | Morena | 20.2 | 0.376 | 3.5 | 0.564 |
| | Bhind | 21.0 | 0.375 | 3.4 | 0.574 |
| | Gwalior | 8.7 | 0.531 | 11.0 | 0.411 |
| | Datia | 18.8 | 0.376 | 3.5 | 0.558 |
| | Shivpuri | 35.0 | 0.266 | 2.9 | 0.831 |
| | Tikamgarh | 24.3 | 0.332 | 1.6 | 0.642 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Chhatarpur | 35.1 | 0.255 | 2.1 | 0.942 |
| | Panna | 43.8 | 0.229 | 0.3 | 0.736 |
| | Sagar | 26.4 | 0.295 | 2.0 | 0.660 |
| | Damoh | 37.3 | 0.229 | 2.1 | 0.871 |
| | Satna | 32.4 | 0.260 | 5.0 | 1.025 |
| | Rewa | 48.4 | 0.223 | 0.8 | 0.825 |
| | Umaria | 42.1 | 0.229 | 2.5 | 0.893 |
| | Neemuch | 13.7 | 0.378 | 3.0 | 0.508 |
| | Mandsaur | 15.6 | 0.332 | 3.3 | 0.583 |
| | Ratlam | 23.3 | 0.334 | 4.9 | 0.709 |
| | Ujjain | 9.6 | 0.443 | 9.5 | 0.532 |
| | Dewas | 14.5 | 0.367 | 6.2 | 0.609 |
| | Dhar | 31.3 | 0.295 | 2.3 | 0.790 |
| | Indore | 4.4 | 0.549 | 14.1 | 0.375 |
| | Khargone (West Nimar) | 17.4 | 0.406 | 4.7 | 0.530 |
| | Barwani | 34.8 | 0.266 | 1.7 | 0.742 |
| | Rajgarh | 29.3 | 0.275 | 1.7 | 0.733 |
| | Vidisha | 19.9 | 0.332 | 2.2 | 0.582 |
| | Bhopal | 8.4 | 0.549 | 9.9 | 0.402 |
| | Sehore | 18.5 | 0.332 | 2.7 | 0.577 |
| | Raisen | 19.5 | 0.332 | 2.2 | 0.602 |
| | Betul | 34.0 | 0.276 | 2.9 | 0.789 |
| | Harda | 14.3 | 0.420 | 7.3 | 0.518 |
| | Hoshangabad | 23.0 | 0.371 | 4.1 | 0.613 |
| | Katni | 31.5 | 0.256 | 1.7 | 0.922 |
| | Jabalpur | 27.8 | 0.295 | 0.0 | 0.569 |
| | Narsimhapur | 29.5 | 0.295 | 2.5 | 0.680 |
| | Dindori | 61.1 | 0.151 | 0.5 | 1.091 |
| | Mandla | 46.7 | 0.223 | 2.5 | 0.884 |
| | Chhindwara | 34.8 | 0.295 | 3.7 | 0.764 |
| | Seoni | 43.0 | 0.229 | 3.1 | 0.930 |
| | Balaghat | 25.7 | 0.308 | 0.3 | 0.551 |
| | Guna | 30.0 | 0.295 | 3.5 | 0.707 |
| | Ashoknagar | 30.6 | 0.266 | 1.8 | 0.723 |
| | Shahdol | 45.7 | 0.229 | 1.5 | 0.921 |
| | Anuppur | 45.2 | 0.223 | 1.4 | 0.904 |
| | Sidhi | 47.5 | 0.229 | 1.6 | 0.883 |
| | Singrauli | 45.9 | 0.229 | 3.0 | 0.999 |
| | Jhabua | 58.0 | 0.194 | 2.4 | 0.978 |
| | Alirajpur | 45.0 | 0.229 | 1.9 | 0.777 |
| | Khandwa (East Nimar) | 21.9 | 0.332 | 1.7 | 0.608 |
| | Burhanpur | 24.0 | 0.317 | 2.4 | 0.640 |
| | Agar Malwa | 19.9 | 0.332 | 1.3 | 0.499 |
| | Shajapur | 16.3 | 0.332 | 1.7 | 0.557 |
| Gujarat | Kachchh | 8.6 | 0.402 | 3.5 | 0.449 |
| | Banas Kantha | 25.6 | 0.295 | 0.8 | 0.592 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Patan | 13.6 | 0.332 | 0.9 | 0.474 |
| | Mahesana | 14.5 | 0.332 | 1.7 | 0.508 |
| | Gandhinagar | 9.6 | 0.439 | 6.3 | 0.425 |
| | Porbandar | 5.4 | 0.439 | 6.1 | 0.419 |
| | Amreli | 8.0 | 0.402 | 0.3 | 0.349 |
| | Anand | 14.0 | 0.367 | 2.5 | 0.481 |
| | Dohad | 40.1 | 0.229 | 0.8 | 0.651 |
| | Narmada | 35.5 | 0.260 | 0.3 | 0.593 |
| | Bharuch | 13.3 | 0.402 | 2.1 | 0.434 |
| | The Dangs | 40.7 | 0.229 | 0.0 | 0.678 |
| | Navsari | 14.3 | 0.402 | 3.6 | 0.460 |
| | Valsad | 12.0 | 0.402 | 3.8 | 0.432 |
| | Surat | 8.9 | 0.439 | 7.8 | 0.450 |
| | Tapi | 23.5 | 0.332 | 1.9 | 0.536 |
| | Ahmadabad | 4.0 | 0.439 | 8.3 | 0.442 |
| | Aravali | 20.9 | 0.295 | 0.9 | 0.540 |
| | Bhavnagar | 14.7 | 0.332 | 7.3 | 0.617 |
| | Botad | 7.2 | 0.402 | 1.2 | 0.355 |
| | Chhota Udaipur | 31.5 | 0.264 | 0.4 | 0.555 |
| | Devbhumi Dwarka | 6.4 | 0.354 | 1.2 | 0.461 |
| | Gir Somnath | 7.7 | 0.332 | 1.2 | 0.425 |
| | Jamnagar | 3.5 | 0.439 | 3.2 | 0.339 |
| | Junagadh | 6.7 | 0.402 | 2.6 | 0.389 |
| | Kheda | 18.5 | 0.332 | 3.2 | 0.573 |
| | Mahisagar | 23.9 | 0.295 | 1.7 | 0.558 |
| | Morbi | 4.2 | 0.439 | 4.9 | 0.383 |
| | Panch Mahals | 26.4 | 0.295 | 0.5 | 0.662 |
| | Rajkot | 3.6 | 0.439 | 6.5 | 0.399 |
| | Sabar Kantha | 21.1 | 0.332 | 2.5 | 0.577 |
| | Surendranagar | 6.5 | 0.402 | 0.4 | 0.354 |
| | Vadodara | 9.8 | 0.439 | 11.2 | 0.450 |
| Dadra & Nagar Haveli and Daman and Diu | Diu | 5.3 | 0.439 | 5.3 | 0.372 |
| | Daman | 15.1 | 0.340 | 2.7 | 0.548 |
| | Dadra & Nagar Haveli | 17.8 | 0.332 | 2.3 | 0.511 |
| Maharashtra | Nandurbar | 37.6 | 0.260 | 1.2 | 0.736 |
| | Dhule | 20.5 | 0.332 | 3.6 | 0.632 |
| | Jalgaon | 14.3 | 0.405 | 2.5 | 0.469 |
| | Buldana | 14.2 | 0.334 | 2.8 | 0.582 |
| | Akola | 10.6 | 0.408 | 2.7 | 0.445 |
| | Washim | 17.1 | 0.332 | 1.1 | 0.531 |
| | Amravati | 10.4 | 0.422 | 3.0 | 0.425 |
| | Wardha | 10.1 | 0.443 | 3.1 | 0.415 |
| | Nagpur | 5.3 | 0.531 | 12.9 | 0.397 |
| | Bhandara | 12.6 | 0.382 | 2.9 | 0.482 |
| | Gondiya | 13.2 | 0.334 | 1.4 | 0.526 |
| | Gadchiroli | 24.1 | 0.295 | 0.8 | 0.585 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Chandrapur | 15.3 | 0.403 | 2.1 | 0.465 |
| | Yavatmal | 17.8 | 0.376 | 1.1 | 0.478 |
| | Nanded | 18.9 | 0.332 | 2.7 | 0.587 |
| | Hingoli | 15.3 | 0.332 | 1.4 | 0.541 |
| | Parbhani | 20.2 | 0.332 | 1.4 | 0.554 |
| | Jalna | 21.2 | 0.332 | 1.0 | 0.541 |
| | Aurangabad | 14.4 | 0.383 | 4.7 | 0.550 |
| | Nashik | 20.7 | 0.332 | 2.8 | 0.597 |
| | Mumbai Suburban | 1.5 | 0.510 | 12.3 | 0.381 |
| | Mumbai | 1.7 | 0.620 | 23.2 | 0.330 |
| | Raigarh | 9.2 | 0.420 | 3.8 | 0.411 |
| | Pune | 6.7 | 0.439 | 6.2 | 0.441 |
| | Latur | 16.9 | 0.332 | 0.9 | 0.539 |
| | Osmanabad | 16.0 | 0.332 | 0.4 | 0.473 |
| | Solapur | 17.2 | 0.332 | 1.6 | 0.521 |
| | Satara | 12.4 | 0.336 | 1.6 | 0.520 |
| | Ratnagiri | 10.4 | 0.332 | 3.0 | 0.533 |
| | Sindhudurg | 9.1 | 0.332 | 2.5 | 0.530 |
| | Kolhapur | 8.4 | 0.420 | 3.2 | 0.434 |
| | Sangli | 10.9 | 0.401 | 3.1 | 0.459 |
| | Palghar | 12.8 | 0.402 | 7.2 | 0.539 |
| | Thane | 3.8 | 0.510 | 9.1 | 0.395 |
| | Srikakulam | 12.4 | 0.295 | 1.4 | 0.522 |
| Andhra Pradesh | Vizianagaram | 17.1 | 0.295 | 0.3 | 0.479 |
| | Visakhapatnam | 13.7 | 0.367 | 4.1 | 0.564 |
| | East Godavari | 12.8 | 0.402 | 4.8 | 0.489 |
| | West Godavari | 7.6 | 0.402 | 2.9 | 0.430 |
| | Krishna | 10.2 | 0.367 | 2.4 | 0.480 |
| | Guntur | 13.4 | 0.371 | 1.9 | 0.483 |
| | Prakasam | 13.7 | 0.332 | 1.3 | 0.539 |
| | Sri Potti Sriramulu Nellore | 12.6 | 0.367 | 1.5 | 0.484 |
| | Y.S.R. | 7.2 | 0.402 | 0.5 | 0.387 |
| | Kurnool | 11.1 | 0.332 | 0.9 | 0.490 |
| | Anantapur | 13.5 | 0.332 | 0.9 | 0.455 |
| | Chittoor | 10.0 | 0.332 | 1.8 | 0.509 |
| Karnataka | Belgaum | 13.9 | 0.332 | 1.8 | 0.494 |
| | Bagalkot | 15.1 | 0.332 | 0.2 | 0.398 |
| | Bijapur | 19.2 | 0.332 | 0.9 | 0.487 |
| | Bidar | 16.0 | 0.317 | 0.7 | 0.448 |
| | Raichur | 16.0 | 0.332 | 1.2 | 0.456 |
| | Koppal | 16.9 | 0.306 | 1.3 | 0.474 |
| | Gadag | 18.1 | 0.317 | 0.7 | 0.506 |
| | Dharwad | 7.7 | 0.332 | 3.5 | 0.533 |
| | Uttara Kannada | 9.2 | 0.334 | 4.2 | 0.537 |
| | Haveri | 15.2 | 0.332 | 1.8 | 0.439 |
| | Bellary | 10.4 | 0.332 | 3.5 | 0.524 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Chitradurga | 8.6 | 0.332 | 1.3 | 0.432 |
| | Davanagere | 9.8 | 0.332 | 1.3 | 0.440 |
| | Shimoga | 7.8 | 0.350 | 1.4 | 0.458 |
| | Udupi | 3.1 | 0.420 | 5.3 | 0.403 |
| | Chikmagalur | 8.7 | 0.332 | 2.3 | 0.507 |
| | Tumkur | 9.4 | 0.332 | 1.2 | 0.492 |
| | Bangalore | 4.4 | 0.526 | 12.4 | 0.375 |
| | Mandya | 10.2 | 0.332 | 1.2 | 0.444 |
| | Hassan | 8.7 | 0.332 | 1.7 | 0.460 |
| | Dakshina Kannada | 3.3 | 0.439 | 5.0 | 0.405 |
| | Kodagu | 7.7 | 0.401 | 6.7 | 0.501 |
| | Mysore | 11.2 | 0.332 | 2.5 | 0.521 |
| | Chamarajanagar | 14.2 | 0.332 | 0.5 | 0.435 |
| | Gulbarga | 13.0 | 0.332 | 2.2 | 0.508 |
| | Yadgir | 15.6 | 0.295 | 0.8 | 0.475 |
| | Kolar | 6.9 | 0.383 | 2.1 | 0.432 |
| | Chikkaballapura | 9.9 | 0.332 | 1.4 | 0.453 |
| | Bangalore Rural | 5.3 | 0.394 | 2.6 | 0.393 |
| | Ramanagara | 10.4 | 0.332 | 1.6 | 0.492 |
| Goa | North Goa | 1.4 | 0.616 | 21.7 | 0.319 |
| | South Goa | 0.5 | 0.618 | 27.7 | 0.321 |
| Lakshadweep | Lakshadweep | 3.0 | 0.521 | 6.1 | 0.311 |
| Kerala | Kasaragod | 5.6 | 0.439 | 4.4 | 0.402 |
| | Kannur | 1.4 | 0.510 | 7.3 | 0.345 |
| | Wayanad | 12.1 | 0.402 | 3.9 | 0.481 |
| | Kozhikode | 2.3 | 0.526 | 8.7 | 0.324 |
| | Malappuram | 1.1 | 0.489 | 9.0 | 0.372 |
| | Palakkad | 5.7 | 0.439 | 5.2 | 0.416 |
| | Thrissur | 1.4 | 0.526 | 13.5 | 0.365 |
| | Ernakulam | 1.7 | 0.547 | 13.8 | 0.339 |
| | Idukki | 7.2 | 0.413 | 2.3 | 0.439 |
| | Kottayam | 1.6 | 0.526 | 10.1 | 0.348 |
| | Alappuzha | 2.8 | 0.489 | 8.2 | 0.360 |
| | Pathanamthitta | 1.8 | 0.510 | 11.3 | 0.366 |
| | Kollam | 2.1 | 0.489 | 8.2 | 0.363 |
| | Thiruvananthapuram | 3.6 | 0.495 | 11.0 | 0.394 |
| Tamil Nadu | Thiruvallur | 3.5 | 0.526 | 7.0 | 0.359 |
| | Chennai | 1.0 | 0.547 | 13.4 | 0.326 |
| | Kancheepuram | 3.6 | 0.439 | 8.3 | 0.439 |
| | Vellore | 5.6 | 0.439 | 4.5 | 0.383 |
| | Tiruvannamalai | 8.7 | 0.402 | 2.6 | 0.457 |
| | Viluppuram | 8.2 | 0.399 | 1.1 | 0.406 |
| | Salem | 5.7 | 0.402 | 1.4 | 0.383 |
| | Namakkal | 8.1 | 0.439 | 2.4 | 0.389 |
| | Erode | 5.2 | 0.402 | 2.9 | 0.386 |
| | The Nilgiris | 7.2 | 0.332 | 1.2 | 0.469 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Dindigul | 10.6 | 0.343 | 2.4 | 0.501 |
| | Karur | 9.8 | 0.367 | 2.5 | 0.438 |
| | Tiruchirappalli | 7.2 | 0.402 | 3.0 | 0.427 |
| | Perambalur | 10.3 | 0.373 | 1.6 | 0.420 |
| | Ariyalur | 12.2 | 0.332 | 0.9 | 0.436 |
| | Cuddalore | 8.9 | 0.420 | 3.5 | 0.416 |
| | Nagapattinam | 9.1 | 0.367 | 2.2 | 0.467 |
| | Thiruvarur | 11.0 | 0.371 | 2.4 | 0.421 |
| | Thanjavur | 7.3 | 0.402 | 2.8 | 0.427 |
| | Pudukkottai | 7.1 | 0.371 | 1.8 | 0.406 |
| | Sivaganga | 4.7 | 0.420 | 1.5 | 0.359 |
| | Madurai | 5.4 | 0.408 | 4.7 | 0.428 |
| | Theni | 6.8 | 0.402 | 2.3 | 0.416 |
| | Virudhunagar | 7.9 | 0.332 | 1.6 | 0.488 |
| | Ramanathapuram | 6.5 | 0.402 | 1.2 | 0.369 |
| | Thoothukkudi | 4.1 | 0.439 | 5.4 | 0.396 |
| | Tirunelveli | 7.6 | 0.371 | 1.7 | 0.429 |
| | Kanniyakumari | 3.6 | 0.439 | 4.8 | 0.393 |
| | Dharmapuri | 9.9 | 0.342 | 1.5 | 0.425 |
| | Krishnagiri | 5.5 | 0.402 | 1.5 | 0.357 |
| | Coimbatore | 4.3 | 0.439 | 4.2 | 0.412 |
| | Tiruppur | 6.5 | 0.408 | 4.4 | 0.448 |
| Puducherry | Yanam | 3.3 | 0.511 | 6.7 | 0.380 |
| | Puducherry | 2.6 | 0.547 | 13.9 | 0.354 |
| | Mahe | 0.0 | 0.573 | 15.0 | 0.290 |
| | Karaikal | 3.7 | 0.439 | 6.7 | 0.415 |
| Andaman & Nicobar Islands | Nicobars | 17.6 | 0.377 | 0.0 | 0.428 |
| | North & Middle Andaman | 12.5 | 0.402 | 1.6 | 0.414 |
| | South Andaman | 3.1 | 0.510 | 5.3 | 0.342 |
| Telangana | Adilabad | 17.6 | 0.360 | 1.0 | 0.488 |
| | Bhadradri Kothagudem | 13.1 | 0.383 | 1.7 | 0.452 |
| | Hyderabad | 3.3 | 0.549 | 9.8 | 0.340 |
| | Jagitial | 11.8 | 0.383 | 1.2 | 0.449 |
| | Jangoan | 12.7 | 0.332 | 0.9 | 0.456 |
| | Jayashankar Bhupalapally | 14.1 | 0.332 | 0.7 | 0.489 |
| | Jogulamba Gadwal | 9.8 | 0.332 | 0.6 | 0.447 |
| | Kamareddy | 16.9 | 0.302 | 1.2 | 0.580 |
| | Karimnagar | 10.7 | 0.406 | 3.1 | 0.447 |
| | Khammam | 9.3 | 0.406 | 1.6 | 0.428 |
| | Komaram Bheem Asifabad | 18.6 | 0.295 | 1.0 | 0.583 |
| | Mahabubabad | 15.7 | 0.332 | 0.4 | 0.473 |
| | Mahabubnagar | 11.5 | 0.332 | 2.5 | 0.536 |
| | Mancherial | 14.2 | 0.406 | 1.1 | 0.444 |
| | Medak | 15.3 | 0.295 | 1.0 | 0.513 |
| | Medchal-Malkajgiri | 6.8 | 0.526 | 11.0 | 0.392 |

| State/UT | District | Households having *ai* <0.200 (Per cent) | Median *ai* | Households having *ai* ≥0.800 (Per cent) | Within-district inequality in household wealth |
|---|---|---|---|---|---|
| | Nagarkurnool | 16.9 | 0.295 | 0.4 | 0.522 |
| | Nalgonda | 12.8 | 0.348 | 2.0 | 0.566 |
| | Nirmal | 16.5 | 0.335 | 1.2 | 0.524 |
| | Nizamabad | 10.1 | 0.383 | 1.1 | 0.423 |
| | Peddapalli | 9.7 | 0.440 | 1.2 | 0.391 |
| | Rajanna Sircilla | 8.4 | 0.406 | 1.2 | 0.398 |
| | Ranga Reddy | 7.4 | 0.454 | 6.7 | 0.460 |
| | Sangareddy | 12.2 | 0.332 | 0.9 | 0.456 |
| | Siddipet | 11.2 | 0.371 | 1.3 | 0.531 |
| | Suryapet | 12.8 | 0.371 | 1.5 | 0.480 |
| | Vikarabad | 16.6 | 0.295 | 0.4 | 0.516 |
| | Wanaparthy | 10.2 | 0.332 | 0.3 | 0.447 |
| | Warangal Rural | 16.0 | 0.332 | 0.4 | 0.460 |
| | Warangal Urban | 10.7 | 0.443 | 3.0 | 0.423 |
| | Yadadri Bhuvanagiri | 10.6 | 0.369 | 1.2 | 0.434 |
| Ladakh | Leh (Ladakh) | 8.3 | 0.395 | 2.1 | 0.424 |
| | Kargil | 24.4 | 0.260 | 0.0 | 0.658 |

Source: Author

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# Child Well-being in Madhya Pradesh, India

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## Abstract

This paper explores the opportunities to enhance child well-being in Madhya Pradesh, India and in its constituent districts though the lens of social protection. By employing a specifically developed composite child deprivation index the study highlights areas where children can benefit from targeted interventions. The findings show significant inter-district variations that offer significant opportunities for improvement in child well-being, especially with a decentralised, multi-dimensional and integrated approach to social protection system Recognizing children as a distinct and vital demographic in the state's social and developmental policies can lead to meaningful and positive changes in their lives.

## Background

In recent years, there has been an increased focus on strengthening social protection systems using life cycle approach. Child well-being is recognised as critical foundation of in the evolution of social protection policies It is now increasingly being recognised that social protection can play an important role in securing child well-being, particularly when considered in the context of broader social-economic development framework which encompasses the actions taken by governments and society to ensure child well-being.

Children are at the forefront of the social protection policy as they are the future of society. Investing in children is an investment in the future of humanity. There are three compelling reasons for countries, societies, and families to invest in children: 1) ethically, it is necessary for achieving human rights; 2) socially, it is important for achieving social cohesion; and 3) fit is vital for achieving productivity gains necessary for economic growth and maintaining a high standard of living. There are compelling statistics to support this argument. According to International Labour Organization (ILO), only 35 per cent children worldwide were covered by social protection benefits in 2015 which highlights a significant gap in ensuring child well-being. Social protection programmes show that child deprivation can be reduced by up to 30 per cent in countries with comprehensive social protection system. Children receiving social protection benefits are 20 per cent more likely to attend school while 15 per cent are more likely to receive essential health services compared to children who are devoid of social protection benefits. Investing in child well-being can yield a return of up to $7 for every $1 spent, due to improved health, education, and future productivity. Effective social protection can reduce child labour by 10 per cent, allowing children to focus on education and development. These statistics underscore the critical role of social protection in enhancing child well-being and broader socio-economic benefits of such investments (International Labour Organization, 2025). Another rationale for child-sensitive social protection is that children, along with women, constitute the most vulnerable group of population. They have limited freedom in making decisions related to their own welfare (White et al 2002). They depend upon family elders including their parents in meeting their basic needs. They also rely, significantly, upon the production of public goods and services, especially, in education and health (Gordon et al 2003a, 2003b; Minujin et al 2006; Notten and de Neubourg 2011; Waddington 2004; White et al 2002). These and many other dependencies of children get manifested in poor social and economic settings. Poverty, at the early stages of life, has enduring consequences on those children who survive into the adulthood. It condemns them to recurrent poverty spells and a life full of hardship (Grinspun 2004).

The United Nations Convention on the Rights of the Child has also laid down the basic principles of non-discrimination in the best interest of the child along with common standards for various rights of children. The Convention takes into the account different cultural, social, economic, and political realities in which children live (United Nations 1989). By ratifying the Convention in 1992, India has committed herself to protecting and advancing child rights. The rights of the child have also been enshrined in the fundamental rights and the directive principles of state policy in the Constitution of India and reaffirmed by the National Policy on Children (Government of India 1974; 2013). Efforts to main-streaming child rights issues in the development discourse in India are reflected in the Integrated Child Protection Scheme which aims to promote the best interests of the child, to prevent violations of child rights through appropriate punitive measures and to ensure rehabilitation for all children in need of care and protection (Government of India 2007).

Despite all efforts, ensuring child well-being remains a major development challenge in India. There is growing recognition of the need to address these issues. Traditional structures of patriarchy and other social ). Traditional structures of patriarchy and other social groupings have historically justified extreme forms of chastisement of children, including adolescents (Kushwah and Prasad 2009A child-cantered social protection approach is, therefore, crucial to realizing child rights and tackling child deprivations. When social protection efforts are well-coordinated, children benefit immensely, gaining access to key opportunities critical to their well-being. Social protection is particularly significant for children, as promoting well-being during childhood has lifelong positive impacts.

Institutionalising child well-being perspective within the social policy framework requires an understanding of the multi-dimensional nature of child well-being. Numerous studies have identified distinct domains or dimensions of child well-being from different perspectives (Hauser et al 1997; Land et al 2001; Pollard et al 2002; Raidy and Winjie 2002; Child Trend 2003). These include, among others, child rights perspective (Ben-Arieh 2001); child needs perspective (Ryan and Deci 2001); child development perspective (Mickelwright and Stewart 1999); and child outcomes perspective (Maryland Partnership for Children, Youth and Families 2002). Different domains or dimensions of child well-being can also be identified following the capabilities approach first propounded by Sen (1985) and later discussed in Nussbaum and Sen (1993) and Nussbaum (2000). In terms of Sen's capability approach, domains of child well-being can be defined in terms of child endowments, child capacities and child opportunities (Chaurasia 2010).

One approach to understanding the social protection perspective of child well-being is to analyse different forms of deprivation faced by children. Deprivation may be defined as circumstances or situations that are highly likely to have adverse implications to the well-being of an individual. People are considered deprived if they lack access to facilities and services necessary for their well-being. They are deemed poor if they lack resources to escape deprivation (Townsend, 1987). Child deprivation, therefore, refers to circumstances or situations or both that are highly likely to have adverse implications to child well-being. Children are deprived if they lack access to services and facilities necessary for their well-being. They are considered poor if they lack resources to escape deprivation. Mitigating child deprivation is crucial for ensuring child well-being (Minujin et al 2006). Deprivation measures reflect the extent to which well-being needs of children are met (de Neubourg 2012).

The foregoing considerations constitute the rationale for this paper which focuses on the deprivation faced by children of Madhya Pradesh, one of the less developed states of India. The state ranks at 28 in terms of per capita income which is amply reflected in the well-being of children. Madhya Pradesh is the only state/Union Territory in India where infant mortality rate was more than 40 infant deaths per 1000 live births while the under-five mortality rate was more than 50 under-five deaths for every 1000 live births as late as 2020 (Government of India, 2022a). It is estimated that out of every 1000 new-born in the state, around 75 fail to survive to their 20$^{th}$ birthday (Government of India, 2022b). Children in Madhya Pradesh face multiple deprivations that significantly impact their well-being and which can largely be mitigated through a social protection approach.

The present paper is divided into six sections in addition to this introduction. The next section constructs a composite child deprivation index to measure child deprivation. The third section describes the data used in the analysis, which is based on the data available through the fifth (2019-21) round of the National Family Health Survey (Government of India, 2022c). The fourth section presents the findings of the analysis. The last section summarises these findings and discusses their implications for formulating a child sensitive social protection policy of Madhya Pradesh.

## Composite Child Deprivation Index (CDI)

The composite child deprivation index constructed in this paper is based on the framework provided by the United Nations Convention on the Rights of the Child (United Nations, 1989). The Convention identifies four rights of children: 1) right to survival and health; 2) right to physical growth and development; 3) right to cognitive development; and 4) right to protection from a range of social, economic, cultural, and environmental hazards. The Convention advocates that these four rights are critical to child well-being. This means that child well-being or, equivalently, child deprivation should be measured and monitored in terms of services and facilities that have an impact on the survival, physical growth and development, cognitive development, and protection of children from a range of social, economic, cultural, and environmental hazards. Moreover, household standard of living has a strong impact on all the four rights of children which means that the deprivation faced by children can be conceptualised in a five-dimensional space with each dimension having its own relevance to child well-being.

The United Nations Convention on the Rights of the Child defines a child as a person below 18 years of age. The National Policy on Children also defines a person as child if she or he has not reached 18 years of age (Government of India, 2013). The relative importance of different dimensions child well-being is, however, different for children of different ages. The survival context of child well-being is the most critical to children below one year of age while the protection context may be assumed to be the most important for children aged at least 15 years. An age-specific approach, therefore, should be adopted for measuring child deprivation. In other words, a two dimensional framework is required to measure child deprivation. This framework identifies the dimensions of child well-being which are the most relevant to children of different ages from the social protection perspective.

The present analysis is based on a composite child deprivation index (CDI) that has been developed based on a set of 24 indicators related to different dimensions of child well-being. The list of indicators along with their threshold values to classify a child as deprived are given in table 1. The indicators are different for children of different ages as only those dimensions which are relevant to children of a particular age have been considered for the construction of CDI.

Table 1: Indicators used for the construction of CDI along with their threshold level.

| Age in years | Dimension of child well-being | Indicator | Deprivation threshold |
|---|---|---|---|
| <1 | Survival | 1. Weight at birth | < 2.5 Kg |
| | | 2. Check-up within two days of birth | No |
| | | 3. Breastfeeding within 1 hour of birth | No |
| | | 4. Standard of living | Poorest |
| 1-2 | Survival | 5, Vaccination status | Incomplete vaccination |
| | Growth | 6. Height-for-age | Low height-for-age |
| | | 7 Received Vitamin A in last six months | No |
| | | 8. Standard of living | Poorest |
| 3-5 | Growth | 9, Weight-for-height | Low weight-for-height |
| | Protection | 10. Availability of birth certificate | Not available |
| | Development | 11. Schooling status | Irregular school attendance |
| | | 12. Standard of living | Poorest |
| 6-10 | Development | 13. Schooling status | Irregular school attendance |
| | Protection | 14. Orphan status | Child is orphan |
| | Protection | 15. Has bank account | No |
| | | 16. Standard of living | Poorest |
| 11-14 | Development | 17. Schooling status | Not attending school |
| | Protection | 18. Orphan status | Child is orphan |
| | Protection | 19. Marital status | Ever married |
| | | 20. Standard of living | Poorest |
| 15-19 | Development | 21. Schooling status | Irregular school attendance |
| | Growth | 22. Body mass index (BMI) | Less than 18.5 |
| | Protection | 23. Marital status of the child | Ever married |
| | | 24. Standard of living | Poorest |

Source: Author

Following Anand and Sen (1997), let $d_{ij}$ is the normalised value of the proportion of children in the age group *i* who are classified as deprived in terms of the indicator *j*. Then the deprivation index for children of age group *i* is defined as

$$D_i = \left(\frac{\sum_{j=1}^{n} d_{ij}^{\alpha}}{n}\right)^{1/\alpha}$$

where *n* is the number of indicators considered to measure the deprivation in the age group and $\alpha$ is the order or the power of the mean and is greater than 1. The index $D_i$ is the power mean or the generalised mean of order $\alpha$ of the normalised values of the proportion of children classified as deprived in terms of the indicator *j*. When $\alpha=1$, $D_i$ is equal to the simple arithmetic mean of the well-being indicators used to measure the deprivation in children of a particular age group. This implies that the impact of a unit increase (or decrease) in all indicators of well-being is the same irrespective of the progress reflected in terms of different well-being indicators. This contradicts the usual assumption that as the extent of deprivation with respect to a well-being indicator increases, the weight of the indicator in deciding the deprivation index should also increase. To ensure this $\alpha$ must be greater than 1. The value of $\alpha>1$ places greater weight on those indicators of child well-being which reflect higher deprivation in comparison to those indicators which reflect lower deprivation. In using the mean of order $\alpha$, the relative weight given to an indicator increases as the deviation of the normalised value of the indicator from the simple arithmetic mean of all indicators increases. The use of mean of order $\alpha$ also addresses the problem of additive compensability associated with simple arithmetic mean or the mean of order 1. There is, however, an escapable arbitrariness in the selection of the order of the mean. When $\alpha=3$, the impact of the indicator in which the deprivation is the highest on the index *d* is four times the impact of the indicator in which the deprivation is the lowest. Assigning the importance in relation to the level of deprivation in terms of the indicator is relevant in the context of social protection.

It may be noticed that $d_{ij}$ for each *i* and *j* are actually headcounts of children who are classified as deprived with respect to a specific indicator of well-being. However, the index $D_i$ cannot be thought of the proportion of children deprived with respect to the well-being space comprising of different well-being indicators. If the proportion of children who are deprived happens to be the same with respect to all indicators of well-being that constitute $D_i$, then $D_i$ will be equal to this common proportion. $D_i$ can be interpreted as the degree of overall deprivation faced by children of a particular age group that is equivalent to having $d_{ij}$ proportion of children classified as deprived with respect to different well-being indicators relevant to the age group.

The weighted average of the deprivation index $D_i$ for children of age *i* is now defined as the composite child deprivation index, *D*, for all children with weights equal to the proportionate share of children of age *i* to children of all ages (0-19 years). If $p_i$ is the proportion of children of age group *i* in children of all ages, then *D* is calculated as

$$D = \sum_{i=1}^{k} p_i * D_i$$

$$\sum_{i=1}^{k} p_i = 1$$

The index $D$ depicts the big of the composite picture of the multidimensional deprivation faced by children. It takes into consideration only those dimensions of child well-being which are relevant to children of a particular age group. For example, deprivation faced by children below one year of age is captured through the dimension of survival and only as this dimension is the most relevant for the well-being of children below one year of age. The index permits spatio-temporal analysis of child well-being, although it masks the spatio-temporal variation in individual indicators of child well-being. The index $D$ helps in a simple and straightforward comparison of the deprivation faced by children across space and over time. The index may be used as the starting point for a deeper analysis of child deprivation.

The construction of CDI requires that different child well-being indicators are normalised by taking into consideration the plausible lowest and highest values or setting the goal posts. This is essential as the plausible lowest and highest values of different well-being indicators are different. The goal posts used for normalising the 24 well-being indicators used to in the present analysis are given in table 2. These goal posts have been arrived at by analysing the variation in the well-being indicators across the districts of the state.

Table 2: Goal posts (plausible minimum and maximum values) used for normalising child well-being indicators.

| Indicator (Per cent) | | Minimum | Maximum |
|---|---|---|---|
| 1 | Children with low weight at birth | 0.0 | 62.6 |
| 2 | Children not checked up within 2 days of birth | 27.5 | 100.0 |
| 3 | Children not initiated breastfeeding within 1 hour of birth | 5.3 | 100.0 |
| 4 | Children living in the poorest households | 0.0 | 100.0 |
| 5 | Children who did not receive all basic vaccinations | 0.0 | 100.0 |
| 6 | Children low height-for-age | 0.0 | 83.3 |
| 7 | Children not received Vitamin A in the last six months | 0.0 | 72.2 |
| 8 | Children living in the poorest households | 0.0 | 100.0 |
| 9 | Children low weight-for-height | 0.0 | 55.5 |
| 10 | Children without birth certificate | 7.1 | 96.9 |
| 11 | Children 3-5 years not attending school regularly | 63.2 | 100.0 |
| 12 | Children living in the poorest households | 0.0 | 100.0 |
| 13 | Children 6-10 years not attending school regularly | 0.0 | 43.7 |
| 14 | Children orphan | 0.0 | 12.0 |
| 15 | Children without bank account | 0.0 | 63.5 |
| 16 | Children living in the poorest households | 0.0 | 100.0 |
| 17 | Children 11-14 years not attending school regularly | 0.0 | 51.8 |
| 18 | Children orphan | 0.0 | 16.9 |
| 19 | Children ever married | 0.0 | 4.1 |
| 20 | Children living in the poorest households | 0.0 | 100.0 |
| 21 | Children 15-19 years not attending school regularly | 8.9 | 80.6 |
| 22 | Children with body mass index (BMI) less than 18.5 | 9.1 | 84.0 |
| 23 | Children ever married | 0.0 | 28.4 |
| 24 | Children living in the poorest households | 0.0 | 100.0 |

Source: Author.

## Data Source

The analysis is based on the data available through the fifth round (2019-21) of the National Family Health Survey (NFHS) which is instituted by the Government of India with the objective of providing essential data related to fertility, mortality including infant and child mortality, nutrition, and use of reproductive and child health services in addition to household level characteristics that permit assessing the household standard of living index. The survey also provides data pertaining to the key population characteristics including education, marital status, and work status of the population (Government of India, 2022). The survey covered all 51 districts of Madhya Pradesh as they existed at the time of the survey. The survey covered 43,552 households from 51 districts and surveyed more than 195 thousand population. The data available from the survey have been used to estimate 24 indicators of child well-being for the state and for its 51 districts. These estimates have then been used for the construction of age-specific deprivation index and the deprivation index for all children.

## Child Deprivation in Madhya Pradesh

The composite child deprivation index (CDI) in Madhya Pradesh is estimated to be 0.360 with substantial variation across children of different ages (Figure 1) which reflects that a substantial proportion of children of the state are devoid of services that are critical to their well-being. It also appears from the analysis that the challenge of meeting the well-being needs is the most dominating in children below 1 year of age and in children aged 3-5 years. Figure 1 also indicates that deprivation in children aged 15-19 years is comparatively higher than deprivation in children aged 6-14 years. This observation emphasises the need of attention at the policy level to mitigate the deprivation faced by children 15-19 years of age. Another observation 1 from the policy perspective is that child well-being efforts should be age specific as well-being needs of children of different ages are different. Figure 1 suggests that there is no one common prescription that applies to children of all age-groups. The priorities to mitigate deprivation in children of different age-groups are different and, therefore, an age-specific approach is needed.

The deprivation faced by children of different population groups in the context of meeting their well-being needs is different as may be seen from figure 2 which also implies that reducing the inequality in the deprivation faced by children of different population groups can go a long way in improving child well-being in the state. Figure 2 also suggests that the challenge of meeting the well-being needs of Scheduled Tribes children appears to be the most daunting if figure 2 is any indication. The odds that a Scheduled Tribes child in the state is deprived in terms of the well-being needs is more than four times the odds that a child of the Other Castes is deprived which means that well-being needs of Scheduled Tribes children are at least four times more challenging than the well-being needs of children of Other Castes. The Other Castes constitute, primarily, the upper social, cultural, and economic strata of the society. Social class disparities in child well-being, as revealed through the figure 2 matter for mitigating child deprivation and promoting child well-being in the state as almost 35 per cent of the population of the state is either Scheduled Tribes or Scheduled Castes which are the marginalised section of the community.

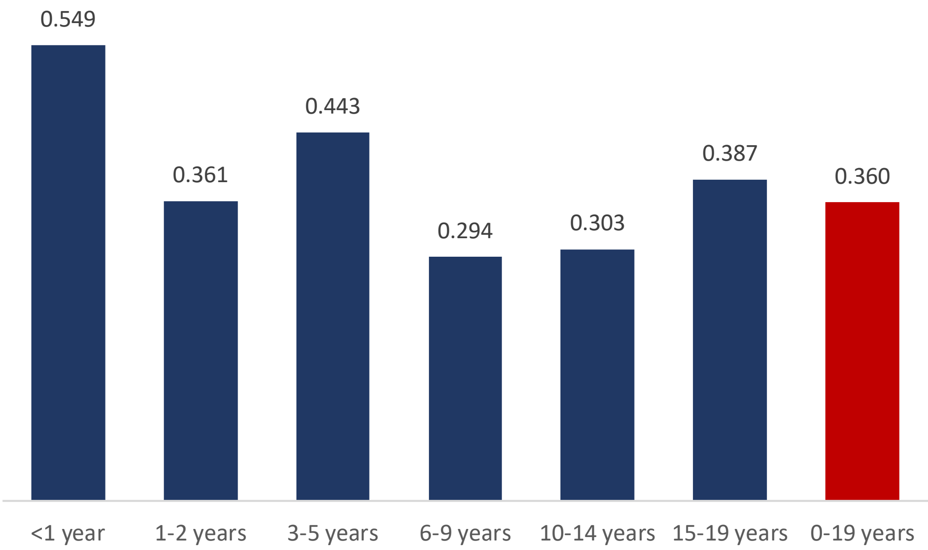


Figure 1: Composite deprivation index in children of different age groups in Madhya Pradesh, 2019-2021.
Source: Author.

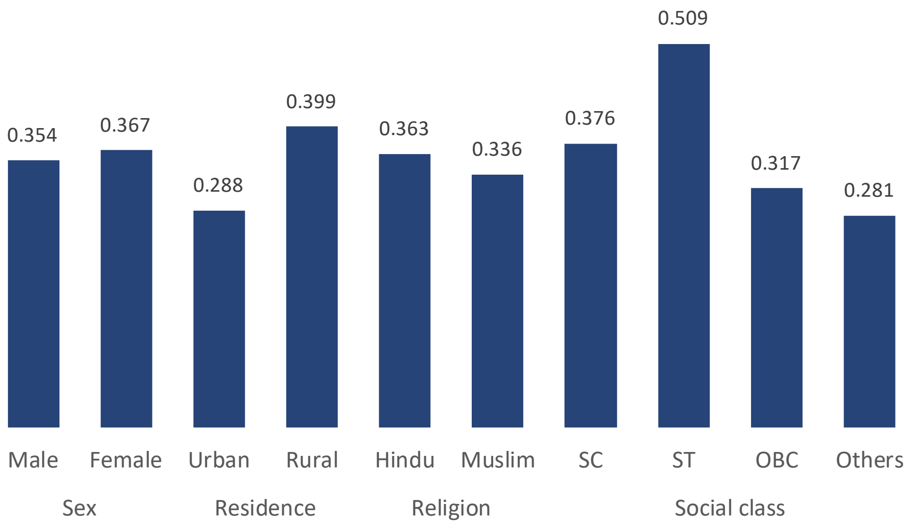


Figure 2: Composite child deprivation index in different sub-groups of population in Madhya Pradesh, 2019-2021.
Source: Author.

Figure 2 also highlights the rural-urban gap in meeting the well-being needs of children as the deprivation faced by rural children of the state is substantially higher than the deprivation faced by urban children. This means that access to services that are critical to child well-being - survival, physical growth, cognitive development, and protection – is substantially poor in the rural population of the state as compared to access to these services in the urban areas. Figure 2 also suggests that the deprivation faced by Hindu children is relatively higher than the deprivation faced by Muslim children.

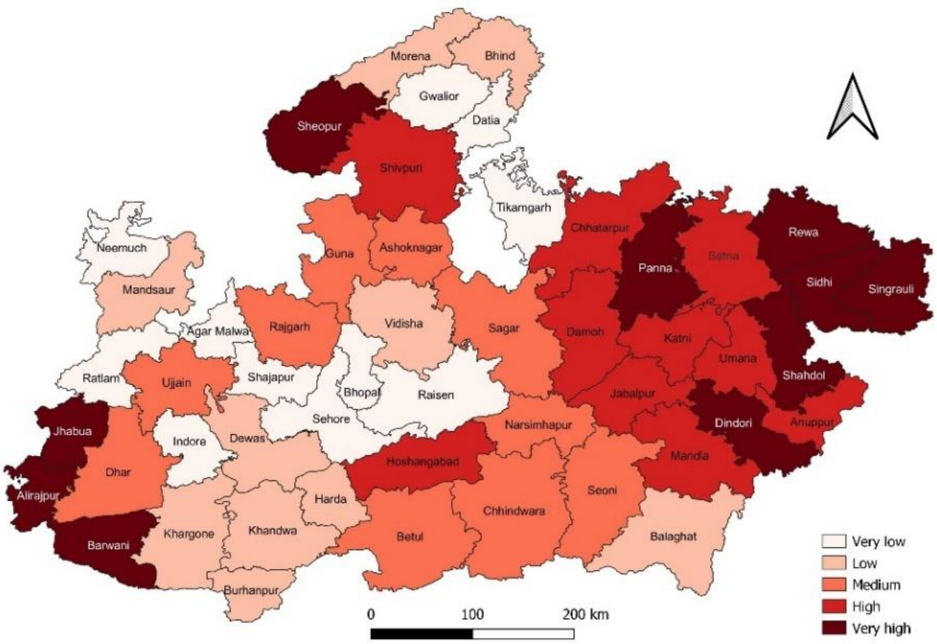


Figure 3: Inter-district variation in CDI in Madhya Pradesh, 2019-2021.
Source: Author

Within the state, there is very marked variation in CDI across districts (Figure 3). Child deprivation is very high in Panna, Rewa, Sidhi, Singrauli, Shahdol, Dindori, Jhabua, Alirajpur, and Barwani districts of the state with the poorest scenario in the Rewa administrative division whereas the child well-being scenario appears to be relatively better in Bhopal and Ujjain administrative divisions. In Indore and Sagar administrative divisions, child deprivation is very high in some districts but very low in other districts which indicates that access to child well-being services is contrastingly different in different districts of the same administrative division. The very marked variation in CDI across districts of the state calls for a decentralised, district-based approach to improving access to services and facilities that are critical to child well-being. A district-based approach would lead to reducing the disparity in the deprivation faced by children across districts or reducing inter-district child well-being inequality. The reduction in inter-district child well-being inequality is an operationally feasible approach to improving child well-being in the state as a whole. In each district, there may be specific dimensions of child well-being in which the progress may be lagging behind relative to the progress in other dimensions of child well-being. These dimensions of child well-being need to be identified for each district as the first step to mitigate the deprivation faced by the children of the district.

The CDI suggests that child well-being is relatively the poorest in district Jhabua but relatively the best in district Indore of the state. The five districts which rank the poorest in child well-being are, in order, Jhabua, Alirajpur, Dindori, Rewa and Panna. The first three of these five districts have a heavy concentration of the Scheduled Tribes population which suggests that high to very high deprivation faced by the Scheduled Tribes children appears to be a reason behind very poor children well-being in these districts. On the other hand, the five districts which rank the best in child well-being in terms of the composite child deprivation index are, in order, Indore, Neemuch, Shajapur, Raisen and Bhopal. Among these districts Indore and Bhopal are very highly urbanised districts with more than 80 per cent population of the district living in the urban areas according to the 2011 population census. The relatively very low composite child deprivation index in the urban population appears to be the reason behind relatively very good child well-being in these districts.

There may, however, be the possibility that in districts where child well-being is very poor as revealed through the composite child deprivation index, there may be population groups in which child well-being may be very good. Similarly, in districts where child well-being is very good, there may be population groups in which child well-being may be very poor. State level analysis of the deprivation faced by children of different population groups suggests that this may be a possibility in every district and this disparity should be analysed in the context of the district-based approach for mitigating child deprivation and promoting child well-being. However, data available from NFHS do not permit such an analysis as the size of the sample of households covered under the survey in each district is too small to carry out a segregated analysis at the district level. In any case, the present analysis suggests that understanding the factors responsible for the deprivation faced by children in each district is necessary to operationalise the district-based approach of promoting child well-being.

An important finding of the present analysis is that the deprivation faced by children of different age-categories is different within the same district as may be seen from figures 4 through 9. There is no district where the deprivation faced by children of all age-categories is the same - either high or low. In all districts of the state, there is considerable variation in the deprivation faced by children of different age-categories – high in some age-categories while low in others. The present analysis reveals that there are four districts – Panna, Rewa, Dindori and Jhabua – in which the deprivation faced by children of five of the six age-categories is found to be very high. These five districts may be regarded as the hot-spot districts of the state as far as the child well-being of children is concerned. On the other hand, there are four districts – Tikamgarh, Neemuch, Ratlam and Indore – in which the deprivation faced by children of five of the six-age-categories is found to be very low. Figures 4 through 9 reflect the complexity of the deprivation faced by the children of the state as regards their well-being in terms of survival, physical growth, cognitive development, and protection from a range of economic, social, cultural and environmental hazards. There is a need of further deeper analysis of the reasons why the deprivation faced by children within the same district is high or very high in children of one age-category but not in other age-categories.

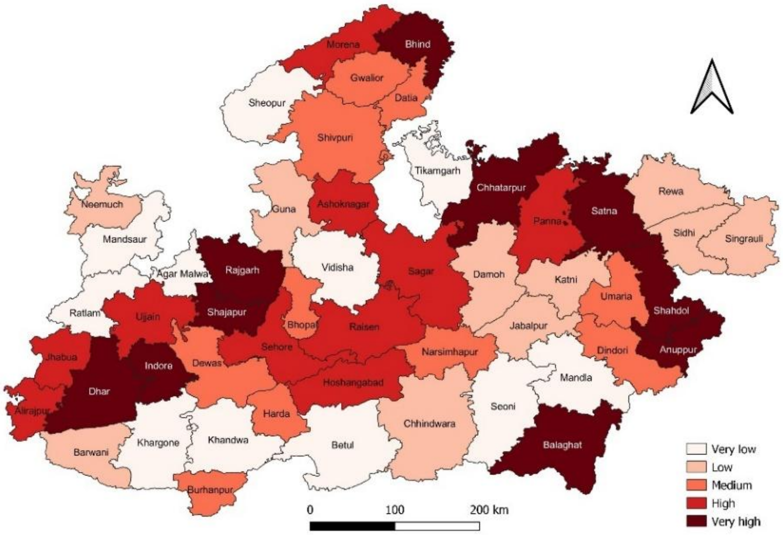


Figure 4: Inter-district variation in composite deprivation index in children below 1 year of age, 2019-2021.

Source: Author

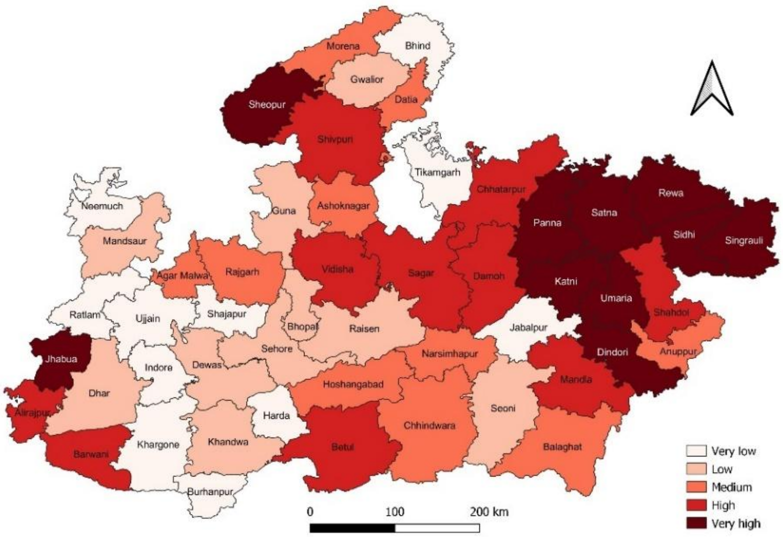


Figure 5: Inter-district variation in composite deprivation index in children 1-2 years of age 2019-2021,

Source: Author

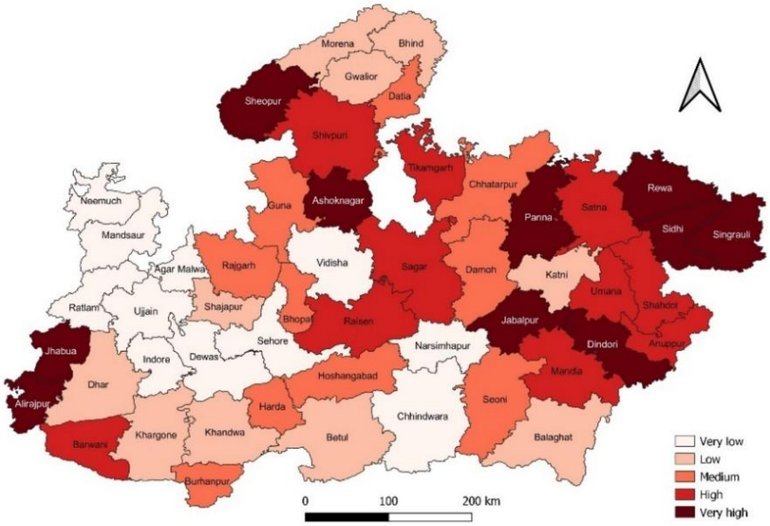


Figure 6: Inter-district variation in composite deprivation index in children 3-5 years of age 2019-2021.
Source: Author

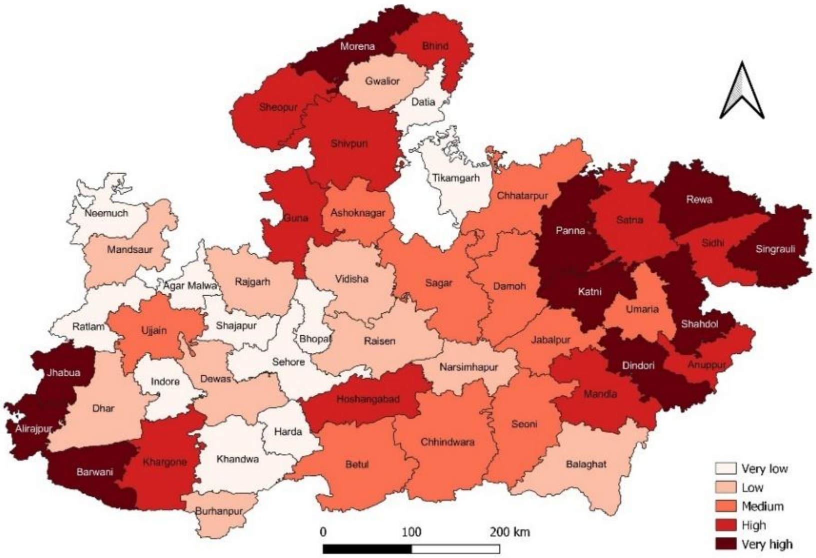


Figure 7: Inter-district variation in composite deprivation index in children aged 6-10 years 2019-2021.
Source: Author

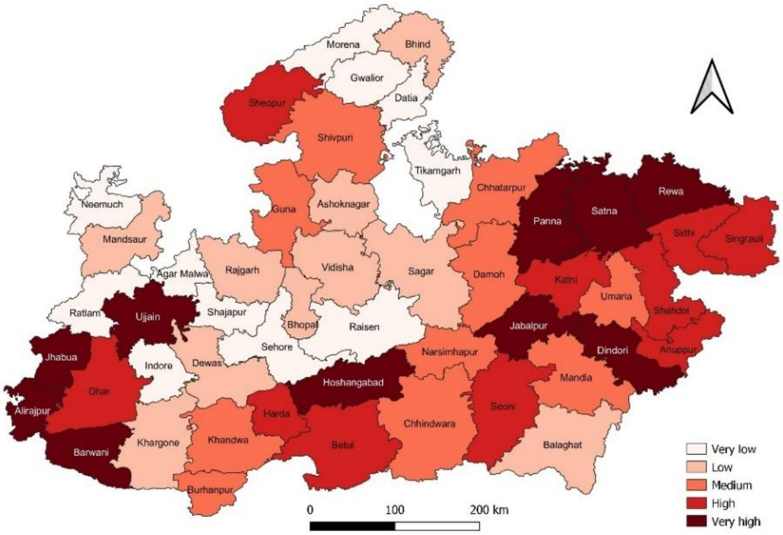


Figure 8: Inter-district variation in composite deprivation index in children aged 11-4 years 2019-2021.
Source: Author

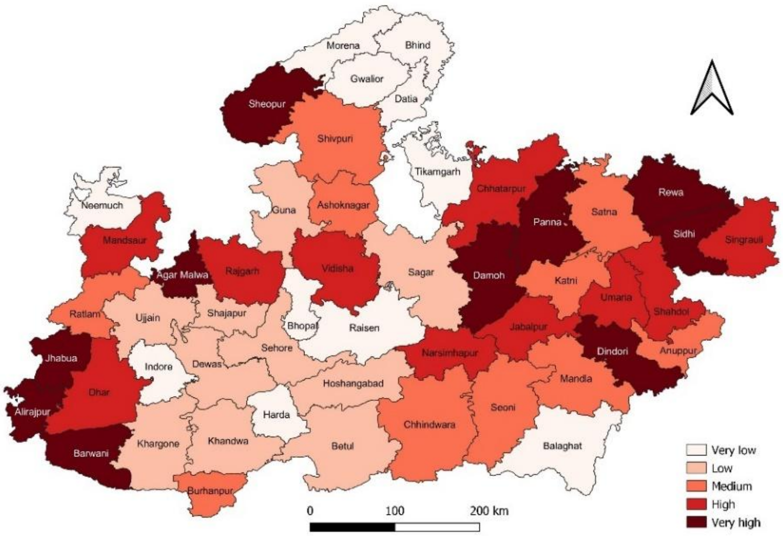


Figure 9: Inter-district variation in composite index of deprivation in children aged 15-19 years 2019-2021.
Source: Author

Table 3: Districts ranked relatively the best and relatively the poorest in terms of well-being in different age-categories of children, 2019-2021.

| Age category | District ranked best in terms of child well-being | District ranked poorest in terms of child well-being |
|---|---|---|
| Less than 1 year | Agar Malwa | Indore |
| 1-2 years | Jabalpur | Dindori |
| 3-5 years | Mandsaur | Alirajpur |
| 6-10 years | Indore | Jhabua |
| 11-14 years | Shajapur | Jabalpur |
| 15-19 years | Raisen | Barwani |

Source: Author

Districts ranked relatively the best and relatively the poorest in terms of the composite deprivation index (CDI) in different age-categories of children are presented in table 3. It is apparent from the table that there is no consistent pattern of well-being in different age-categories of children across the districts. The districts having relatively the best and relatively the poorest rank in terms of well-being of children of different age categories are different. This observation again confirms the argument that a decentralised district-based approach must be adopted for promoting and sustaining child well-being in the state. The present analysis suggests that the strategy of mitigating child deprivation and promoting child well-being is bound to be different in different districts of the state and the strategy to mitigate child deprivation applicable to one district cannot be replicated in other district because of the child well-being scenario of different districts is quite different. Designing and implementing a district-based approach of universalising child well-being, however, requires district-specific analysis of the factors responsible for child deprivation.

Another important observation of table 3 is that there are two districts – Indore and Jabalpur – which are ranked relatively the best in terms of well-being of children of one age-category but relatively the poorest in terms of well-being of children of another age-category. District Indore is ranked relatively the best in terms of the well-being of children aged 6-10 years, but it is ranked relatively the poorest in terms of the well-being of children aged less than 1 year. District Jabalpur, on the other hand, is ranked relatively the best in terms of the well-being of children aged 1-2 years but relatively the poorest in terms of the well-being of children aged 11-14 years. Reasons for extreme ranking of these two districts in terms of the well-being of children of different age-categories are not known at present and need to be investigated in an effort to promote child well-being. Both Indore and Jabalpur districts are amongst the most developed districts of the state with a high proportion of population living in the urban areas, especially, in the metropolitan towns of Indore and Jabalpur, respectively. It appears that there are district-specific factors that influence the deprivation faced by children below 1 year of age in district Indore and children 11-14 years of age in district Jabalpur because of which the deprivation faced by children below 1 year of age in district Indore and the deprivation faced by children aged 11-14 years in district Jabalpur is relatively the highest in the state. Similarly, there may be district specific factors responsible for relatively the lowest deprivation faced by children aged 1-2 years in district Jabalpur and children aged 6-10 years in district Indore that need to be identified.

## Conclusions

The analysis of the deprivation faced by children of Madhya Pradesh, based on the latest data available from the National Family Health Survey (NFHS) highlights that concerted efforts are needed to promote child well-being. This includes enhancing survival, promoting physical growth, facilitating cognitive development, and protecting children from a range of social, cultural, and economic risks. Improving child well-being is essential for the rapid social and economic development. Improving child well-being is essential for the rapid social and economic development of the state and the overall quality of life of its people.

Given the complexities of the deprivation faced by the children, it is clear that a multidimensional integrated and decentralised approach. Is necessary to improve child well-being. The data from the National Family Health Survey suggests that each district in the state faces unique challenges in meeting the needs of children that are critical to their survival, physical growth, cognitive development, and protection from social, cultural, and economic risks/vulnerabilities. Therefore, it is crucial to identify specific factors or conditions responsible for child deprivation in different districts and to plan and implement targeted interventions.

The analysis also suggests that promoting child well-being in the state requires, required recognising children as a distinct group in the social-economic development discourse. The recognition should be reflected in policies, monitoring and evaluation of social, economic, welfare programmes and interventions. The beginning, in this direction may be made by formulating a policy on the children in the state. Madhya Pradesh does not have at present, a policy that squarely focusses on the well-being of children in the context of their right to survival, right to physical growth, right to cognitive development, and right to protection from a range of social, cultural, and economic hazards. The evidence available from the National Family Health Survey highlights the need for such a policy. It is also obvious that such a policy must follow the integrated approach of meeting the survival, physical growth, cognitive development, and protection needs of children. This integrated approach is required because a large proportion of children of the state face deprivation in more than one dimension of child well-being.

The analysis also suggests that promoting child well-being in Madhya Pradesh requires recognizing children as a distinct group in the social and development discourse. This recognition should be reflected in policies, monitoring, and evaluation of social, economic, and welfare programmes. A good starting point would be to formulate a comprehensive child-focused policy that comprehensively addresses the well-being of children in terms of their right to survival, physical growth, cognitive development, and protection from various risks and vulnerabilities. The evidence from the National Family Health Survey underscores the need for such a policy.

Developing a policy that focuses on the well-being needs of children in the state requires thorough discussions and deliberations with stakeholders, including the government, civil society organizations, parents, and children. Additionally, a comprehensive analysis of the factors and conditions that prevent children from accessing critical services and facilities for their survival, growth, development, and protection is essential. These barriers may include both demand-side and supply-side factors, which can vary across different population groups and districts.

The data available from the National Family Health Survey have limitations in providing the comprehensive analysis of child well-being in the state that is needed for the formulation of child sensitive social protection policy. The present analysis reveals that the challenge of mitigating the deprivation faced by the child of the state is quite complex. More research is needed to disentangle the complexities of child deprivation that are so pervasive in the state. The need is to identify economic, social, cultural, and environmental impediments that contribute to child deprivation. The situation gets further complicated because these impediments vary widely within the state, across districts, and possibly, across different population groups within the same district. In any case, addressing the impediments that exacerbate child deprivation is crucial to effectively promoting child well-being in the state.

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Appendix Table: Deprivation index in children of different age categories in districts of Madhya Pradesh, 2019-2021.

| District | Below 1 year | | 1-2 years | | 3-5 years | | 6-10 years | | 11-14 years | | 15-19 years | | 0-19 years | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Index | Rank | Index | Rank | Index | Rank | Index | Rank | Index | Rank | Index | Rank | Index | Rank |
| Sheopur | 0.482 | 5 | 0.478 | 44 | 0.542 | 44 | 0.358 | 37 | 0.385 | 35 | 0.469 | 44 | 0.439 | 42 |
| Morena | 0.591 | 35 | 0.379 | 30 | 0.434 | 16 | 0.388 | 42 | 0.235 | 10 | 0.356 | 9 | 0.367 | 20 |
| Bhind | 0.628 | 43 | 0.318 | 11 | 0.453 | 20 | 0.347 | 33 | 0.323 | 20 | 0.333 | 4 | 0.366 | 19 |
| Gwalior | 0.571 | 28 | 0.343 | 21 | 0.427 | 12 | 0.243 | 12 | 0.224 | 8 | 0.354 | 8 | 0.323 | 10 |
| Datia | 0.561 | 25 | 0.376 | 27 | 0.469 | 24 | 0.194 | 5 | 0.229 | 9 | 0.358 | 10 | 0.315 | 8 |
| Shivpuri | 0.572 | 31 | 0.418 | 35 | 0.53 | 40 | 0.387 | 41 | 0.338 | 23 | 0.414 | 27 | 0.416 | 39 |
| Tikamgarh | 0.47 | 3 | 0.317 | 10 | 0.496 | 33 | 0.235 | 11 | 0.22 | 6 | 0.352 | 7 | 0.317 | 9 |
| Chhatarpur | 0.654 | 48 | 0.438 | 39 | 0.48 | 30 | 0.331 | 29 | 0.335 | 22 | 0.44 | 35 | 0.407 | 34 |
| Panna | 0.585 | 34 | 0.478 | 45 | 0.55 | 46 | 0.474 | 47 | 0.444 | 46 | 0.484 | 47 | 0.486 | 47 |
| Sagar | 0.617 | 39 | 0.431 | 38 | 0.528 | 39 | 0.293 | 23 | 0.298 | 17 | 0.399 | 20 | 0.389 | 27 |
| Damoh | 0.539 | 15 | 0.441 | 40 | 0.488 | 31 | 0.325 | 27 | 0.358 | 29 | 0.454 | 42 | 0.41 | 35 |
| Satna | 0.683 | 50 | 0.496 | 48 | 0.531 | 41 | 0.359 | 39 | 0.442 | 44 | 0.416 | 28 | 0.439 | 41 |
| Rewa | 0.55 | 18 | 0.471 | 43 | 0.533 | 42 | 0.522 | 50 | 0.495 | 48 | 0.485 | 48 | 0.505 | 48 |
| Umaria | 0.56 | 24 | 0.491 | 47 | 0.513 | 37 | 0.332 | 30 | 0.349 | 25 | 0.449 | 38 | 0.415 | 37 |
| Neemuch | 0.549 | 17 | 0.291 | 6 | 0.349 | 2 | 0.163 | 3 | 0.185 | 4 | 0.35 | 6 | 0.272 | 2 |
| Mandsaur | 0.513 | 9 | 0.326 | 14 | 0.311 | 1 | 0.271 | 15 | 0.32 | 19 | 0.445 | 36 | 0.351 | 16 |
| Ratlam | 0.521 | 11 | 0.289 | 5 | 0.427 | 11 | 0.229 | 10 | 0.25 | 11 | 0.431 | 31 | 0.327 | 11 |
| Ujjain | 0.574 | 32 | 0.302 | 9 | 0.395 | 7 | 0.312 | 24 | 0.442 | 45 | 0.377 | 16 | 0.378 | 24 |
| Dewas | 0.568 | 27 | 0.326 | 15 | 0.361 | 3 | 0.268 | 14 | 0.332 | 21 | 0.367 | 13 | 0.34 | 13 |
| Dhar | 0.637 | 46 | 0.332 | 17 | 0.432 | 15 | 0.29 | 19 | 0.419 | 40 | 0.435 | 33 | 0.395 | 30 |
| Indore | 0.687 | 51 | 0.294 | 7 | 0.375 | 6 | 0.1 | 1 | 0.167 | 3 | 0.322 | 3 | 0.254 | 1 |
| Khargone (West Nimar) | 0.502 | 7 | 0.297 | 8 | 0.432 | 14 | 0.359 | 38 | 0.315 | 18 | 0.367 | 12 | 0.365 | 18 |
| Barwani | 0.531 | 13 | 0.428 | 37 | 0.504 | 36 | 0.436 | 46 | 0.434 | 42 | 0.507 | 51 | 0.465 | 46 |
| Rajgarh | 0.631 | 44 | 0.377 | 28 | 0.478 | 29 | 0.29 | 21 | 0.284 | 16 | 0.45 | 40 | 0.382 | 25 |
| Vidisha | 0.516 | 10 | 0.398 | 32 | 0.412 | 9 | 0.283 | 17 | 0.256 | 12 | 0.438 | 34 | 0.357 | 17 |
| Bhopal | 0.572 | 30 | 0.342 | 20 | 0.464 | 23 | 0.19 | 4 | 0.263 | 13 | 0.309 | 2 | 0.307 | 5 |
| Sehore | 0.602 | 37 | 0.331 | 16 | 0.426 | 10 | 0.223 | 9 | 0.165 | 2 | 0.395 | 18 | 0.315 | 7 |

| District | Below 1 year | | 1-2 years | | 3-5 years | | 6-10 years | | 11-14 years | | 15-19 years | | 0-19 years | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Index | Rank | Index | Rank | Index | Rank | Index | Rank | Index | Rank | Index | Rank | Index | Rank |
| Raisen | 0.62 | 40 | 0.335 | 19 | 0.497 | 34 | 0.29 | 20 | 0.194 | 5 | 0.254 | 1 | 0.287 | 3 |
| Betul | 0.48 | 4 | 0.409 | 33 | 0.435 | 17 | 0.321 | 26 | 0.434 | 41 | 0.399 | 19 | 0.399 | 31 |
| Harda | 0.563 | 26 | 0.281 | 4 | 0.457 | 22 | 0.217 | 7 | 0.403 | 37 | 0.346 | 5 | 0.344 | 15 |
| Hoshangabad | 0.602 | 36 | 0.344 | 22 | 0.475 | 27 | 0.356 | 36 | 0.441 | 43 | 0.37 | 14 | 0.404 | 33 |
| Katni | 0.542 | 16 | 0.48 | 46 | 0.456 | 21 | 0.394 | 44 | 0.384 | 34 | 0.401 | 22 | 0.415 | 38 |
| Jabalpur | 0.555 | 21 | 0.255 | 1 | 0.561 | 47 | 0.292 | 22 | 0.541 | 51 | 0.446 | 37 | 0.427 | 40 |
| Narsimhapur | 0.556 | 22 | 0.347 | 24 | 0.411 | 8 | 0.288 | 18 | 0.356 | 28 | 0.435 | 32 | 0.376 | 22 |
| Dindori | 0.571 | 29 | 0.523 | 51 | 0.589 | 49 | 0.519 | 49 | 0.497 | 49 | 0.503 | 50 | 0.523 | 50 |
| Mandla | 0.458 | 2 | 0.417 | 34 | 0.514 | 38 | 0.353 | 34 | 0.366 | 30 | 0.405 | 24 | 0.403 | 32 |
| Chhindwara | 0.553 | 19 | 0.346 | 23 | 0.374 | 5 | 0.315 | 25 | 0.375 | 31 | 0.407 | 25 | 0.378 | 23 |
| Seoni | 0.484 | 6 | 0.32 | 12 | 0.471 | 25 | 0.344 | 31 | 0.376 | 32 | 0.408 | 26 | 0.389 | 29 |
| Balaghat | 0.626 | 42 | 0.381 | 31 | 0.44 | 18 | 0.265 | 13 | 0.282 | 15 | 0.364 | 11 | 0.342 | 14 |
| Guna | 0.555 | 20 | 0.324 | 13 | 0.473 | 26 | 0.345 | 32 | 0.35 | 26 | 0.401 | 21 | 0.387 | 26 |
| Ashoknagar | 0.61 | 38 | 0.36 | 25 | 0.544 | 45 | 0.331 | 28 | 0.274 | 14 | 0.43 | 30 | 0.389 | 28 |
| Shahdol | 0.656 | 49 | 0.454 | 41 | 0.492 | 32 | 0.398 | 45 | 0.404 | 38 | 0.449 | 39 | 0.442 | 43 |
| Anuppur | 0.636 | 45 | 0.378 | 29 | 0.501 | 35 | 0.356 | 35 | 0.397 | 36 | 0.402 | 23 | 0.412 | 36 |
| Sidhi | 0.532 | 14 | 0.461 | 42 | 0.541 | 43 | 0.384 | 40 | 0.409 | 39 | 0.483 | 46 | 0.451 | 45 |
| Singrauli | 0.524 | 12 | 0.501 | 49 | 0.595 | 50 | 0.394 | 43 | 0.378 | 33 | 0.451 | 41 | 0.445 | 44 |
| Jhabua | 0.62 | 41 | 0.522 | 50 | 0.579 | 48 | 0.574 | 51 | 0.485 | 47 | 0.502 | 49 | 0.543 | 51 |
| Alirajpur | 0.574 | 33 | 0.421 | 36 | 0.599 | 51 | 0.508 | 48 | 0.523 | 50 | 0.48 | 45 | 0.515 | 49 |
| Khandwa (East Nimar) | 0.506 | 8 | 0.332 | 18 | 0.441 | 19 | 0.219 | 8 | 0.344 | 24 | 0.381 | 16 | 0.339 | 12 |
| Burhanpur | 0.557 | 23 | 0.277 | 3 | 0.476 | 28 | 0.277 | 16 | 0.356 | 27 | 0.419 | 29 | 0.373 | 21 |
| Agar Malwa | 0.37 | 1 | 0.37 | 26 | 0.37 | 4 | 0.196 | 6 | 0.222 | 7 | 0.459 | 43 | 0.31 | 6 |
| Shajapur | 0.644 | 47 | 0.274 | 2 | 0.429 | 13 | 0.16 | 2 | 0.165 | 1 | 0.377 | 15 | 0.291 | 4 |

Source: Author

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# Prevalence and Socioeconomic Determinants of Hypertension among Women in India: A Cross-sectional Study from the Nationally Representative Data

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## Abstract

Hypertension is a global health concern and is emerging as a prominent non-communicable disease in India. It has substantial implications for the health of women. This paper analyses demographic and socioeconomic determinants of hypertension among Indian women aged 15-49 years based on the data from the fifth round of the National Family Health Survey. The analysis reveals that the prevalence of hypertension increases with age which aligns with the global trend. Education plays a pivotal role, as women with lower educational levels are at higher risk of hypertension than women with higher levels of education. The prevalence of hypertension has also been found to be relatively higher in women with high standard of living and women residing in the rural areas. Obesity, diabetes, and smoking are found to be strong predictors of hypertension. The geospatial analysis reveals regional disparities, with higher prevalence in north-eastern and northern districts of the region. There is a need of adopting multifaceted approaches to addressing the problem of hypertension in India women. The findings of the study may serve as a vital resource for policymakers and public health practitioners for addressing the growing epidemic of hypertension in the country.

## Introduction

According to the World Health Organization, there are five important risk factors for non-communicable diseases (NCDs), one of which is hypertension (Ezzati et al, 2002). Hypertension plays a substantial role in elevating the disability-adjusted life years (DALYs) related to cardiovascular diseases when compared to other metabolic risk factors such as elevated total cholesterol, increased fasting blood sugar level, and a high body mass index (BMI) (Ezzati et al, 2002). Hypertension is a severe and chronic medical condition that promotes the risk of mortality related to cardiovascular and kidney diseases. This condition arises when the pressure within blood vessels becomes excessively elevated (Abarca-Gómez et al, 2017). The prevalence of hypertension is on the rise in recent years, and it has emerged as a particularly concerning issue among women globally and in India (Anchala et al, 2014). Approximately four out of every five people with hypertension do not receive adequate treatment of hypertension. It is, however, estimated that if countries can scale up the coverage, 76 million deaths may be averted between 2023 and 2050 (WHO, 2023). This is a matter of great importance, as health and well-being of women not only affect their own lives but have far-reaching implications for families and communities. The health consequences of hypertension can be compounded by other factors that increase the odds of heart attack, stroke, and kidney failure. These factors include tobacco use, unhealthy diet, harmful use of alcohol, lack of physical activity, exposure to persistent stress as well as obesity, high cholesterol, and diabetes mellitus (WHO, 2015).

With its diverse population and complex healthcare landscape, India presents a unique context for studying the prevalence and determinants of hypertension among women. Hypertension is a leading non-communicable disease in India (Dolui et al, 2023; Gupta, 2004) and the prevalence of hypertension in women aged 15-49 years is increasing (Bhimarasetty et al, 2022). Available studies substantiate the link between hypertension and BMI and family history of non-communicable diseases (Daniel et al, 2022). Among young adults aged 20-39 years, one in every nine, and in the general adult population, over 25 per cent have been found to be suffering from hypertension while one third of the young adults were found to be pre-hypertensive (Geevar et al, 2022). Among women aged 15 years and older, approximately 21 per cent have been diagnosed with hypertension, while 39 per cent are in the pre-hypertensive category (Government of India, 2021).

India has recently renewed its commitment to tackling hypertension on a population scale by introducing population-based screening programme for hypertension, diabetes, and cancers along with efforts to reinforce primary and secondary healthcare (Government of India, 2022). Management of hypertension in the community requires regular blood pressure evaluation to allow for the earliest possible introduction of secondary prevention measures (Saha et al. 2008). Screening of psychological distress in high-risk hypertensive patients, particularly those who struggle to attain adequate blood pressure control or are apprehensive about the potential complications associated with hypertension. It is estimated that 25 per cent of hypertensive patients exhibited signs of psychological distress, including symptoms associated with depression, anxiety, or stress. (Loke and Ching, 2022). Usual habits of an individual also play an important role as smoking and using smokeless tobacco and alcohol consumption have been found to be the risk factors of hypertension in women (Mishra et al, 2022). Socioeconomic and lifestyle factors are also found to be important reasons for the difference in the prevalence of hypertension in urban and rural India (Boro and Banerjee, 2022a).

## Data and Methods

The analysis is based on the data available from the Round 5 of the National Family Health Survey (NFHS-5) which was conducted during the period 2019-2021) by the International Institute for Population Sciences (IIPS), Mumbai under the aegis of the Government of India, Ministry of Health and Family Welfare. The survey covered the entire country and covered 6,36,699 households, 1,01,839 men aged 15-54 years, and 7,24,115 eligible women aged 15-49 years. Estimates of the prevalence of hypertension are available from the survey for the country, for states/Union Territories and for 707 districts, with reference to the status as of March 31st, 2017. Details of NFHS-5 including the sampling frame, survey design, and data collection process are discussed elsewhere (Government of India, 2022). The present analysis is limited to the data on systolic and diastolic blood pressure measured from 7,24,115 women aged 15-49 years covered during the survey. Based on the level of systolic and diastolic blood pressure, a woman was classified as hypertensive if at least one of four conditions were satisfied: 1) woman reported high blood pressure on two or more occasions by a doctor or other health professional, 2) woman taking prescribed medicine to lower blood pressure at the time of the survey, 3) woman had an average systolic blood pressure (SBP) ≥140 mmHg, 4) woman had an average diastolic blood pressure (DBP) ≥90 mmHg at the time of the survey. The blood pressure of the women was measured three times with an interval of five minutes using Omron Blood Pressure Monitor during the survey and the average of the three measurements are taken for the purpose of classification.

The outcome variable of the present analysis is a dichotomous variable which takes value 1 if a woman is hypertensive and 0 otherwise. On the other hand, a set of explanatory variables including age, education, religion, caste, standard of living, residence, Body Mass Index (BMI), whether woman is diabetic or not, type of cooking fuel used in the house, smoking behaviour, experience of passive Smoking, and use of tobacco. Bivariate and multivariate statistical methods have been used to explore the determinants of hypertension. Descriptive statistics are used to understand the variation in the prevalence of hypertension by background characteristics. Logistic regression analysis has been used to assess how different explanatory variables influence the prevalence of hypertension. The multicollinearity test using variance inflation factors (VIF) is applied to root out multicollinearity among explanatory variables. Finally, geospatial patterning of the prevalence of hypertension was carried using district level data. All statistical analysis and spatial mapping exercise was performed using STATA 17.0 and ArcGIS 10.8.2 software.

## Results

Table 1 provides background characteristics of women aged 15-49 years covered during the 1920-2021 round of NFHS. A large proportion of women was in the age group 15-29 years. More than half of the women had at least higher secondary level education. More than three-fourth were Hindu while around 43 per cent belonged to Other Backward Classes. More than two-third were residing in rural areas. The prevalence of obesity, as measured by BMI, was around 24 per cent while around 18 per cent of women had low BMI. The prevalence of diabetes was 2.6 per cent, around 4 per cent were smokers, and around 3 per cent were consuming tobacco. Around 48 per cent women experienced passive smoking. Around 44 per cent were exposed to polluting cooking fuel.

Table 2 presents the prevalence of hypertension among women by their background characteristics. The overall prevalence of hypertension was around 14 per cent but it was higher in women aged 45-49 years. The prevalence of hypertension was higher in women with no education, women belonging to other religions and Other Social Classes. The prevalence of hypertension was higher in urban obese women than in rural obese women, and in smokers and tobacco chewers. There the prevalence of hypertension increases with the standard of living of the woman, The prevalence of hypertension was the lowest among women with the poorest standard of living.

Table 1: Background characteristics of women aged 15-49 years surveyed.

| Background Characteristics | Women surveyed | |
|---|---|---|
| | Per cent | Number |
| Age | | |
| 15-29 | 49.60 | 359559 |
| 30-44 | 38.63 | 280497 |
| 45-49 | 11.77 | 84059 |
| Education | | |
| No Education | 22.43 | 167304 |
| Primary | 11.73 | 84983 |
| Secondary | 50.18 | 370012 |
| Higher | 15.65 | 101816 |
| Religion | | |
| Hindu | 81.36 | 546007 |
| Muslim | 13.48 | 90729 |
| Others | 5.16 | 87379 |
| Caste | | |
| Scheduled Caste | 21.89 | 139957 |
| Scheduled Tribe | 9.29 | 135239 |
| Other Backward Classes (OBC) | 42.92 | 276881 |
| Others | 25.91 | 172038 |
| Wealth Index | | |
| Poorest | 18.50 | 149844 |
| Poorer | 20.00 | 160340 |
| Middle | 20.52 | 151505 |
| Richer | 20.81 | 139607 |
| Richest | 20.17 | 122819 |
| Region | | |
| North | 14.11 | 147615 |
| Central | 31.04 | 184017 |
| East | 16.61 | 104342 |
| Northeast | 3.69 | 103433 |
| West | 13.94 | 69811 |
| South | 20.60 | 114897 |
| Residence | | |
| Urban | 32.49 | 179535 |
| Rural | 67.51 | 544580 |
| Body Mass Index (BMI) | | |
| Underweight | 18.38 | 124989 |
| Normal | 57.74 | 420415 |

| Background Characteristics | Women surveyed | |
|---|---|---|
| | Per cent | Number |
| Overweight | 23.88 | 153957 |
| Diabetes | | |
| No | 97.33 | 707116 |
| Yes | 2.67 | 16999 |
| Uses of Cooking Fuel | | |
| Clean Fuel | 55.88 | 367560 |
| Polluting Fuel | 44.12 | 356555 |
| Self-Smoking | | |
| No | 96.04 | 678443 |
| Yes | 3.96 | 45672 |
| Exposure to Passive Smoking | | |
| No | 52.27 | 362507 |
| Yes | 47.73 | 361608 |
| Uses of Tobacco | | |
| No | 97.26 | 690703 |
| Yes | 2.74 | 33412 |
| Total | 100 | 724115 |

Source: Authors' calculations.
Remarks: The sample size for BMI was 699361 as BMI for 24754 women was missing.

The prevalence of hypertension among women aged 15-49 years has been found to be different in different regions of the country. The central region of the country comprising of the states of Bihar, Chhattisgarh, Jharkhand, Madhya Pradesh, and Uttar Pradesh has relatively the highest prevalence of hypertension whereas the prevalence was relatively the lowest in the west region. The prevalence of hypertension in women has also been found to be relatively high in the north and south regions compared to east and northeast regions of the country.

Table 2: Prevalence of hypertension by background characteristics of women.

| Background Characteristics | Hypertension | | |
|---|---|---|---|
| | Prevalence (per cent) | $\chi^2$ | N |
| Age | | 350.14 ($p<0.05$) | |
| 15-29 | 7.19 | | 359559 |
| 30-44 | 18.25 | | 280497 |
| 45-49 | 29.70 | | 84059 |
| Education | | 624.20 ($p<0.05$) | |
| No Education | 19.43 | | 167304 |
| Primary | 17.41 | | 84983 |
| Secondary | 12.13 | | 370012 |
| Higher | 10.40 | | 101816 |
| Religion | | 717.27 ($p<0.05$) | |
| Hindu | 13.92 | | 546007 |
| Muslim | 14.14 | | 90729 |

| Background Characteristics | Hypertension | | |
|---|---|---|---|
| | Prevalence (per cent) | $\chi^2$ | N |
| Others | 17.07 | | 87379 |
| Caste | | 39.10 (p<0.05) | |
| Scheduled Caste | 13.93 | | 139957 |
| Scheduled Tribe | 13.20 | | 135239 |
| OBC* | 14.20 | | 276881 |
| Others | 14.46 | | 172038 |
| Wealth Index | | 672.07 (p<0.05) | |
| Poorest | 12.84 | | 149844 |
| Poorer | 13.46 | | 160340 |
| Middle | 14.41 | | 151505 |
| Richer | 14.70 | | 139607 |
| Richest | 15.03 | | 122819 |
| Regions | | 671.15 (p<0.05) | |
| North | 14.96 | | 147615 |
| Central | 15.04 | | 184017 |
| East | 13.47 | | 104342 |
| Northeast | 13.86 | | 103433 |
| West | 11.65 | | 69811 |
| South | 14.37 | | 114897 |
| Residence | | 190.65 (p<0.05) | |
| Urban | 14.48 | | 179535 |
| Rural | 13.94 | | 544580 |
| BMI** | | 235.74 (p<0.05) | |
| Underweight | 8.21 | | 124989 |
| Normal | 12.42 | | 420415 |
| Overweight | 25.24 | | 153957 |
| Diabetes | | 725.25 (p<0.05) | |
| No | 13.46 | | 707116 |
| Yes | 38.04 | | 16999 |
| Uses of Cooking Fuel | | 792.63 (p<0.05) | |
| Clean Fuel | 14.96 | | 367560 |
| Polluting Fuel | 13.04 | | 356555 |
| Self-Smoking | | 580.09 (p<0.05) | |
| No | 13.92 | | 678443 |
| Yes | 18.88 | | 45672 |
| Exposure to Passive Smoking | | 137.14 (p<0.05) | |
| No | 14.43 | | 362507 |
| Yes | 13.77 | | 361608 |
| Uses of Tobacco | | 388.85 (p<0.05) | |
| No | 13.98 | | 690703 |
| Yes | 19.00 | | 33412 |
| Total | 14.11 | | 724115 |

Source: Authors' calculations

Figure 1 illustrates the spatial clustering of the prevalence of hypertension among women across states and union territories. The overall prevalence of hypertension in the country is estimated to be around 14.1 per cent. The prevalence of hypertension among women, however, is relatively the highest in Sikkim (25.2 per cent) followed by Punjab (23.6 per cent) and Arunachal Pradesh (22.2 per cent) but lowest in Dadra and Nagar Haveli (8.7 per cent).

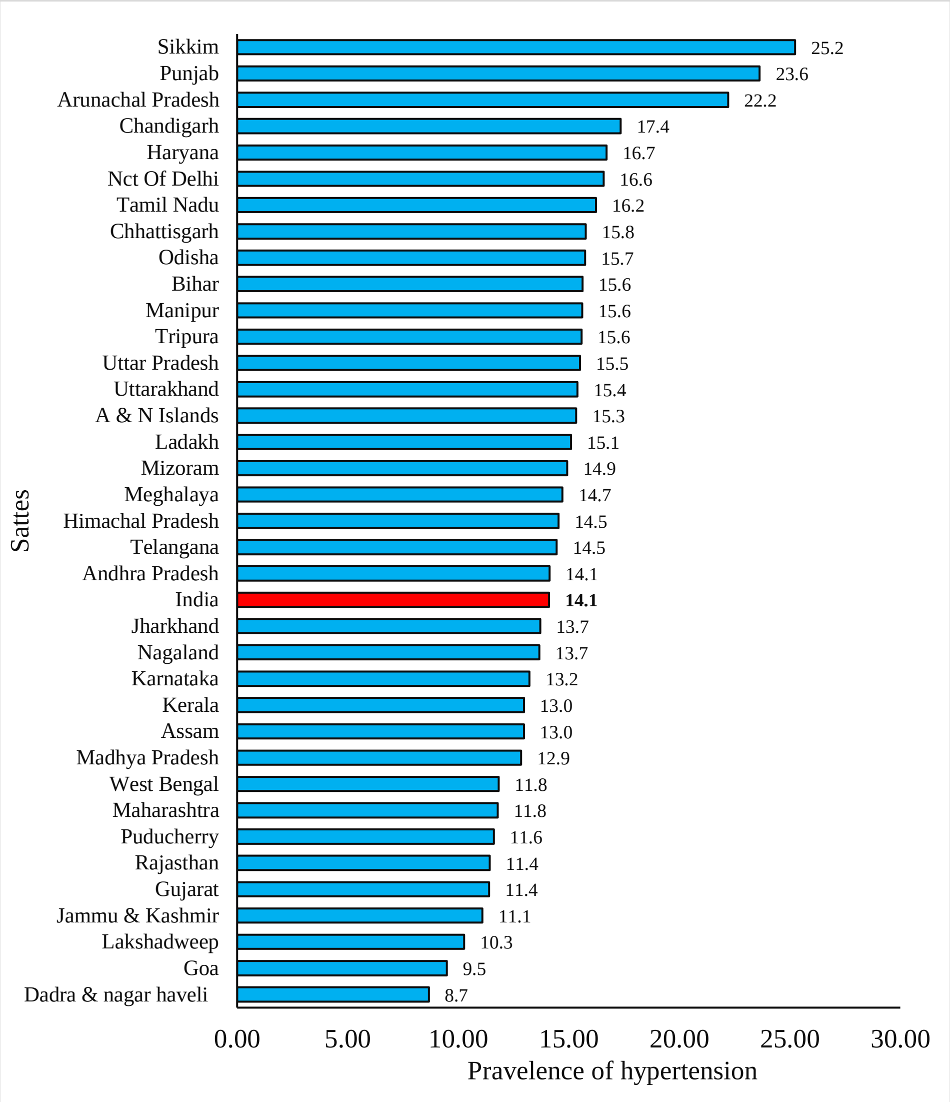


Figure 1: Prevalence (per cent) of hypertension in states and Union Territories of India, 2019-2021.

Source: Authors

Figure 2 depicts the variation in the prevalence of hypertension in women across districts. High prevalence of hypertension is found in districts of northeastern, and northern region, whereas low prevalence is found in districts of western and central regions. A few districts from the southern region also have high prevalence of hypertension. Moderate and high prevalence may also be observed in some of the districts of western and eastern regions. The prevalence of hypertension is found to be the highest (30.9 per cent) in North district of Sikkim but the lowest (2.4 per cent) in Shupiyan district of Jammu & Kashmir.

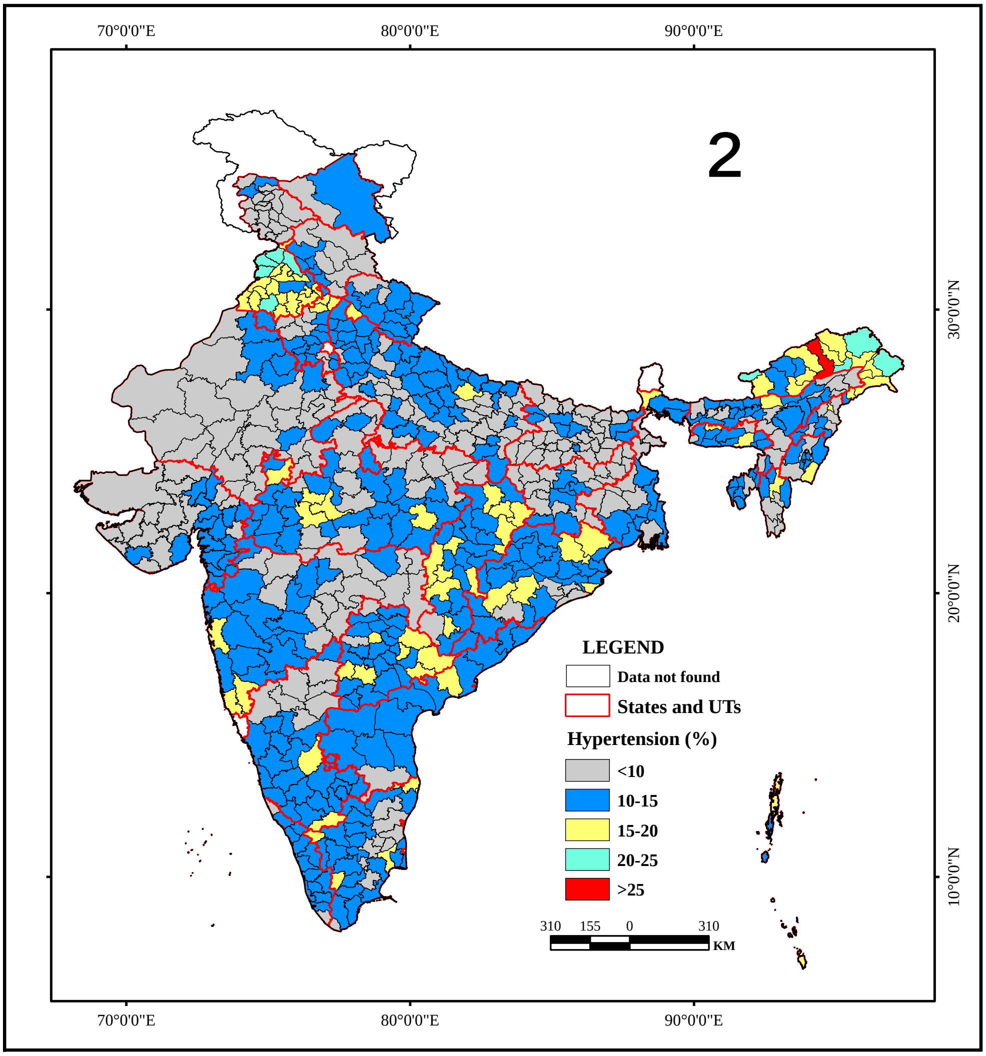


Figure 2: Variation in the prevalence of hypertension in women across districts of India, 2019-2021.
Source: Authors

Results of the logistic regression analysis are presented in table 3 in terms of unadjusted odds ratios (UOR) and adjusted odds ratios (AOR). We have presented both UOR and AOR to understand the independent effect of the explanatory variables on the prevalence of hypertension. The UOR shows the crude association between the cofounder and the outcome variable without controlling other factors, while AOR reflects the associations after controlling the potential cofounders to assess true effects because it prevents the distortion resulting from the external factors.

Table 3: Binary logistic regression model showing associations and determinants of hypertension among women in India.

| Background characteristics | Hypertension | | | |
|---|---|---|---|---|
| | UOR [CI: 95%] | 'p' | AOR [CI: 95%] | 'p' |
| Age | | | | |
| 15-29® | 1 | | 1 | |
| 30-44 | 2.883 [2.838-2.929] | 0.000 | 2.270 [2.230-2.310] | 0.000 |
| 45-49 | 5.456 [5.351-5.563] | 0.000 | 4.003 [3.914-4.094] | 0.000 |
| Education | | | | |
| No Education | 2.077 [2.031-2.125] | 0.000 | 1.330 [1.293-1.368] | 0.000 |
| Primary | 1.816 [1.769-1.864] | 0.000 | 1.299 [1.261-1.339] | 0.000 |
| Secondary | 1.188 [1.163-1.214] | 0.000 | 1.139 [1.112-1.166] | 0.000 |
| Higher secondary® | 1 | | 1 | |
| Religion | | | | |
| Hindu® | 1 | | 1 | |
| Muslim | 1.018 [0.998-1.038] | 0.072 | 1.053 [1.031-1.076] | 0.000 |
| Others | 1.273 [1.238-1.308] | 0.000 | 1.267 [1.229-1.306] | 0.000 |
| Caste | | | | |
| Scheduled Caste | 0.957 [0.939-0.976] | 0.009 | 1.016 [0.994-1.038] | 0.163 |
| Scheduled Tribe | 0.899 [0.876-0.922] | 0.000 | 1.099 [1.068-1.131] | 0.000 |
| OBC* | 0.978 [0.963-0.995] | 0.000 | 1.024 [1.005-1.042] | 0.012 |
| General® | 1 | | 1 | |
| Wealth Index | | | | |
| Poorest® | 1 | | 1 | |
| Poorer | 1.056 [1.033-1.079] | 0.000 | 1.046 [1.022-1.071] | 0.000 |
| Middle | 1.142 [1.118-1.167] | 0.000 | 1.083 [1.055-1.111] | 0.000 |
| Richer | 1.169 [1.145-1.195] | 0.000 | 1.079 [1.048-1.110] | 0.000 |
| Richest | 1.201 [1.175-1.123] | 0.000 | 1.066 [1.031-1.102] | 0.000 |
| Residence | | | | |
| Urban® | 1 | | 1 | |
| Rural | 0.956 [0.942-0.969] | 0.000 | 1.034 [1.016-1.052] | 0.000 |
| BMI** | | | | |
| Underweight® | 1 | | 1 | |
| Normal | 1.585 [1.550-1.620] | 0.000 | 1.274 [1.245-1.304] | 0.000 |
| Overweight | 3.774 [3.688-3.862] | 0.000 | 2.479 [2.418-2.541] | 0.000 |
| Diabetes | | | | |
| No® | 1 | | 1 | |
| Yes | 3.948 [3.832-4.068] | 0.000 | 2.257 [2.187-2.330] | 0.000 |

| Background characteristics | Hypertension | | | |
|---|---|---|---|---|
| | UOR [CI: 95%] | 'p' | AOR [CI: 95%] | 'p' |
| Uses of Cooking Fuel | | | | |
| Clean Fuel® | 1 | | 1 | |
| Polluting Fuel | 0.852 [0.841-0.864] | 0.000 | 0.916 [0.899-0.934] | 0.000 |
| Self-Smoking | | | | |
| No® | 1 | | 1 | |
| Yes | 1.440 [1.397-1.484] | 0.000 | 1.144 [1.080-1.211] | 0.000 |
| Exposure to Passive Smoking | | | | |
| No® | 1 | | 1 | |
| Yes | 0.947 [0.935-0.959] | 0.000 | 0.929 [0.916-0.942] | 0.000 |
| Uses of Tobacco | | | | |
| No® | 1 | | 1 | |
| Yes | 1.443 [1.392-1.497] | 0.000 | 0.991 [0.926-1.06] | 0.000 |
| Pseudo $R^2$ | | | 0.084 | |
| Chi-Square | | | 48508.309 | |
| Akaike crit. (AIC) | | | 529704.406 | |
| Bayesian crit. (BIC) | | | 530025.228 | |
| Log-likelihood | | | -264824.2 | |

Source: Authors' calculations

Note: CI - Confidence interval at 95 per cent significance level; ® - Reference category; OBC - Other Backward Classes; BMI - Body Mass Index; AIC - Akaike's information criterion; BIC - Bayesian information criterion.

It may be seen from table 3 that the odd of having hypertension is more than four times higher in women aged 45-49 years compared to women aged 15-29 years as revealed through the adjusted odds ratio. On the other hand, the odd of having hypertension is around 33 per cent higher in women having no education as compared to women having more than secondary level education after controlling other factors. On the contrary, the odd of having hypertension is found to be the highest in women with middle standard of living but the lowest in women with poor level of standard of living relative to the odd of having hypertension in women with the poorest standard of living. The difference in the odd of having hypertension in women of different standard of living, however, has not been found to be large. The table also suggests that women living in the rural areas are less likely to have hypertension as compared to women living in the urban areas. However, when other factors are controlled, rural women have relatively higher chance of having hypertension compared to urban women. Obese women definitely have higher chance of having hypertension compared to normal women. Similarly, women having diabetes have higher chance of having hypertension compared to non-diabetic women. The chance of having hypertension is definitely higher in smoking women as compared to non-smoking women but the chance of having hypertension is relatively lower in passive smokers compared to women who are not passive smokers. On the basis of UOR, Scheduled Tribes women residing in the rural areas are less likely to have hypertension as compared to women of General Class but, on the basis of AOR, they are more likely to have hypertension compared to General Class women of the rural areas. However, the AOR is found to be statistically insignificant,

# Discussion

Hypertension is a prominent risk factor for cardiovascular diseases and frequently contributes to multimorbidity (Dolui et al, 2023; Mohanty et al, 2021). The prevalence of hypertension has been found to be the highest among all morbidities (Dolui et al, 2023). The present analysis has unveiled several noteworthy findings. Our analysis confirms that prevalence of hypertension increases with age. It is well-known that the prevalence of hypertension was significantly higher among women of older ages compared to women of younger ages (Pires et al, 2013). Our finding aligns with similar observations in India, where the prevalence of hypertension is found to be higher among adults in the age group 45 years and above (Geldsetzer et al, 2018; Meshram et al, 2022; Mohanty et al, 2021). This association can be attributed to the progressive increase in mean systolic blood pressure throughout adulthood, with a steeper rise of blood pressure observed in women compared to men (Kearney et al, no date; Ong et al, 2008; Pimenta, 2011; Roger et al, 2011; Westheim et al, 2001).

We have also found that educational level of women is negatively associated with the prevalence of hypertension. This finding aligns with a previous study, which has also demonstrated that individuals with below-average educational level have higher risk of hypertension (Sun et al, 2022). It has also been observed that, for each additional year of education, there is a corresponding decrease in the systolic blood pressure, which reduces the likelihood of hypertension (Liu et al, 2011). The risk of hypertension is also found to be low in Scheduled Tribes and Other Backward Classes (OBC), exhibited lower awareness and were more prone to hypertension. Additionally, Women from Scheduled tribe categories are likely to be part of the causes of the high prevalence of hypertension, as suggested by previous studies (Anchala et al, 2014; Chakma et al, 2017; Gupta, 2004; Laxmaiah et al, 2015; Rizwan et al, 2014). Similarly, some studies revealed that women from tribal backgrounds with lower educational attainment face a higher risk of hypertension (Gupta et al, 1994; Hajjar et al, 2001; Kopp, 2005; Laxmaiah et al, 2015; Stamler et al, 1996, 2002). The present study also confirms that the risk of hypertension is directly related to the standard of living – the higher the standard of living the higher the prevalence of hypertension as observed in other studies (Mohanty et al, 2021).

Likewise, our study has revealed that women in the urban areas have higher risk of hypertension compared to women in the rural areas. An earlier study (Gupta et al, 1995) has also found higher risk of hypertension in urban women. However, the adjusted odds ratio suggests that the risk of hypertension is higher in rural women than in urban women which is also supported by various studies (Bisquera et al, 2022; Boro and Banerjee, 2022; Busingye et al, 2017; Chauhan et al, 2021; Gupta, 2004). The risk of hypertension has also been found to be directly associated with the obesity in women as revealed through BMI. A similar study has also reported that obese individuals with hypertension are at a greater risk of developing coronary heart disease than the non-obese one (Chiang et al, 1969). On the contrary, some studies have highlighted that low BMI can also be a contributing risk factor for hypertension, particularly among people in rural areas who may have low BMI because of chronic micronutrient deficiencies (Chakma et al, 2017; Dolui, et al, 2023; Goldbourt et al, 1987; Hu et al, 2000; Tesfaye et al, 2007).

The prevalence of hypertension among diabetic women is notably higher and regressively associated in various aspects when compared to other groups. These findings align with those from earlier studies (Chauhan et al, 2021; Geldsetzer et al, 2018). Additionally, a significant risk factor for hypertension among women is self-smoking. Earlier studies have shown that maternal smoking or smoking during pregnancy leads to the risk of hypertension (Liang et al, 2022; Seal et al, 2013). However, the present analysis suggests passive smoking does not appear to be a risk factor in hypertension.

The present study has certain limitations. First, it is based on the cross-sectional data, which may not capture the long-term trend in the prevalence of hypertension or causality. Second, the study is limited to women aged 15-49 years only, which may not fully represent the entire women population. The National Family Health Survey has also collected data on the blood pressure for men covered under the survey and there are several studies that have analysed the prevalence of hypertension and its determinants in both men and women using the NFHS data. In the present analysis, however, we have focused, particularly, on women aged 16-49 years to find out how selected demographic and socio-economic characteristics of these women impact upon the level of blood pressure. These limitations should be considered when interpreting the findings of the present analysis and may offer opportunities for further research and data collection to address these gaps.

## Conclusion

The present study draws attention to the pressing issue of hypertension among women in India and offers crucial insights into the chronic burden of women, which contributes substantially to the prevalence of cardiovascular diseases and multimorbidity. The findings emphasise that elderly women, those with lower levels of education, and belonging to the socioeconomically disadvantaged section of the community, face a higher risk of hypertension. The prevalence of hypertension may lead to other non-communicable diseases, such as diabetes, and reveals the impact of smoking on blood pressure. Recognising these vulnerability factors is of utmost importance for the development of effective public health interventions aimed at reducing the prevalence of hypertension and associated risk factors in women. The government of India has launched the India Hypertension Control Initiative (IHCI) in 2017 which aims aims to accelerate progress towards the Non-Communicable Diseases (NCD) target set by the Government of India by supplementing and intensifying evidence-based strategies to strengthen the building blocks of hypertension management and control. The Government of India aims to reduce premature mortality due to non-communicable diseases (NCDs) by 25 per cent by 2025. One of the nine voluntary targets is to reduce the prevalence of high blood pressure by 25 per cent by 2025. The present study suggests that target-specific interventions based on education, wealth and age such as awareness campaigning for quitting smoking substances, healthy dietary patterns, physical activities, community diagnosis and screening and easy access to low-cost or free antihypertensive medication is necessary to manage hypertension in women.

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# Age at Diagnosis and Diabetes Free Life Expectancy by Gender in Kerala: Evidence from LASI

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## Abstract

Kerala known as diabetes capital of India. This study attempts to determine the prevalence and age at diagnosis of diabetes and diabetes free life expectancy in Kerala based on the data from the wave 1 of the Longitudinal Ageing Study in India conducted during 2017-18. The life table was constructed based on data from the Sample Registration System (SRS) matching the survey period. Sullivan method was applied to estimate diabetes-free life expectancy in the context of the study. The self-reported prevalence of diabetes in Kerala the highest among states and Union Territories of the country. The study reveals gender differentials in the age at the diagnosis of diabetes. The study reveals that a substantial proportion of older individuals spend a significant amount of their lives with diabetes. For the next decades, the impact of diabetes on healthy life expectancy is likely to rise unless preventive measures are taken.

## Introduction

Kerala has entered an advanced stage of demographic and epidemiological transition which marks significant evolution of the population dynamics and disease pattern in the state. An implication of this transition is the aging of the population, increase in the prevalence of non-communicable diseases, and rising morbidity rates. The rapid increase in the proportion of the old age population in the state has emerged as a prominent concern from the public health perspective. The rapid increase in the old population of the state has resulted in marked changes in the disease profile and causes of death pattern with a marked increase in the prevalence of non-communicable diseases (NCDs). For example, a study carried out by the Indian Council of Medical Research estimated in the year 2011 that around 24 per cent population of the state had diabetes and this proportion is one of the highest in the country (Anjana et al, 2011). The latest round of the National Family Health Survey, 2019-2021 estimates that around 25 per cent of women aged 15 years and above and around 27 per cent of men aged 15 years and above in the state were diabetic - having a random blood glucose level of more than 140 mg/dl or were taking medicines to control blood glucose level at the time of the survey (Government of India, 2020a). The survey has also revealed that this proportion varies widely across the districts of the state. The prevalence of diabetes in males has been found to be the highest in district Thiruvananthapuram but the lowest in district Kasaragod whereas the prevalence of diabetes in females has been found to be the highest in Pathanamthitta but the lowest in district Kasaragod. There is no district in the state where the proportion of men or women aged at least 15 years who were diabetic at the time of the survey was less than 20 per cent (Government of India, 2020b).

Diabetes is a metabolic condition that is marked by elevated blood glucose level. The elevated blood glucose level damages vital and other organs in the human body, potentially leading to increased mortality and other health problems (WHO, 2016). Diabetes affects people all over the world. In most of the high-income countries, it is either the fourth or the fifth leading cause of death, and there is strong evidence that it has become an epidemic in the newly developed and economically developing countries. According to the World Health Organization, the number of people living with diabetes increased from 200 million in 1990 to 830 million in 2022 and the prevalence of the disease is rising more rapidly in low- and middle-income countries than in high-income countries. In 2021, diabetes was the direct cause of 1.6 million deaths and 47 per cent of all deaths due to diabetes occurred before the age of 70 years. Another 530 000 kidney disease deaths were caused by diabetes, and high blood glucose caused around 11 per cent of cardiovascular deaths (Global Burden of Disease Collaborative Network, 2024).

Diabetes is acknowledged as a significant contributor to premature mortality and disability. Studies show that the life expectancy in population with diabetes is lower than the life expectancy in population without diabetes and the difference increases with age (Sikdar, 2010; Bardenheier, 2016). Moreover, studies also highlight an increase in the duration of morbidity associated with the disease (Muschik, 2017). Diabetes has a negative impact on the quality of life of an individual also. It places significant financial burden on the individual, the family, and the society.

There are studies in India which have analysed the impact of diabetes on life expectancy in India and in other countries (Andrade, 2009; Sharma et al, 2024; Luhar et al, 2021; Emerging Risk Factors Collaboration, 2023; Alam and Sheoti, 2024; Khyati et al, 2021). A study based on a survey carried out in 2004 in Kerala had estimated that diabetes-free life expectancy of males and females were 67.8 and 74.1 years, respectively (Krishnakumar et al, 2025). This study has also found statistically significant differences between males and females in the diabetes-free life expectancy in all ages except 85 years and over. Another finding of the study is that males and females of the state lived with diabetes, on average, 3.6 years, and 4.3 years, respectively their lifetime.

This paper has two objectives. The first is to estimate the prevalence of self-reported diabetes and age of diagnosis of diabetes in population aged at least 45 years in the state while the second objective is to estimate the diabetes free life expectancy. The comparison between the overall life expectancy and the diabetes free life expectancy sheds light on the specific impact of diabetes on longevity and quality of life in Kerala. The analysis has been carried out separately for males and females to highlight, if any, the differential impact of diabetes on the lifespan of men and women.

## Data and Methods

The study is based on the data available from the first wave of the Longitudinal Ageing Study in India (LASI) which was conducted in 2017-2018 (Government of India, 2020c). LASI is a nationally representative household survey that covers all states and Union Territories of India with the objective of investigating health, economic, and social determinants and consequences of population ageing in India. Households with at least one member aged 45 and above are taken as the eventual observation unit in LASI. The Indian Council of Medical Research (ICMR) provided the essential guidance and approval for data collection. Written informed consent was obtained from each household and every eligible individual. The data available from LASI provide valuable insights into the prevalence and burden of chronic diseases in India. At the national level, the first wave of LASI covered a sample of 72,250 individuals aged 45 years and above and their spouses, irrespective of the age of the spouse. In Kerala, 2497 individuals aged 45 years were covered under the first wave of LASI. During the survey, all respondents were asked "Has any health professional ever diagnosed you with diabetes or high blood sugar." The response to the question was coded either "Yes" or "No" and all respondents whose response was "Yes" to the question were classified as having diabetes. The blood glucose level of the respondents was also measured during the survey. However, the present study is based on the response given by the respondents only. The prevalence of diabetes presented here, therefore, is the self-reported prevalence of diabetes. Moreover, the age when diabetes was first diagnosed was also asked from those respondents who reported to have been diagnosed for diabetes.

The Sullivan Method has been used to estimate the diabetes free life expectancy (DFLE) and diabetes life expectancy (DLE) (Sullivan, 1971). This method is the most widely used method to estimate population health indicators (Sullivan, 1971). The method involves dividing the person-years lived in an age interval into two mutually exclusive groups – one having diabetes and the other not having diabetes. The person-years lived in an age interval is obtained from the prevailing age-specific mortality rates by constructing the life table and the person-years lived in the age interval having diabetes is assumed to be proportional to the prevalence of diabetes in the age interval. Construction of the life table for the total population (diabetic and non-diabetic) is necessary for the application of the Sullivan method. The life expectancy of the total population is the sum of the life expectancy of the non-diabetic population and the life expectancy of the diabetic population. Using the standard life table notations, the life expectancy at age $x$ in a population is given by

$$LE_x = \frac{1}{l_x}\sum_x L_x \tag{1}$$

and

$$DLE_x = \frac{1}{l_x}\sum_x p_x L_x \tag{2}$$

$$DFLE_x = \frac{1}{l_x}\sum_x (1-p_x) L_x \tag{3}$$

The life tables for Kerala are constructed from the age-specific death rates available from the sample registration system for the year 2018 (Government of India, 2020d).

Table 1 gives the reported prevalence of diabetes in the population aged 45 years and above in the state. Among the 2497 persons aged 45 years and above covered during the first wave of LASI, 686 persons reported that they had diabetes which gives a prevalence rate of 27.5 per cent. The reported prevalence of diabetes is estimated to be 30.5 per cent for males but 25.5 per cent for females. The reported prevalence of diabetes increases with age and is found to be relatively higher in the urban areas as compared to the rural areas of the state. The level of education of the individual has not been found to be associated with the reported prevalence of diabetes as it is found to be the highest in respondents having up to primary education only. However, the reported prevalence is found to be the highest in respondents with the richest standard of living but the lowest in respondents with the poorest standard of living. The reported prevalence of diabetes has been found to be the lowest in respondents of Hindu religion but the highest in respondents of other religion – neither Hindu nor Muslim. Similarly, the reported prevalence of diabetes is found to be lowest in Scheduled Tribes respondents but the highest in respondents of social classes other than Scheduled Tribes, Scheduled Castes, and Other Backward Classes. In general, reported prevalence of diabetes in found to be lower in females than in males but, in the Scheduled Tribes population, the reported prevalence of diabetes is found to be higher in females than in males. Similarly, the reported prevalence of diabetes is found to be higher in females than in males in population with no education and in population with the poorest standard of living. The male-female difference in the reported prevalence of diabetes varies by the background characteristics of the population.

## Age at Diagnosis of Diabetes

Table 2 presents distribution of the age at diagnosis of diabetes in Kerala along with the distribution of the age at diagnosis of diabetes in India for the total population and for males and females separately based on the data available from LASI. In India, the median age at diagnosis of diabetes was 51 years for both males and females and, therefore, in the total population. In Kerala, however, the median age at diagnosis of diabetes was 53 years for males but 50 years for females. For the male and female combined population, the median age at diagnosis of diabetes was 50 years which is very close to that in India. The median age at diagnosis of diabetes in males was higher in Kerala compared to India but the median age at diagnosis in females was lower in Kerala than that in India. There is, however, big difference between India and Kerala in terms of both youngest age at diagnosis of diabetes and oldest age at diagnosis of diabetes. In India, the youngest age at diagnosis of diabetes was 6 years for both males and females compared to 26 years for both males and females in Kerala. On the other hand, the oldest age at diagnosis of diabetes was 83 years for males and 85 years for females but 77 years and 71 years respectively in Kerala.

The age at diagnosis of diabetes in Kerala has also been found to vary by the background characteristics of the respondents such as gender, place of residence, religion, social group, and the standard of living (Table 3). The median age at the diagnosis of diabetes has been found to be higher in rural respondents as compared to urban respondents. On the other hand, the median age at diagnosis has been found to be comparatively the highest in Muslim respondents but the lowest in Hindu respondents.

Among different social classes, the age at diagnosis has been found to be the highest in Scheduled Tribes respondents but the lowest in respondents belonging to Other Backward Classes. Finally, the age at diagnosis of diabetes has been found to be the lowest in respondents with the poorest and the richest standard of living as measured through the mean per capita consumption expenditure (MPCE). Among respondents with average and richer standard of living, the median age at diagnosis of diabetes has been found to be around 3 years higher than the median age at diagnosis among respondents with either the poorest or the richest standard of living index, Table 3 also shows that both minimum and maximum age at diagnosis of diabetes have also been found to vary widely across the background characteristics of the respondents. For example, although the median age at diagnosis of diabetes is found to be the same in respondents with the lowest and the highest standard of living, yet the minimum age at diagnosis was found to be substantially lower in respondents with the richest standard of living than that in respondents with the poorest standard of living. On the other hand, the maximum age at the diagnosis has been found to be the lowest in respondents with above average – richer and richest – standard of living, it was the lowest in respondents with middle standard of living.

Table 1: Reported prevalence of diabetes in population aged 45 years and above in Kerala as revealed through LASI.

| Background characteristics of respondents | | Reported prevalence of diabetes (per cent) | | |
|---|---|---|---|---|
| | | Male | Female | Person |
| Age | 45-59 | 23.1 | 18.5 | 20.1 |
| | 60-74 | 35.2 | 34.7 | 35.0 |
| | 75+ | 42.2 | 33.5 | 37.3 |
| Residence | Urban | 34.2 | 26.2 | 29.3 |
| | Rural | 27.3 | 25.1 | 26.0 |
| Education | No education | 20.9 | 28.6 | 26.4 |
| | Up to Primary | 28.9 | 28.9 | 28.9 |
| | Middle/Secondary | 31.3 | 24.7 | 27.4 |
| | Higher Secondary & above | 37.2 | 18.5 | 26.0 |
| Religion | Hindu | 28.2 | 22.3 | 24.6 |
| | Muslim | 31.6 | 28.8 | 29.9 |
| | Christian | 36.4 | 32.4 | 34.1 |
| Caste | General | 31.9 | 29.1 | 30.3 |
| | SC | 18.8 | 17.6 | 18.1 |
| | ST | 15.8 | 23.8 | 20.0 |
| | OBC | 31.9 | 24.5 | 27.4 |
| Wealth | Poorest | 21.3 | 25.7 | 24 |
| | Poorer | 29.2 | 23.7 | 25.8 |
| | Middle | 34.6 | 23.2 | 27.7 |
| | Richer | 29.7 | 25.9 | 27.4 |
| | Richest | 34.6 | 28.9 | 31.3 |
| All | | 30.5 | 25.5 | 27.5 |
| N | | 991 | 1506 | 2497 |

Source: Authors' calculations

Table 2: Age at diagnosis of diabetes (years) by gender in India and Kerala

| | Minimum | Q1 | Median | Q3 | Maximum | IQR |
|---|---|---|---|---|---|---|
| | | | India | | | |
| Total | 6 | 45 | 51 | 59 | 85 | 14 |
| Male | 6 | 45 | 51 | 60 | 83 | 15 |
| Female | 6 | 45 | 51 | 58 | 85 | 13 |
| | | | Kerala | | | |
| Total | 26 | 45 | 50 | 58 | 77 | 13 |
| Male | 26 | 48 | 53 | 58 | 77 | 10 |
| Female | 26 | 45 | 50 | 58 | 71 | 13 |

Source: Authors' calculations

Table 3: Age at diagnosis of diabetes by selected demographic and social and economic characteristics of persons at least 45 years of age who self-reported that they have been diagnosed with diabetes.

| Characteristics | Minimum | Q1 | Median | Q3 | Maximum | IQR |
|---|---|---|---|---|---|---|
| Age (years) | | | | | | |
| 45-59 | 26 | 36 | 42 | 43 | 47 | 7 |
| 60+ | 32 | 51 | 55 | 60 | 77 | 9 |
| Sex | | | | | | |
| Male | 26 | 48 | 53 | 58 | 77 | 10 |
| Female | 26 | 45 | 50 | 58 | 71 | 13 |
| Residence | | | | | | |
| Rural | 26 | 47 | 55 | 60 | 77 | 13 |
| Urban | 26 | 42 | 50 | 55 | 72 | 13 |
| Religion | | | | | | |
| Hindu | 26 | 45 | 50 | 56 | 77 | 11 |
| Christian | 33 | 47 | 52 | 56 | 66 | 9 |
| Muslim | 32 | 44 | 54 | 60 | 72 | 16 |
| Social Group | | | | | | |
| Scheduled Tribes | 26 | 44 | 55 | 67 | 77 | 23 |
| Other Backward Classes | 26 | 45 | 50 | 56 | 72 | 11 |
| Others | 30 | 45 | 52 | 59 | 71 | 14 |
| Standard of living | | | | | | |
| Poorest | 32 | 48 | 50 | 55 | 72 | 7 |
| Poorer | 30 | 45 | 51 | 57 | 71 | 12 |
| Middle | 33 | 43 | 53 | 63 | 77 | 20 |
| Richer | 31 | 46 | 53 | 59 | 67 | 13 |
| Richest | 26 | 44 | 50 | 56 | 67 | 12 |

Source: Authors' calculations.

Remarks: The standard of living of the individuals has been classified into five mutually exclusive yet exhaustive categories based on the average monthly consumption expenditure at current prices of the household of the individual.

## Prevalence of Diabetes

Table 4 gives the prevalence of diabetes in population above age 45 years in Kerala estimated from the data available through LASI. Prevalence of diabetes is found to be higher among males than females among all the age groups and similar pattern is found in rural and urban areas also.

Table 4: Prevalence of diabetes (per cent) in population at least 45 years of age in Kerala.

| | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | Total | | | | |
| Person | 13.5 | 21.6 | 29.0 | 31.3 | 34.0 | 41.6 | 41.6 | 38.7 | 27.8 |
| Male | 17.3 | 23.8 | 27.3 | 29.1 | 36.9 | 40.0 | 44.3 | 44.4 | 34.5 |
| Female | 12.2 | 19.9 | 30.4 | 32.9 | 31.4 | 43.1 | 39.3 | 33.3 | 24.0 |
| | | | | | Rural | | | | |
| Person | 13.2 | 17.9 | 29.3 | 32.1 | 24.9 | 37.1 | 41.8 | 48.9 | 23.3 |
| Male | 19 | 18.9 | 23.9 | 28.8 | 27.7 | 33.3 | 41.9 | 48.1 | 28.6 |
| Female | 11.4 | 17.0 | 33.3 | 34.2 | 22.2 | 40.7 | 41.7 | 50.0 | 20.7 |
| | | | | | Urban | | | | |
| Person | 13.7 | 25.4 | 28.7 | 30.5 | 44.0 | 46.7 | 41.3 | 23.3 | 33.3 |
| Male | 15.8 | 29.7 | 30.4 | 29.4 | 47.3 | 47.9 | 46.2 | 33.3 | 40.0 |
| Female | 13.0 | 22.5 | 27.4 | 31.3 | 41.2 | 45.6 | 36.1 | 19.0 | 28.6 |

Source: Authors' calculations

## Life Expectancy and Diabetes-Free Life Expectancy

Life expectancy (LE) highlights, on average, the longevity in the population and is the universally used measure of population health. The diabetes-free life expectancy (DFLE), on the other hand, reflects the average number of years, a person is expected to live without diabetes whereas diabetes life expectancy (DLE) reflects the average number of years, a person is expected to live with diabetes. The estimation of DFLE and DLE requires construction of the life table for the total population – population with or without diabetes – and estimates of the prevalence of diabetes by age.

For the estimation of DFLE and DLE, we have first constructed life tables for the total population and for males and females for Kerala and for its rural and urban areas for the year 2018 from the age-specific death rates available from the official Sample Registration System of the country (Government of India, 2020c). The life tables so constructed are given in the appendix table. According to our calculations, the life expectancy at birth in Kerala was around 75 years for the total population and 72 years for males and 78 years for females. Life tables for Kerala have also been prepared by the Registrar General of India based on the data available from the official Sample Registration System. According to the life tables prepared by the Registrar General of India, the life expectancy at birth in Kerala was 70 years for the male-female combined population and around 72 years for males and 78 years for females during the period 2016-2021 (Government of India, 2022).

Table 5 gives estimates of life expectancy (LE), diabetes free life expectancy (DFLE) and diabetes life expectancy (DLE) in Kerala in the year 2018 at different ages of the life span beginning 45 years of age for total, rural and urban populations separately for males and females. Table 5 suggests that a male aged 45 years in Kerala is expected to live on average, about 30 more years out of which around 21 years will be without diabetes while around 9 years will be with diabetes. In other words, more than 30 per cent of the expected future life of a male aged 45 years in the state is likely to be with diabetes. On the other hand, a female aged 45 years in the state is expected to live on average, about 35 years more, out of which about 25 years is likely to be without diabetes while about 10 years will be with diabetes. This means that more than almost 29 per cent of the future life of a female aged 45 years in the state is likely to be with diabetes.

Table 5: Life expectancy, diabetes-free life expectancy (DFLE), and diabetes life expectancy (DLE) in Kerala, based on self-reported diabetes from LASI, 2018

| Age | Male | | | | Female | | | |
|---|---|---|---|---|---|---|---|---|
| | LE (years) | DFLE (years) | DLE (Years | Proportion of expected future life likely to be lived with diabetes (per cent) | LE (years) | DFLE (years) | DLE (Years | Proportion of expected future life likely to be lived with diabetes (per cent) |
| 45 | 29.97 | 20.89 | 9.08 | 30.30 | 34.95 | 24.83 | 10.12 | 28.96 |
| 60 | 17.23 | 10.81 | 6.42 | 37.25 | 21.27 | 13.87 | 7.40 | 34.79 |
| 70 | 10.87 | 6.29 | 4.59 | 42.18 | 13.70 | 8.65 | 5.05 | 36.87 |
| 80 | 5.58 | 3.28 | 2.30 | 41.28 | 7.35 | 5.20 | 2.15 | 29.24 |
| 85+ | 3.32 | 2.17 | 1.15 | 34.50 | 4.90 | 3.72 | 1.18 | 24.00 |
| | | | | Rural | | | | |
| 45 | 30.02 | 20.92 | 9.10 | 30.30 | 34.83 | 24.76 | 10.07 | 28.92 |
| 60 | 17.41 | 10.93 | 6.48 | 37.20 | 21.08 | 13.75 | 7.33 | 34.76 |
| 70 | 10.82 | 6.28 | 4.54 | 42.00 | 13.41 | 8.47 | 4.94 | 36.86 |
| 80 | 6.12 | 3.62 | 2.50 | 40.80 | 7.35 | 5.20 | 2.15 | 29.30 |
| 85+ | 4.00 | 2.62 | 1.38 | 34.50 | 4.68 | 3.55 | 1.13 | 24.00 |
| | | | | Urban | | | | |
| 45 | 29.84 | 20.81 | 9.03 | 30.27 | 35.05 | 24.89 | 10.16 | 29.00 |
| 60 | 16.98 | 10.65 | 6.33 | 37.29 | 21.46 | 13.99 | 7.47 | 34.81 |
| 70 | 10.84 | 6.25 | 4.59 | 42.38 | 14.01 | 8.84 | 5.17 | 36.87 |
| 80 | 5.00 | 2.90 | 2.10 | 41.91 | 7.37 | 5.22 | 2.15 | 29.14 |
| 85+ | 2.53 | 1.66 | 0.87 | 34.50 | 5.22 | 3.97 | 1.25 | 24.00 |

Source: Authors' calculations

Table 5 also shows that there is only a marginal difference in the proportion of expected future life of males and females aged 45 years with diabetes in the rural and in the urban areas of the state. The table also shows that the proportion of expected future life likely to be lived with diabetes is the highest in both males and females who have reached 70 years of age but is lower in both males and females who are older than 70 years of age. Another observation of table 5 is that the life expectancy at all ages in higher in females as compared to males in the state but the proportion of the expected future life likely to be lived with diabetes is higher for males as compared to females. The relatively higher proportion of the expected future life of a male likely to be lived with diabetes may be one of the reasons for the comparatively lower life expectancy of a male aged 45 years relative to a female aged 45 years in the state.

## Discussion

India has the highest prevalence of diabetes mellitus globally, with Kerala having leaped ahead. Kerala has emerged as the 'Diabetic Capital' of India with the prevalence of diabetes at 19.2 per cent (Sarma, 2019). Any country transitioning from a developing to a developed economy is likely to experience similar trends in non-communicable diseases. The present study found that self-reported diabetes mellitus is associated with increasing age, and it confirms the findings of Tiwari et al (2008), Agrawal (2011) and Sharma et al (2024). The current study observed that females had a slightly higher likelihood of developing diabetes compared to males, though the prevalence was higher for males than for females. The study by Maiti et al (2023) lends credence to this finding. Lifestyle differences may be a significant reason for the differences in the prevalence of this condition between women and men (Wandell, 2014). The prevalence was higher in urban than in rural areas (Kalra, 2024). From the present study, it was found that in Kerala, elderly males lead a healthier life compared to elderly females. The number of years before progressing to diabetes is higher among females up to the age of 45 years only, and later, the pattern changes though the difference in the number of years before being diagnosed with diabetes among males and females isn't statistically significant Sharma et al (2024). Our study highlighted that even though life expectancy is higher for females than males, the proportion of years spent with diabetes is more for males and it is contradictory to the finding that women with diabetes live longer but experience a greater number of years with a disability (Payne, 2023).

## Conclusion

Kerala, a state with one of the best health indicators in India, has a high prevalence of diabetes. The prevalence of self-reported diabetes is higher among males than females. Even though the prevalence rate is higher among males, the age at diagnosis of diabetes is earlier in females than in males. Females have also been found to live longer than males with diabetes. Kerala is at an advanced stage of demographic transition so that there is a rapid growth in the old population in the state. It is, therefore, crucial to promote healthy eating and exercise among the old people of the state as a way of reducing the burden of diabetes. Management of diabetes faces many challenges in Kerala. These include rising prevalence of diabetes, lifestyle alterations, delayed diagnosis, low degree of awareness, and expensive treatment cost. The present analysis shows that a significant proportion of the rapidly increasing old population of the state is likely to be living with diabetes in the years to come. It is, therefore, important that health policy of the state should prioritise diabetes preventive and management measures like early screening of the old population, diabetes management education, and lifestyle interventions to help reduce the burden of diabetes and extend diabetes free life expectancy in the middle-aged and old population of the state. It is also important that equitable healthcare access is ensured through appropriate resources allocation to support prevention and management of diabetes, especially in rural areas of the state.

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Appendix Table 1: Life tables for Kerala, 2018

| Age group | $m_x$ | $_nq_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x$ |
|---|---|---|---|---|---|---|---|
| | | | | Total Male | | | |
| 0-4 | 2.2 | 0.0109 | 100000 | 1094 | 497265 | 7240350 | 72.40 |
| 5-9 | 0.2 | 0.0010 | 98906 | 99 | 494283 | 6743085 | 68.18 |
| 10-14 | 0.4 | 0.0020 | 98807 | 197 | 493542 | 6248802 | 63.24 |
| 15-19 | 0.6 | 0.0030 | 98610 | 295 | 492310 | 5755260 | 58.36 |
| 20-24 | 0.5 | 0.0025 | 98314 | 245 | 490958 | 5262950 | 53.53 |
| 25-29 | 1.2 | 0.0060 | 98069 | 587 | 488878 | 4771992 | 48.66 |
| 30-34 | 0.9 | 0.0045 | 97482 | 438 | 486317 | 4283114 | 43.94 |
| 35-39 | 1.7 | 0.0085 | 97045 | 821 | 483169 | 3796797 | 39.12 |
| 40-44 | 3.3 | 0.0164 | 96223 | 1575 | 477179 | 3313628 | 34.44 |
| 45-49 | 3.1 | 0.0154 | 94648 | 1456 | 469603 | 2836449 | 29.97 |
| 50-54 | 6.3 | 0.0310 | 93193 | 2890 | 458738 | 2366846 | 25.40 |
| 55-59 | 11.5 | 0.0559 | 90303 | 5047 | 438895 | 1908108 | 21.13 |
| 60-64 | 16.8 | 0.0806 | 85255 | 6873 | 409095 | 1469213 | 17.23 |
| 65-69 | 38.5 | 0.1756 | 78383 | 13764 | 357503 | 1060118 | 13.52 |
| 70-74 | 46.4 | 0.2079 | 64619 | 13433 | 289510 | 702615 | 10.87 |
| 75-79 | 73.6 | 0.3108 | 51185 | 15909 | 216155 | 413105 | 8.07 |
| 80-84 | 122.9 | 0.4701 | 35276 | 16582 | 134926 | 196950 | 5.58 |
| 85+ | 301.4 | 1.0000 | 18694 | 18694 | 62024 | 62024 | 3.32 |
| | | | | Total Female | | | |
| 0-4 | 2.0 | 0.0100 | 100000 | 995 | 497512 | 7806432 | 78.06 |
| 5-9 | 0.4 | 0.0020 | 99005 | 198 | 494530 | 7308920 | 73.82 |
| 10-14 | 0.1 | 0.0005 | 98807 | 49 | 493912 | 6814389 | 68.97 |
| 15-19 | 0.4 | 0.0020 | 98758 | 197 | 493296 | 6320477 | 64.00 |
| 20-24 | 0.6 | 0.0030 | 98560 | 295 | 492064 | 5827182 | 59.12 |
| 25-29 | 0.4 | 0.0020 | 98265 | 196 | 490835 | 5335117 | 54.29 |
| 30-34 | 0.7 | 0.0035 | 98069 | 343 | 489488 | 4844282 | 49.40 |
| 35-39 | 0.5 | 0.0025 | 97726 | 244 | 488021 | 4354794 | 44.56 |
| 40-44 | 1.5 | 0.0075 | 97482 | 728 | 485590 | 3866773 | 39.67 |
| 45-49 | 1.9 | 0.0095 | 96754 | 915 | 481482 | 3381183 | 34.95 |
| 50-54 | 3.2 | 0.0159 | 95839 | 1521 | 475392 | 2899701 | 30.26 |
| 55-59 | 4.8 | 0.0237 | 94318 | 2237 | 465997 | 2424309 | 25.70 |
| 60-64 | 10.2 | 0.0497 | 92081 | 4579 | 448957 | 1958312 | 21.27 |
| 65-69 | 18.7 | 0.0893 | 87502 | 7816 | 417968 | 1509355 | 17.25 |
| 70-74 | 26.0 | 0.1221 | 79686 | 9727 | 374111 | 1091387 | 13.70 |
| 75-79 | 47.6 | 0.2127 | 69959 | 14880 | 312595 | 717276 | 10.25 |
| 80-84 | 83.3 | 0.3447 | 55079 | 18987 | 227930 | 404681 | 7.35 |
| 85+ | 204.2 | 1.0000 | 36093 | 36093 | 176752 | 176752 | 4.90 |

| Age group | $m_x$ | ${}_nq_x$ | $l_x$ | ${}_nd_x$ | ${}_nL_x$ | $T_x$ | $e_x$ |
|---|---|---|---|---|---|---|---|
| | | | | Rural Male | | | |
| 0-4 | 2.2 | 0.0109 | 100000 | 1094 | 497265 | 7274039 | 72.74 |
| 5-9 | 0.3 | 0.0015 | 98906 | 148 | 494159 | 6776774 | 68.52 |
| 10-14 | 0.3 | 0.0015 | 98758 | 148 | 493419 | 6282614 | 63.62 |
| 15-19 | 0.3 | 0.0015 | 98610 | 148 | 492679 | 5789195 | 58.71 |
| 20-24 | 0.4 | 0.0020 | 98462 | 197 | 491818 | 5296516 | 53.79 |
| 25-29 | 1.0 | 0.0050 | 98265 | 490 | 490101 | 4804698 | 48.90 |
| 30-34 | 1.2 | 0.0060 | 97775 | 585 | 487413 | 4314598 | 44.13 |
| 35-39 | 1.7 | 0.0085 | 97190 | 823 | 483895 | 3827184 | 39.38 |
| 40-44 | 2.0 | 0.0100 | 96368 | 959 | 479441 | 3343290 | 34.69 |
| 45-49 | 3.4 | 0.0169 | 95409 | 1608 | 473023 | 2863849 | 30.02 |
| 50-54 | 7.2 | 0.0354 | 93800 | 3317 | 460709 | 2390826 | 25.49 |
| 55-59 | 11.1 | 0.0540 | 90483 | 4886 | 440201 | 1930117 | 21.33 |
| 60-64 | 16.4 | 0.0788 | 85597 | 6743 | 411129 | 1489916 | 17.41 |
| 65-69 | 35.0 | 0.1609 | 78855 | 12689 | 362550 | 1078786 | 13.68 |
| 70-74 | 57.6 | 0.2517 | 66165 | 16657 | 289184 | 716237 | 10.82 |
| 75-79 | 67.7 | 0.2895 | 49508 | 14333 | 211710 | 427052 | 8.63 |
| 80-84 | 113.6 | 0.4424 | 35176 | 15561 | 136977 | 215343 | 6.12 |
| 85+ | 250.3 | 1.0000 | 19615 | 19615 | 78366 | 78366 | 4.00 |
| | | | | Rural Female | | | |
| 0-4 | 2.1 | 0.0104 | 100000 | 1045 | 497389 | 7821550 | 78.22 |
| 5-9 | 0.2 | 0.0010 | 98955 | 99 | 494530 | 7324161 | 74.01 |
| 10-14 | 0.1 | 0.0005 | 98857 | 49 | 494159 | 6829631 | 69.09 |
| 15-19 | 0.3 | 0.0015 | 98807 | 148 | 493666 | 6335472 | 64.12 |
| 20-24 | 0.3 | 0.0015 | 98659 | 148 | 492926 | 5841806 | 59.21 |
| 25-29 | 0.4 | 0.0020 | 98511 | 197 | 492064 | 5348880 | 54.30 |
| 30-34 | 0.5 | 0.0025 | 98314 | 245 | 490958 | 4856817 | 49.40 |
| 35-39 | 0.6 | 0.0030 | 98069 | 294 | 489610 | 4365859 | 44.52 |
| 40-44 | 1.0 | 0.0050 | 97775 | 488 | 487656 | 3876249 | 39.64 |
| 45-49 | 1.5 | 0.0075 | 97287 | 727 | 484620 | 3388592 | 34.83 |
| 50-54 | 3.1 | 0.0154 | 96561 | 1485 | 479090 | 2903972 | 30.07 |
| 55-59 | 4.9 | 0.0242 | 95075 | 2301 | 469624 | 2424882 | 25.50 |
| 60-64 | 10.3 | 0.0502 | 92774 | 4658 | 452226 | 1955259 | 21.08 |
| 65-69 | 17.8 | 0.0852 | 88116 | 7508 | 421811 | 1503032 | 17.06 |
| 70-74 | 35.6 | 0.1635 | 80608 | 13176 | 370101 | 1081222 | 13.41 |
| 75-79 | 40.3 | 0.1831 | 67432 | 12344 | 306302 | 711121 | 10.55 |
| 80-84 | 77.4 | 0.3243 | 55088 | 17863 | 230785 | 404818 | 7.35 |
| 85+ | 213.9 | 1.0000 | 37226 | 37226 | 174033 | 174033 | 4.68 |

| Age group | $m_x$ | $_nq_x$ | $l_x$ | $_nd_x$ | $_nL_x$ | $T_x$ | $e_x$ |
|---|---|---|---|---|---|---|---|
| | | | | Urban Male | | | |
| 0-4 | 2.1 | 0.0104 | 100000 | 1045 | 497389 | 7210504 | 72.11 |
| 5-9 | 0.0 | 0.0000 | 98955 | 0 | 494777 | 6713115 | 67.84 |
| 10-14 | 0.5 | 0.0025 | 98955 | 247 | 494160 | 6218338 | 62.84 |
| 15-19 | 0.9 | 0.0045 | 98708 | 443 | 492434 | 5724178 | 57.99 |
| 20-24 | 0.5 | 0.0025 | 98265 | 245 | 490713 | 5231744 | 53.24 |
| 25-29 | 1.5 | 0.0075 | 98020 | 732 | 488268 | 4741031 | 48.37 |
| 30-34 | 0.5 | 0.0025 | 97287 | 243 | 485830 | 4252763 | 43.71 |
| 35-39 | 1.6 | 0.0080 | 97045 | 773 | 483290 | 3766933 | 38.82 |
| 40-44 | 4.6 | 0.0227 | 96271 | 2189 | 475884 | 3283644 | 34.11 |
| 45-49 | 2.8 | 0.0139 | 94082 | 1308 | 467141 | 2807760 | 29.84 |
| 50-54 | 5.4 | 0.0266 | 92774 | 2472 | 457692 | 2340619 | 25.23 |
| 55-59 | 11.9 | 0.0578 | 90303 | 5218 | 438469 | 1882927 | 20.85 |
| 60-64 | 17.2 | 0.0825 | 85085 | 7016 | 407885 | 1444458 | 16.98 |
| 65-69 | 42.5 | 0.1921 | 78069 | 14996 | 352855 | 1036572 | 13.28 |
| 70-74 | 35.7 | 0.1639 | 63073 | 10336 | 289524 | 683717 | 10.84 |
| 75-79 | 80.9 | 0.3365 | 52737 | 17743 | 219326 | 394192 | 7.47 |
| 80-84 | 134.5 | 0.5033 | 34993 | 17611 | 130939 | 174867 | 5.00 |
| 85+ | 395.7 | 1.0000 | 17382 | 17382 | 43928 | 43928 | 2.53 |
| | | | | Urban Female | | | |
| 0-4 | 1.8 | 0.0090 | 100000 | 896 | 497760 | 7799401 | 77.99 |
| 5-9 | 0.6 | 0.0030 | 99104 | 297 | 494778 | 7301641 | 73.68 |
| 10-14 | 0.0 | 0.0000 | 98807 | 0 | 494036 | 6806863 | 68.89 |
| 15-19 | 0.5 | 0.0025 | 98807 | 247 | 493419 | 6312827 | 63.89 |
| 20-24 | 0.9 | 0.0045 | 98560 | 443 | 491696 | 5819408 | 59.04 |
| 25-29 | 0.4 | 0.0020 | 98118 | 196 | 490100 | 5327712 | 54.30 |
| 30-34 | 0.9 | 0.0045 | 97922 | 440 | 488510 | 4837613 | 49.40 |
| 35-39 | 0.4 | 0.0020 | 97482 | 195 | 486924 | 4349102 | 44.61 |
| 40-44 | 1.9 | 0.0095 | 97287 | 920 | 484138 | 3862178 | 39.70 |
| 45-49 | 2.4 | 0.0119 | 96368 | 1150 | 478964 | 3378041 | 35.05 |
| 50-54 | 3.3 | 0.0164 | 95218 | 1558 | 472195 | 2899076 | 30.45 |
| 55-59 | 4.6 | 0.0227 | 93660 | 2130 | 462975 | 2426882 | 25.91 |
| 60-64 | 10.2 | 0.0497 | 91530 | 4552 | 446271 | 1963907 | 21.46 |
| 65-69 | 19.8 | 0.0943 | 86978 | 8205 | 414379 | 1517636 | 17.45 |
| 70-74 | 16.1 | 0.0774 | 78773 | 6096 | 378628 | 1103257 | 14.01 |
| 75-79 | 55.4 | 0.2433 | 72678 | 17683 | 319181 | 724629 | 9.97 |
| 80-84 | 90.5 | 0.3690 | 54995 | 20294 | 224240 | 405448 | 7.37 |
| 85+ | 191.5 | 1.0000 | 34701 | 34701 | 181207 | 181207 | 5.22 |

Source: Authors' calculations

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# Education of Women and Reproductive and Child Health in Madhya Pradesh: District Level Analysis

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## Abstract

In this paper we explore how inter-district variation in women education explains inter-district variation in selected reproductive and child health indicators in Madhya Pradesh. We find that inter-district variation in women education explain only a small proportion of inter-district variation some of the reproductive and child health indicators. This means that reducing inter-district variation in women education may have only a limiting role in reducing inter-district variation in reproductive and child health situation in the state. Reduction in inter-district variation in women education may be more effective in reducing inter-district variation in reproductive and child health situation in the state when reduction in inter-district variation in women education is associated with reduction in inter-district variation in the availability of and access to core reproductive and child health services.

## Background

Many studies have shown the benefits that education of women has on the health of women and health of their children. These studies link women education with reduced child and maternal deaths, improved child health and nutrition, and lower fertility. Women with at least some formal education have been found to be more likely than uneducated women to practice family planning for regulating their fertility, either spacing or limiting births, and marry later. Educated women are also better informed on their nutritional and other health needs and nutrition and other health needs of their children. The total fertility rate in women with 10-12 years of schooling in India was 1.88 children per woman of reproductive age compared to the total fertility rate of 2.82 children per women of reproductive age in women with no education during 2019-2021 (Government of India, 2022). The total wanted fertility rate in India is found to be lower in women with at least 10 years of schooling compared to women with less than 10 years of schooling (Government of India, 2022). In Mali, women with secondary or higher education have been found to have an average of 3 children while those with no education have an average of 7 children (UNESCO, 2010a). In Uganda, women with additional schooling have been found to be more likely to have used contraception before first pregnancy and to delay marriage (Keats, 2018). Similarly, a study in Guatemala has found that for each additional year a young woman spent in school, the age at which she had her first child was delayed by approximately six to 10 months (Behrman et al, 2006). The median age at first marriage in women aged 25-49 years with at least 10 years of schooling in India is found to be more than 19 years compared to less than 19 years in women of this age group with less than 10 years of schooling (Government of India, 2022).

There is also evidence to suggest that improvement in the education of women is directly related to improved utilization of maternal health care services. In Burkina Faso, mothers with secondary education have been found to be twice as likely to give birth more safely in a health facility as compared to women with no education (UNESCO, 2010a). A study has estimated that an additional year of schooling for 1,000 women helps prevent two maternal deaths (Summars, 1992). Another study, in Uganda has, observed that to improve professional maternal health care utilisation, there is need to focus on education women beyond the primary level (Amwonya et al, 2022).

Increasing women education has positive effects on infant and child survival and health. Data from the National Family Health Survey, 2019-2021 suggest that the risk of death in the first five years of life in India is found to be less than 35 deaths for every 1000 live births in children whose mothers have at least 10 years of schooling compared to more than 40 deaths for every 1000 live births in children whose mothers have less than 10 years of schooling (Government of India, 2022). It is estimated that a child born to a mother who is able to read is 50 per cent more likely to survive past the age of 5 years as compared to a child born to an illiterate woman (UNESCO, 2010b). In Indonesia, child vaccination rates are 19 per cent when mothers have no education. This figure increases to 68 percent when mothers have at least secondary school education (UNESCO, 2010b). In Bangladesh and Indonesia, the odds of having a child who is shorter than average for its age is found to decrease by around 5 per cent for every additional year of formal education a mother has (Semba et al, 2008). In India, the prevalence of stunting in children below 5 years of age is found to decrease with the increase in number of years of schooling of the mother. These and many other studies suggest that there is a strong association between the variation in the educational status of women of reproductive age and the variation in the reproductive and child health status of the population. It can, therefore, be hypothesized that populations with high level of women education have comparatively better reproductive and child health status as compared to populations with low level of women education.

In this paper, we analyse the above hypothesis in Madhya Pradesh, India through the analysis of inter-district variation in women education and inter-district variation in reproductive and child health situation. We explore how inter-district variation in the educational status of women of reproductive age influences inter-district variation in selected indicators of reproductive and child health. We expect a direct relationship between the educational status of women of reproductive age in the district with the reproductive and child health status in the district as reflected through inter-district variation in a selected set of reproductive and child health indicators. If this relationship is true, then we argue that investing in the education of women of reproductive age must be an integral component of the efforts and interventions directed towards improving reproductive and child health status of the population of the state. Exploring the linkages between inter-district variation in women education and inter-district variation in reproductive and child health is particularly relevant to Madhya Pradesh as both level of women education and reproductive and child health situation vary widely across the districts of the state and reducing this inter-district variation can go a long way towards improving the reproductive and child health situation of the state.

The paper is based on the data available through the fifth and the latest round of the National Family Health Survey, 2019-2021 in Madhya Pradesh (Government of India, 2021). The National Family Health Survey is a nationally representative sample survey that provides estimates of selected indicators including indicators related to the educational status of women of reproductive and indicators related to reproductive and child health status for each of the 707 districts of the country as they existed at the time of the survey. These include 51 districts of Madhya Pradesh as they existed at the time of the survey. The number of districts in Madhya Pradesh has now increased to 55. Data related to the newly created districts are, however, not available. In each district, assessment of women education and reproductive and child health status is based on the information collected from a statistically representative sample of households.

We have measured the education status of women of reproductive age in a district in terms of the proportion of women of reproductive age (15-49 years) who had at least 10 years of schooling at the time of the survey. On the other hand, the following indicators have been used to reflect the reproductive and child health situation in the district:

1. Proportion of women aged 20-24 years who were married before reaching 18 years of age.
2. Proportion of institutional deliveries.
3. Proportion of births registered.
4. Proportion of 3rd and higher order births.
5. Prevalence of modern family planning methods.
6. Prevalence of female sterilization.
7. Proportion of children under 5 years of age stunted.
8. Proportion of children under 5years of age wasted.
9. Proportion of children under 5 years of age under-weight.
10. Proportion of women with low BMI.

## Inter-district Variation in Women Education and Reproductive and Child Health in Madhya Pradesh

The appendix table presents estimates of the 11 indicators used in the present analysis for the 51 districts of Madhya Pradesh as estimated from the data available through the National Family Health Survey, 2019-2021. Summary measures of the inter-district distribution of the 11 indicators are presented in table 1 which shows that all the 11 indicators vary across the districts of the state and the inter-district distribution of different indicators is different. There is no district in which all the 11 indicators are the lowest among the 51 districts. Similarly, there is no district in which all the 11 indicators are the highest among the 51 districts. The rank of all districts is different in different indicators. This shows that the inter-district variability in both women education and reproductive and child health is quite complex in the state.

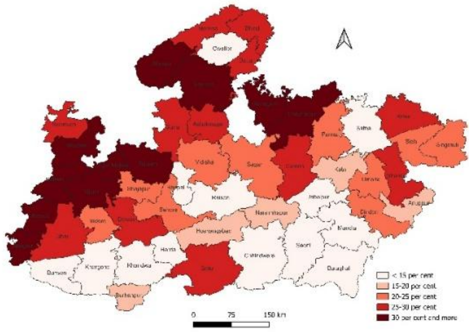
The educational status of women, as measured by the proportion of women with at least 10 years of schooling is found to be the lowest in district Sheopur where less than 16 per cent of the proportion of women were having at least 10 years of schooling at the time of the survey whereas this proportion is the highest in district Indore in which close to 50 per cent of the women were having at least 10 years of schooling at the time of the survey. In addition to district Indore, there are only two districts – Bhopal and Chhindwara – in which more than 40 per cent women were having at least 10 years of schooling at the time of the National Family Health Survey, 2019-2021. By contrast, there are 8 districts in the state in which the proportion of women with at least 10 years of schooling was less than 20 per cent in 2019-2021. In 17 districts of the state, however, this proportion was at least 30 per cent. The median proportion of women with at least 10 years of schooling across the 51 districts of the state is 27.7 per cent with and inter-quartile range of more than 7.

The proportion of women aged 20-24 years who reported that they had got married before reaching 18 years of age ranges between just around 4.4 per cent in district Balaghat to around 46 per cent in district Rajgarh of the state. The median proportion of women aged 20-24 years who reported to have got married before reaching 18 years of age across the 51 districts is found to be 23 per cent with an inter-quartile range of 13.6. In India, the legal minimum age at marriage of females is 18 years. This shows that marriage of females earlier than the legal minimum age at marriage of females is quite common in the state.

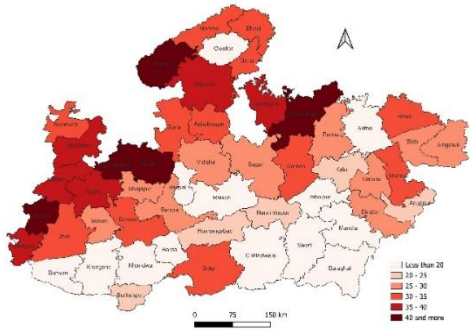
The proportion of women who reported that they had at least four ante-natal care visits at the time of their last pregnancy is found to vary from just around 30 per cent in district Panna to more than 76 per cent in district Dhar of the state. The median proportion of women who reported at the time of the survey that they had at least four ante-natal care visits during their last pregnancy is around 60 per cent with an inter-quartile range of almost 12. There are 10 districts in the state in which less than 50 per cent women reported that they had at least four ante-natal care visits during their last pregnancy.

The proportion of women who reported that their last delivery was an institutional delivery is found to vary from almost 100 per cent in district Mandsaur to less than 70 per cent in district Singrauli of the state at the time of the National Family Health Survey, 2019-2021. The median proportion of women who reported that their last delivery was an institutional delivery across the 51 districts is almost 92 per cent with an inter-quartile range of 8.6 while the range is almost 30. The narrow inter-quartile range indicates that in almost half of the districts of the state, the proportion of women who reported that their last delivery was an institutional delivery varied within a narrow range of 86-95 per cent but in the remaining half of the districts, this proportion varied widely.

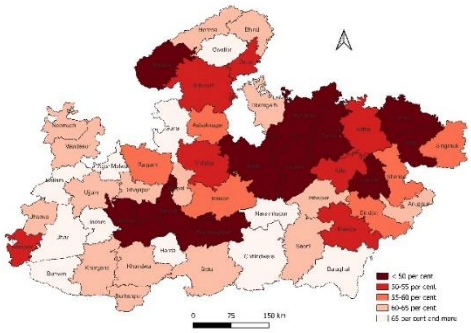
The proportion of women who reported that their last birth was registered with the competent authorities is found to vary from around 86 per cent in district Sheopur to 100 per cent in district Jabalpur. District Jabalpur is the only district in the state where all births reported at the time of the National Family Health Survey were found to be registered. The median proportion of births registered is almost 95 per cent and the inter-quartile range is less than 5 which means that in half of the districts of the state, the proportion of births registered varied within a narrow range of 92-97 per cent.



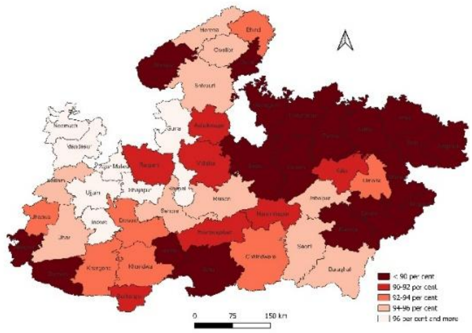

Proportion of women with at least 10 years schooling



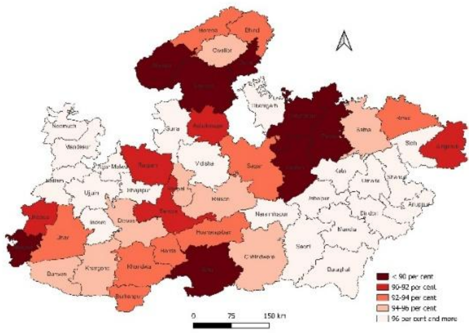

Proportion of women aged 20-24 years married before 18 years of age



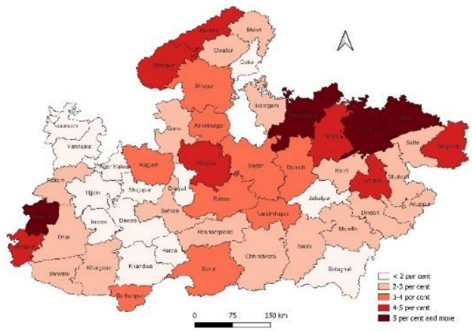

Proportion of women received at least 4 ANC during their last pregnancy



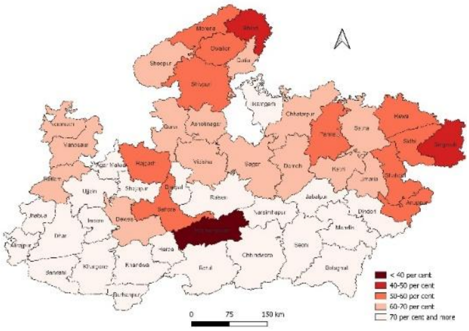

Proportion of women whose last delivery was an institutional delivery



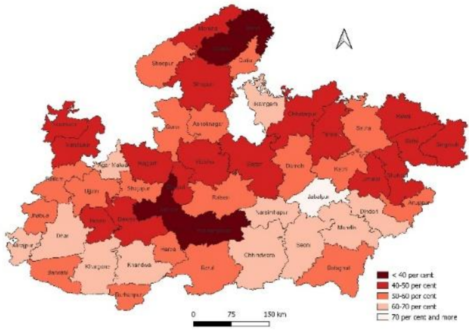

Proportion of women whose birth was registered



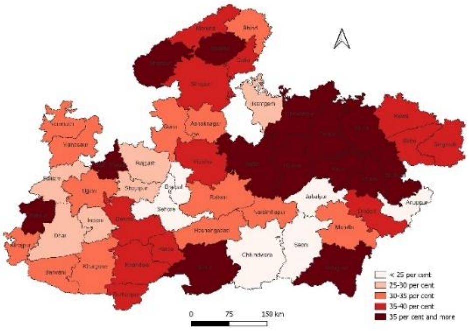

Proportion of women whose most recent birth was 3rd or hgher order birth



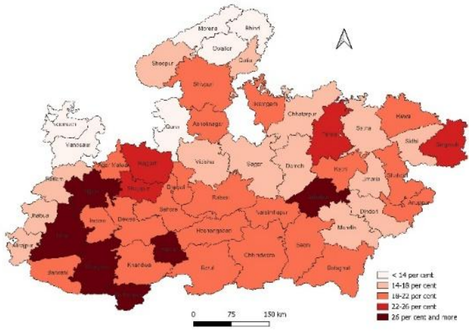
Proportion of women using a modern family planning method



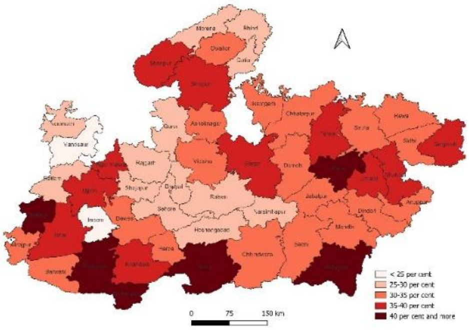
Proportion of women who were sterilised at the time of the survey



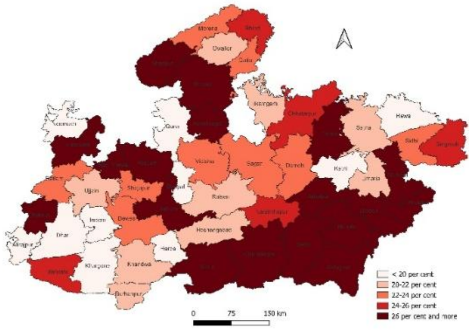
Proporiton of children below 5 years of age who were low height-for-age



Proportion of children below 5 years of age who were low weight for height



Proportion of children below 5 years of age who were low weight-for-age



Proportion of women with body mass index less than 18.5

Figure 1: Inter-district variation in women education and selected indicators of reproductive and child health in Madhya Pradesh, 2019-2021.
Source: Author, based on data from National Family Health Survey, 2019-2021.

Table 1: Summary measures of inter-district distribution of 11 indicators of women education and reproductive and child health in Madhya Pradesh, 2019-2021.

| Indicators | Summary measures of distribution | | | | | | |
|---|---|---|---|---|---|---|---|
| | Lowest | Q1 | Median | Q2 | Highest | IQR | Skewness |
| Women with at least 10 years of schooling (%) | 15.9 | 23.8 | 27.7 | 31.1 | 47.7 | 7.3 | 0.703 |
| Women aged 20-24 years married before 18 years of age (%) | 4.4 | 15.9 | 23.0 | 29.5 | 46.0 | 13.6 | 0.071 |
| Women received at least 4 ANC during their last pregnancy | 30.9 | 52.8 | 60.4 | 64.7 | 76.5 | 11.9 | -0.672 |
| Women whose last birth was institutional birth (%) | 69.9 | 86.3 | 91.8 | 94.8 | 99.4 | 8.6 | -1.056 |
| Women whose last birth is registered (%) | 86.2 | 92.0 | 94.7 | 96.9 | 100.0 | 4.9 | -0.651 |
| Women whose last birth was third or higher order birth (%) | 0.0 | 2.1 | 2.7 | 3.7 | 7.1 | 1.7 | 0.462 |
| Women using a modern family planning method (%) | 28.0 | 60.2 | 68.2 | 72.4 | 79.6 | 12.2 | -1.417 |
| Women who are sterilised | 20.0 | 47.1 | 52.2 | 59.5 | 74.1 | 12.5 | -0.635 |
| Children below 5 years of age low height for age (%) | 18.0 | 30.6 | 36.5 | 40.2 | 49.5 | 9.6 | -0.153 |
| Children below 5 years of age low weight for age (%) | 10.1 | 16.2 | 18.9 | 21.2 | 29.8 | 5.0 | 0.386 |
| Children below 5 years of age low weight for age | 22.9 | 29.3 | 32.8 | 36.0 | 47.2 | 6.7 | 0.585 |
| Women having body mass index (BMI) less than 18.5 (%) | 15.6 | 21.0 | 23.1 | 26.8 | 30.5 | 5.8 | -0.196 |

Source: Author

District Jabalpur is also the only district in the state where the proportion of 3$^{rd}$ and higher order births among the total number of births reported at the time of the National Family Health Survey, 2019-2021 was found to be zero. On the other hand, this proportion is found to be the highest in district Jhabua. The median proportion of 3$^{rd}$ and higher order births is 2.7 per cent with an inter-quartile range of 1.7. The proportion of third and higher order births in a district is directly related to the fertility in the district – the higher this proportion the higher the total fertility rate and vice versa.

The inter-district variation in the proportion of women using a modern family planning method varies widely across the districts of the state. In district Hoshangabad, only around 28 per cent women reported to be using a modern family planning method at the time of the survey whereas this proportion was almost 80 per cent in district Indore which means a range of 52. The median proportion of women using a modern family planning method is around 68 per cent with an inter-quartile range of more than 12. Hoshangabad is the only district in the state where less than 30 per cent of women reported to be using a modern family planning method at the time of the National Family Health Survey, 2019-2021.

The variation in the proportion of women sterilized at the time of the survey is found to be even wider that the variation in the proportion of women using a modern family planning method. In district Jabalpur, more than 74 per cent of women were reported to be sterilized at the time of the survey whereas this proportion was only 20 per cent in district Hoshangabad. The median proportion of women sterilized is 52 per cent and the inter-quartile range is more than 12 which confirms wide variation in the proportion of women sterilized across the districts of the state.

The proportion of women having low body mass index (BMI less than 18.5) is found to vary from the lowest in district Indore to the highest in district Sheopur. In district Indore, only around 15 per cent women were having low BMI at the time of the National Family Health Survey, 2019-2021 whereas this proportion was more than 30 per cent in district Sheopur. The median proportion of women having low BMI across the districts is almost 23 per cent with an inter-quartile range of less than 6. There are 10 districts in the state where this proportion was less than 20 per cent according to the National Family Health Survey, 2019-2021.

Table 1 also shows marked inter-district variation in the three indicators of child under nutrition – prevalence of stunting, prevalence of wasting and prevalence of underweight in children below 5 years of age. The proportion of children below five years of age who were low height-for-age (stunted) at the time of the National Family Health Survey, 2019-2021 varies from less than 23 per cent in district Mandsaur to almost 50 per cent in districts Jhabua and Katni. The median proportion of children below 5 years of age who were stunted at the time of the survey is 36.5 per cent while the inter-quartile range is almost 10. On the other hand, the proportion of children aged less than 5 years who were low weight-for-age (wasted) at the time of the survey ranged from just around 10 per cent in district Morena to almost 30 per cent in districts Ujjain and Dhar. There are seven districts in the state in which at least one fourth of the children below five years of age were found to be wasted at the time of the survey whereas district Morena is the only district where just around 10 per cent of the children aged below 5 years of age were wasted at the time of the survey. The median of the inter-district distribution of the proportion of children below five years of age who were wasted at the time of the survey is almost 19 per cent with an inter-quartile range of almost 5. Finaly, the proportion of children less than 5 years of age who were low weight-for-age (underweight) at the time of the survey ranged from almost 23 per cent in district Mandsaur to more than 47 per cent in district Burhanpur. There are six districts in the state – Balaghat, Barwani, Burhanpur, Jhabua, Katni and Khargone - in which the proportion of children below five years of age who were underweight at the time of the survey was more than 40 per cent whereas, in 15 districts this proportion was less than 30 per cent. Districts Barwani, Burhanpur, Jhabua and Khargone constitute a geographical continuity and are located in the south-west corner of the state. The median of the distribution of the proportion of children below five years of age who were underweight at the time of the National Family Health Survey 2019-2021 is estimated to be almost 33 per cent with an inter-quartile range of almost 7. This means that the proportion of children below five years of age who were underweight at the time of the survey ranged in a narrow range of 30-36 per cent but this proportion varied widely in the remaining 50 per cent districts of the state.

## Inter-district Inequality in Women Education and Reproductive and Child Health

The inter-district variation in the indicators of women education and reproductive and child health may be summarized in terms of the coefficient of variation across districts which is defined as the ratio of the standard deviation to the arithmetic mean. The problem with the use of the coefficient of variation as a summary measure of the inter-district variation across districts or the index of inter-district inequality is that it is difficult to interpret the coefficient of variation when the inter-district distribution is not statistically normally distributed. The statistical normality of the distribution means that the sum of the deviation from the arithmetic mean must be equal to 0. When the inter-district distribution of an indicator is skewed, the use of the coefficient of variation as the summary index of inter-district variation or the index of inter-district inequality in the indicator is flawed.

In view of the limitations of the coefficient of variation as the summary index of variation across districts or the index of inter-district inequality when the inter-district distribution is not statistically normal but skewed, we have measured the index of inter-district inequality in terms of the index of inter-district variation which is defined as the positive square root the mean square deviation from the median of the distribution. In $m$ denotes the median of the distribution, then the index of variation is defined as

$$IV = \sqrt{\frac{\sum_{i=1}^{n}\left(1-\frac{x_i}{m}\right)^2}{n}}$$

where $n$ is the number of districts. It may be noticed that when the inter-district variation is distributed statistically normally, median is the same as the arithmetic mean and, therefore, the index of variation is the same as the coefficient of variation. The index of inter-district inequality for an indicator is zero when the value of the indicator is the same for all districts or when there is no variation in the indicator across the districts, and the higher the value of the index the higher the inequality across districts. Like the coefficient of variation, the index of variation is also dimensionless quantity and, therefore, it can be used for comparison across different variables of different dimensions.

The index of inter-district inequality in the proportion of women having at least 10 years of schooling in Madhya Pradesh is found to be 0.257 which is quite substantial, and which confirms that there is a substantial degree of disparity or the inequality in the educational status of women across the districts of the state. This inter-district inequality in women education may be a factor in the inter-district inequality in reproductive and child health in the state because of the association of reproductive and child health with women education.

Summary measures of the inter-district distribution of the selected reproductive and child health indicators in Madhya Pradesh are given in table 1, along with the index of inter-district inequality in different indicators. The inter-district inequality in the proportion of 3$^{rd}$ and higher order births is found to be the highest among the 11 indicators of reproductive and child health. The inter-district inequality has also been found to be very high in the proportion of women aged 20-24 years who were married before reaching 18 years of age - the legal minimum age at marriage for females in India. On the other hand, inter-district inequality is found to be the lowest in the proportion of births registered followed by the proportion of institutional births. Out of the 11 reproductive and child health indicators, the inter-districts inequality in 8 indicators is lower than that in the proportion of women having at least 10 years of schooling.

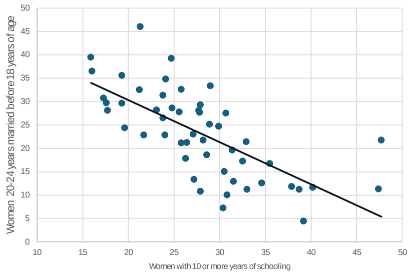
## Relationship between Women Education and Reproductive and Child Health

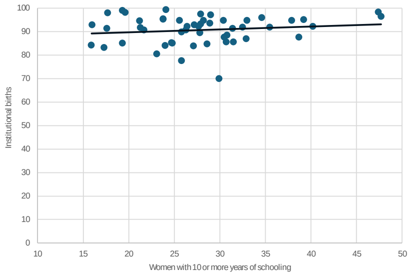
The bivariate relationship between inter-district variation in the proportion of women with at least 10 years of schooling and inter-district variation in 10 indicators of reproductive and child health is depicted in figure 2. The figure suggests that the relationship of the inter-district variation in the proportion of women with at least 10 years of schooling with inter-district variation in different indicators of reproductive and child health is different. The inter-district variation in some indicators does not appear to be associated with inter-district variation in the proportion of women with at least 10 years of schooling. Figure 2 implies that reducing inter-district variation in women education may not lead to reduction in inter-district variation in some reproductive and child health indicators.

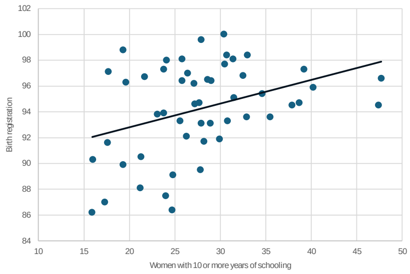
To further examine the relationship between the inter-district variation in women education and inter-district variation in selected reproductive and child health indicators in the state, we have applied the general linear model with the set of 10 reproductive and child health indicators as dependent variables and a set of independent variables including the proportion of women having at least 10 years of schooling. The general linear model is a compact way of simultaneously writing several multiple linear regression models. Different multiple linear regression models may be compactly written as (Mardia et al, 1979)

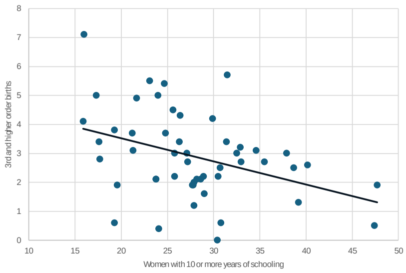
$$Y = XB + U$$

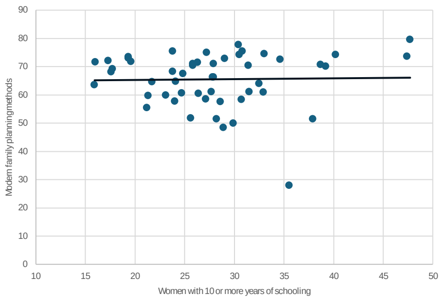
where Y is a matrix with series of multivariate measurements specific to different dependent variables. Each column of the matrix Y is a set of measurements on one of the dependent variables. Similarly, X is a matrix of measurements specific to different independent variables. Each column of X is a set of observations on one of the independent variables while B is a matrix containing parameters that are to be estimated and U is a matrix containing errors. It is assumed that errors are uncorrelated across measurements, and follow a multivariate normal distribution. The general linear model is a generalization of multiple linear regression to the case when there is more than one dependent variable. Hypothesis testing with the general linear model can be made in terms of the multivariate test or in terms of several independent univariate tests. In the multivariate test, the columns of Y or the dependent variables are tested for their association with the set of independent variables simultaneously. In case of univariate tests, each column of Y or each dependent variable is tested independently for its association with the set of the independent variables. When Y is a single column matrix, the general linear model reduces to the multiple linear regression model. When both Y and X are single column matrices, general linear model reduces to simple linear regression.

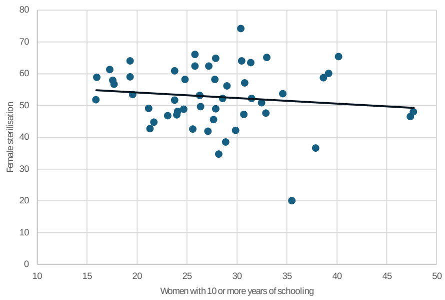

Women 20-24 years married before 18 years of age
Women with 10 or more years of schooling

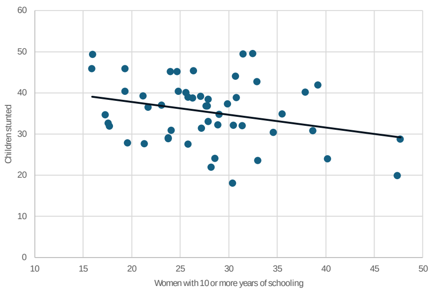

Institutional births
Women with 10 or more years of schooling

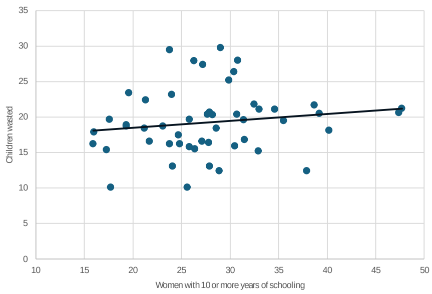

Birth registration
Women with 10 or more years of schooling


3rd and higher order births
Women with 10 or more years of schooling


Modern family planning methods
Women with 10 or more years of schooling


Female sterilisation
Women with 10 or more years of schooling


Children stunted
Women with 10 or more years of schooling


Children wasted
Women with 10 or more years of schooling

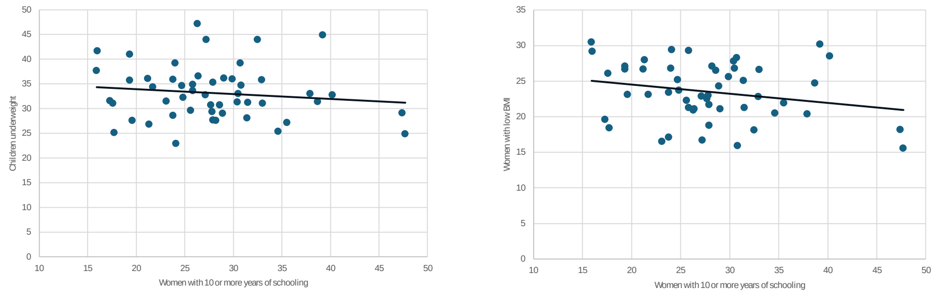



Figure 2: Inter-district variation in the proportion of women with at least 10 years of education and inter-district variation in selected indicators of reproductive and child health in Madhya Pradesh, 2019-2021.
Source: Author

In the present case, Y is a matrix comprising of 51 rows (districts) and 10 columns representing inter-district variation in 10 reproductive and child health indicators while X is a matrix comprising of 51 rows (districts) and 4 columns of independent variables - proportion of women having at least 10 years of schooling, proportion of urban households, reflecting the degree of urbanization in the district, proportion of Muslim households, reflecting the religious composition of the population of the district, and proportion of Scheduled Tribes households, reflecting the social class composition of the population in the district – representing inter-district variation in four independent variables. The last three independent variables are included in the model as control variables. It is assumed that different reproductive and child health indicators in a district may be influenced by the degree of urbanization in the district, and the religious and social class composition of the population of the district.

Results of the application of the general linear model are presented in tables 2 for the multivariate test and in table 3 for univariate tests. The multivariate test confirms that inter-district variation in the set of 10 reproductive and child health indicators in the state are statistically significantly associated with the inter-district variation in the four independent variables which means that inter-district variation in reproductive child health is associated with the inter-district variation not only in women education but also in the inter-district variation in degree or the extent of urbanization, the religious composition of the population and social class composition of the population in the district . Among the four independent variables, the most dominant effect is of the proportion of women with at least 10 years of schooling as may be seen from the value of the F statistic while the effect of the proportion of Scheduled Tribes households in the district is relatively the lowest. The multivariate test thus confirms that the inter-district variation in the reproductive and child health situation in the state, as reflected through the set of 10 reproductive and child health indicators is statistically significantly associated with the inter-district variation in the proportion of women with at least 10 years of schooling, inter-district variation in the degree or the level of urbanization in the district, the religious composition of district population and the distribution of the population of the district by social class. composition of the population of the district. Table 2 also suggests that inter-district variation in the level of urbanization, measured in terms of the proportion of urban households, religious composition of the population measured in terms of the proportion of Muslim population and social class distribution of the population. The inter-district variation in women education appears to be an important predictor of inter-district variation in the 10 indicators of reproductive and child health in the state.

The multivariate test does not reveal how inter-district variation in women education is associated with inter-district variation in individual reproductive and child health indicators. The bivariate analysis suggests that this relationship is different for different reproductive and child health indicators. This relationship can be explored through the independent univariate test with each of the 10 reproductive and child health indicators as the dependent variable. The independent univariate test of the general linear model shows how inter-district variation in the proportion of women with at least 10 years of schooling is associated with inter-district variation in each of the 10 reproductive and child health indicators. The independent univariate tests provide statistical support to the bivariate relationship depicted in figure 2.

Table 2: Results of the general linear model – multivariate tests between reproductive and child health indicators and four independent variables.

| Independent variables | | Value | F | Hypothesis df | Error df | 'p' |
|---|---|---|---|---|---|---|
| Proportion of women with at least 10 years of schooling | Pillai's Trace | 0.763 | 11.889 | 10 | 37 | .000 |
| | Wilks' Lambda | 0.237 | 11.889 | 10 | 37 | .000 |
| | Hotelling's Trace | 3.213 | 11.889 | 10 | 37 | .000 |
| | Roy's Largest Root | 3.213 | 11.889 | 10 | 37 | .000 |
| Proportion of urban households | Pillai's Trace | 0.556 | 4.634 | 10 | 37 | .000 |
| | Wilks' Lambda | 0.444 | 4.634 | 10 | 37 | .000 |
| | Hotelling's Trace | 1.252 | 4.634 | 10 | 37 | .000 |
| | Roy's Largest Root | 1.252 | 4.634 | 10 | 37 | .000 |
| Proportion of Muslim households | Pillai's Trace | 0.586 | 5.244 | 10 | 37 | .000 |
| | Wilks' Lambda | 0.414 | 5.244 | 10 | 37 | .000 |
| | Hotelling's Trace | 1.417 | 5.244 | 10 | 37 | .000 |
| | Roy's Largest Root | 1.417 | 5.244 | 10 | 37 | .000 |
| Proportion of Scheduled Tribes households | Pillai's Trace | 0.395 | 2.414 | 10 | 37 | .025 |
| | Wilks' Lambda | 0.605 | 2.414 | 10 | 37 | .025 |
| | Hotelling's Trace | 0.652 | 2.414 | 10 | 37 | .025 |
| | Roy's Largest Root | 0.652 | 2.414 | 10 | 37 | .025 |
| Intercept | Pillai's Trace | 0.989 | 336.598 | 10 | 37 | .000 |
| | Wilks' Lambda | 0.011 | 336.598 | 10 | 37 | .000 |
| | Hotelling's Trace | 90.972 | 336.598 | 10 | 37 | .000 |
| | Roy's Largest Root | 90.972 | 336.598 | 10 | 37 | .000 |

Source: Author

Results of the independent univariate tests are presented in table 3. Inter-district variation in the proportion of women with at least 10 years of education is found to be statistically significantly associated with inter-district variation in the proportion of women aged 20-24 years who had got married before reaching 18 years of age, the legal minimum age at marriage of females in India; registration of births; 3rd and higher order births; and proportion of children below five years of age who are stunted (low height-for-age) and the regression coefficients are in the expected direction. For example, the regression coefficient of the proportion of women aged 20-24 years who had got married before reaching 18 years of age on the proportion of women with at least 10 years of schooling is negative and statistically significant which means that the higher the proportion of women with at least 10 years of education in a district the lower the proportion of women aged 20-24 years who had got married before reaching 18 years of age in that district and vice versa. This means that women education has a strong impact on female age at marriage – the higher the level of women education the lower the proportion of women who are married at an age younger the legal minimum age at marriage and vice versa. The same is the case with the proportion of 3rd and higher order births and the proportion of children below five years of age who are stunted (low height-for-age) – the higher the proportion of women with at least 10 years of schooling in a district the lower the proportion of 3rd and higher order births and the proportion of children below five years of age who are stunted in that district and vice versa. The regression coefficient of the proportion of births registered on the proportion of women with at least 10 years of schooling is also positive which means that improving women education in the state may contribute significantly towards the realization of the goal of universal birth registration. However, the regression coefficient of the proportion of children below five years of age who are wasted (low weight-for-height) on the proportion of women with at least 10 years of schooling is found to be statistically significantly positive which means the higher the proportion of women with at least 10 years of education in a district the higher the proportion of children below five years of age who are wasted in the district and vice versa. The role of inter-district variation in women education in deciding inter-district variation in one dimension of child nutrition (stunting) and inter-district variation in other dimension of child nutrition (wasting) in the state is in opposite direction which makes the association of inter-district variation in women education with inter-district variation in child nutrition quite complicated and which needs to be explored further.

Table 3 also shows that the inter-district variation in the proportion of women with at least 10 years of schooling has not been found to be statistically significantly associated with inter-district variation in the proportion of institutional births, prevalence of modern methods of family planning, prevalence of female sterilization, proportion of children below 5 years age who are underweight (low weight-for-age) and proportion of women with poor nutritional status (BMI<18.5). It appears that there are factors other than women education which are more dominant as regards inter-district variation in these indicators of reproductive and child health in the state.

Table 3 suggests that the association of inter-district variation in women education with inter-district variation in different components of reproductive and child health is not the same and inter-district variation in indicators related to some components of reproductive and child health does not appear to be associated with inter-district variation in the proportion of women aged 15-49 years with at least 10 years of schooling. This means that reducing inter-district variation in women education may contribute only marginally to reducing inter-district variation in these components of reproductive and child health in the state.

Table 3: Results of general linear model. Independent univariate tests of indicators of reproductive and child health on the proportion of women with at least 10 years of schooling.

| Dependent Variable | Independent variable | B | Std. Error | t | 'p' | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Proportion of women aged 20-24 years married before 18 years of age | Proportion of women with at least 10 years of schooling | -1.297 | 0.148 | -8.775 | 0.000 | -1.594 | -0.999 |
| | Proportion of urban households | 0.318 | 0.084 | 3.763 | 0.000 | 0.148 | 0.488 |
| | Proportion of Muslim households | -0.478 | 0.190 | -2.520 | 0.015 | -0.859 | -0.096 |
| | Proportion of Scheduled Tribes households | -0.052 | 0.044 | -1.182 | 0.243 | -0.141 | 0.037 |
| | Intercept | 55.293 | 3.785 | 14.607 | 0.000 | 47.674 | 62.912 |
| Proportion of institutional births | Proportion of women with at least 10 years of schooling | -0.011 | 0.141 | -0.081 | 0.936 | -0.295 | 0.272 |
| | Proportion of urban households | 0.067 | 0.080 | 0.835 | 0.408 | -0.095 | 0.229 |
| | Proportion of Muslim households | 0.203 | 0.181 | 1.122 | 0.268 | -0.161 | 0.566 |
| | Proportion of Scheduled Tribes households | -0.075 | 0.042 | -1.771 | 0.083 | -0.159 | 0.010 |
| | Intercept | 90.188 | 3.607 | 25.000 | 0.000 | 82.927 | 97.450 |
| Proportion of births registered | Proportion of women with at least 10 years of schooling | 0.294 | 0.085 | 3.472 | 0.001 | 0.124 | 0.464 |
| | Proportion of urban households | -0.099 | 0.048 | -2.052 | 0.046 | -0.197 | -0.002 |
| | Proportion of Muslim households | 0.108 | 0.109 | 0.999 | 0.323 | -0.110 | 0.327 |
| | Proportion of Scheduled Tribes households | -0.013 | 0.025 | -0.510 | 0.612 | -0.064 | 0.038 |
| | Intercept | 88.224 | 2.168 | 40.691 | 0.000 | 83.860 | 92.588 |
| Proportion of third and higher order births | Intercept | 4.974 | 0.882 | 5.642 | 0.000 | 3.199 | 6.749 |
| | Proportion of women with at least 10 years of schooling | -0.103 | 0.034 | -2.992 | 0.004 | -0.172 | -0.034 |
| | Proportion of urban households | 0.029 | 0.020 | 1.467 | 0.149 | -0.011 | 0.068 |

| Dependent Variable | Independent variable | B | Std. Error | t | 'p' | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| | Proportion of Muslim households | -0.062 | 0.044 | -1.416 | 0.164 | -0.151 | 0.026 |
| | Proportion of Scheduled Tribes households | 0.017 | 0.010 | 1.657 | 0.104 | -0.004 | 0.038 |
| Prevalence of modern family planning methods | Proportion of women with at least 10 years of schooling | 0.144 | 0.232 | 0.619 | 0.539 | -0.324 | 0.611 |
| | Proportion of urban households | -0.054 | 0.133 | -0.403 | 0.689 | -0.321 | 0.214 |
| | Proportion of Muslim households | 0.593 | 0.298 | 1.989 | 0.053 | -0.007 | 1.193 |
| | Proportion of Scheduled Tribes households | 0.152 | 0.069 | 2.184 | 0.034 | 0.012 | 0.291 |
| | Intercept | 56.274 | 5.952 | 9.454 | 0.000 | 44.293 | 68.256 |
| Prevalence of female sterilisation | Proportion of women with at least 10 years of schooling | 0.190 | 0.230 | 0.829 | 0.412 | -0.272 | 0.652 |
| | Proportion of urban households | -0.252 | 0.131 | -1.921 | 0.061 | -0.516 | 0.012 |
| | Proportion of Muslim households | 0.219 | 0.294 | 0.744 | 0.461 | -0.374 | 0.812 |
| | Proportion of Scheduled Tribes households | 0.125 | 0.069 | 1.822 | 0.075 | -0.013 | 0.263 |
| | Intercept | 49.453 | 5.881 | 8.410 | 0.000 | 37.616 | 61.290 |
| Proportion of children below 5 years of age stunted | Proportion of women with at least 10 years of schooling | -0.412 | 0.192 | -2.145 | 0.037 | -0.799 | -0.025 |
| | Proportion of urban households | 0.115 | 0.110 | 1.044 | 0.302 | -0.107 | 0.336 |
| | Proportion of Muslim households | -0.340 | 0.247 | -1.378 | 0.175 | -0.836 | 0.157 |
| | Proportion of Scheduled Tribes households | 0.043 | 0.057 | 0.749 | 0.458 | -0.073 | 0.159 |
| | Intercept | 44.743 | 4.925 | 9.086 | 0.000 | 34.830 | 54.656 |
| Proportion of children below 5 years of age wasted | Proportion of women with at least 10 years of schooling | 0.245 | 0.109 | 2.238 | 0.030 | 0.025 | 0.465 |
| | Proportion of urban households | -0.124 | 0.063 | -1.982 | 0.053 | -0.250 | 0.002 |

| Dependent Variable | Independent variable | B | Std. Error | t | 'p' | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| | Proportion of Muslim households | 0.406 | 0.140 | 2.895 | 0.006 | 0.124 | 0.689 |
| | Proportion of Scheduled Tribes households | 0.028 | 0.033 | 0.860 | 0.394 | -0.038 | 0.094 |
| | Intercept | 12.768 | 2.803 | 4.555 | 0.000 | 7.125 | 18.411 |
| Proportion of children under 5 years of age under weight | Proportion of women with at least 10 years of schooling | 0.051 | 0.125 | 0.408 | 0.685 | -0.201 | 0.303 |
| | Proportion of urban households | -0.096 | 0.071 | -1.340 | 0.187 | -0.240 | 0.048 |
| | Proportion of Muslim households | 0.397 | 0.160 | 2.473 | 0.017 | 0.074 | 0.720 |
| | Proportion of Scheduled Tribes households | 0.096 | 0.037 | 2.574 | 0.013 | 0.021 | 0.171 |
| | Intercept | 29.851 | 3.203 | 9.319 | 0.000 | 23.403 | 36.300 |
| Proportion of women with low BMI | Proportion of women with at least 10 years of schooling | 0.030 | 0.095 | 0.316 | 0.753 | -0.161 | 0.221 |
| | Proportion of urban households | -0.128 | 0.054 | -2.364 | 0.022 | -0.237 | -0.019 |
| | Proportion of Muslim households | -0.070 | 0.122 | -0.574 | 0.568 | -0.315 | 0.175 |
| | Proportion of Scheduled Tribes households | -0.006 | 0.028 | -0.217 | 0.829 | -0.063 | 0.051 |
| | Intercept | 26.228 | 2.431 | 10.790 | 0.000 | 21.335 | 31.120 |

Source: Author

The inter-district variation in women education has not been found to be statistically significantly associated with inter-district variation in institutional births in the state. One possible reason is that inter-district variation in the proportional of institutional births is small and in majority of the districts, the proportion of institutional births to total births is more than 90 per cent irrespective of the proportion of women having at least 10 years of schooling. This may be due to monetary incentives provided to women for institutional deliveries to reduce maternal mortality and promote reproductive health (Government of India, *no date*). On the other hand, no statistically significant association between inter-district variation in women education and prevalence of modern family planning methods and female sterilization, appears to be due to highly skewed family planning method mix in favour of permanent methods of family planning, particularly female sterilization. The highly skewed family planning method mix in the state suggests that family planning practices in the state are oriented towards birth limitation rather than birth spacing. The data available from the National Family Health Survey, 2019-2021 suggest that the prevalence of permanent methods of family planning, particularly female sterilization decreases with the increase in the education of women and female sterilization constitutes almost 80 per cent of the total modern family planning methods use in the state (Government of India, 2021). The prevalence of modern methods of family planning in the state has also been found to decrease with the increase in the number of years of schooling of women because the prevalence of female sterilization decreases with the increase in women years of schooling. The prevalence of modern methods family planning in the state is found to be the highest in women with no schooling (76 per cent) but the lowest in women with at least 12 years of schooling (53.7 per cent) because the prevalence of female sterilization is the highest in women with no schooling (70.7 per cent) but the lowest in women with at least 12 years of schooling (23.5 per cent) according to the National Family Health Survey, 2019-2021 (Government of India, 2021). The biasedness in the use of family planning methods towards permanent or terminal methods of family planning, especially female sterilization appears to be the reason behind no association between inter-district variation in women education and Inter-district variation in family planning use in the state. Female sterilization as a method of family planning in the state is found to be the choice of women with either no schooling or up to at the most 8 years of schooling.

The inter-district variation in women education in the state has also not been found to be statistically significantly associated with inter-district variation in child underweight and in women with low nutritional status or women having body mass index (BMI) less than 18.5 $Kg/M^2$. The no association between inter-district variation in women education and inter-district variation in child underweight appears to be conflicting association of inter-district variation in women education with inter-district variation in child stunting and inter-district variation in child wasting as the prevalence of child underweight is the combination of the prevalence of child stunting and the prevalence of child wasting. Similarly, inter-district variation in women education has not been found to be associated with inter-district variation in women with low BMI. It appears that the association of inter-district variation in women education with inter-district variation in the nutritional status of children and women is quite complex that needs further investigation.

## Discussions and Conclusions

The inter-district variation in reproductive and child health status in Madhya Pradesh is quite marked because of the marked social, economic and cultural diversity of the districts of the state. There are districts where almost the entire population lives in the urban areas. At the same time, there are districts where the entire population is Scheduled Tribes. In such a marked social, economic and cultural diversity, reduction in inter-district variation in women education is advocated as a strategy to reduce inter-district variation in reproductive and child health situation as education empowers women to take decisions and actions which are directed towards improving their own health and health of their children. This argument hypotheises that a reduction in inter-district variation in women education may contribute to reduction in inter-district variation in reductive and child situation within the state. The present analysis, however, suggests that reduction in inter-district variation in women education may not contribute significantly to reducing inter-district variation in some components of reproductive and child health. The analysis suggests that reducing inter-district variation in women education may have only a limiting role in reducing inter-district variation in reproductive and child health situation in the state. Inter-district variation in reproductive and child health status in the state may also be due to the inter-district variation in the availability and access to core reproductive and child health services. Data pertaining to inter-district variation in the availability and access to critical reproductive and child health services in Madhya Pradesh is, however, not available to analyse how controlling the inter-district variation in the availability and access to core reproductive and child health services influences the association of the Inter-district variation in women education with inter-district variation in different components of reproductive and child health. The inter-district variation in the availability and access to core reproductive and child health services can have a strong influence on inter-district variation in some of the components of reproductive and child health and may even camouflage the association with inter-district variation in women education.

From the policy and programme perspective, reducing inter-district variation in reproductive and child health situation is an operationally feasible yet effective strategy to improve reproductive and child health situation in the state. The present analysis, however, suggests that reduction in inter-district variation in women education can have only a limited impact in reducing inter-district variation in reproductive and child health situation in the state. Reduction in inter-district variation in women education in the state may be more effective in reducing inter-district variation in reproductive and child health situation when efforts are also made to reduce inter-district variation in the availability of and access to core reproductive and child health services.

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Appendix Table: Inter-district variation in indicators of women education and reproductive and child health in Madhya Pradesh, 2019-2021.

| District | Women (15-49 years) | | | | | | | | Children below 5 years of age | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | With 10 or more years of schooling | Aged 20-24 years married before 18 years of age | Who had last delivery in an institution | Whose last birth registered | Whose last birth was 3rd and higher order birth | Using a modern family planning method | Who are sterilised | With low BMI | Stunted | Wasted | Underweight |
| Agar Malwa | 19.3 | 35.6 | 98.9 | 98.8 | 0.6 | 73.0 | 64.0 | 26.7 | 40.3 | 18.7 | 35.7 |
| Alirajpur | 17.3 | 30.7 | 83.2 | 87.0 | 5.0 | 72.2 | 61.2 | 19.6 | 34.6 | 15.4 | 31.6 |
| Anuppur | 28.6 | 18.6 | 84.8 | 96.5 | 2.1 | 57.6 | 52.2 | 26.5 | 24.0 | 18.4 | 30.7 |
| Ashoknagar | 17.6 | 29.7 | 91.3 | 91.6 | 3.4 | 68.2 | 57.8 | 26.1 | 32.6 | 19.7 | 31.1 |
| Balaghat | 39.2 | 4.4 | 95.1 | 97.3 | 1.3 | 70.1 | 60.0 | 30.2 | 41.9 | 20.5 | 44.9 |
| Barwani | 19.3 | 29.6 | 85.1 | 89.9 | 3.8 | 73.5 | 59.0 | 27.1 | 45.8 | 18.9 | 41.0 |
| Betul | 38.7 | 11.2 | 87.6 | 94.7 | 2.5 | 70.7 | 58.7 | 24.7 | 30.8 | 21.7 | 31.4 |
| Bhind | 28.9 | 25.1 | 93.5 | 93.1 | 2.2 | 48.5 | 38.4 | 24.3 | 32.2 | 12.4 | 29.0 |
| Bhopal | 47.4 | 11.3 | 98.3 | 94.5 | 0.5 | 73.7 | 46.4 | 18.2 | 19.9 | 20.6 | 29.1 |
| Burhanpur | 26.3 | 17.8 | 90.7 | 92.1 | 3.4 | 71.5 | 53.1 | 20.9 | 38.7 | 27.9 | 47.2 |
| Chhatarpur | 24.7 | 39.2 | 85.2 | 86.4 | 5.4 | 60.6 | 48.8 | 25.2 | 45.1 | 17.5 | 34.6 |
| Chhindwara | 40.2 | 11.6 | 92.2 | 95.9 | 2.6 | 74.2 | 65.4 | 28.5 | 23.9 | 18.1 | 32.8 |
| Damoh | 24.8 | 28.6 | 85.0 | 89.1 | 3.7 | 67.5 | 58.1 | 23.7 | 40.3 | 16.2 | 32.3 |
| Datia | 27.8 | 27.7 | 89.4 | 89.5 | 1.9 | 66.3 | 58.2 | 23.0 | 36.8 | 16.4 | 29.4 |
| Dewas | 27.7 | 28.1 | 92.2 | 94.7 | 1.9 | 61.2 | 45.5 | 22.5 | 36.8 | 20.4 | 30.7 |
| Dhar | 23.8 | 26.5 | 95.5 | 93.9 | 2.1 | 75.5 | 60.9 | 17.1 | 28.8 | 29.5 | 35.9 |
| Dindori | 25.8 | 21.1 | 77.6 | 98.1 | 3.0 | 70.4 | 62.4 | 29.3 | 38.9 | 15.8 | 33.6 |
| Guna | 17.7 | 28.1 | 98.0 | 97.1 | 2.8 | 69.2 | 56.6 | 18.4 | 31.9 | 10.1 | 25.1 |
| Gwalior | 37.9 | 11.8 | 94.8 | 94.5 | 3.0 | 51.5 | 36.5 | 20.4 | 40.1 | 12.4 | 33.0 |
| Harda | 30.8 | 10.0 | 88.4 | 93.3 | 0.6 | 75.5 | 57.0 | 15.9 | 38.8 | 28.0 | 34.7 |
| Hoshangabad | 35.5 | 16.7 | 91.8 | 93.6 | 2.7 | 28.0 | 20.0 | 21.9 | 34.8 | 19.5 | 27.2 |
| Indore | 47.7 | 21.7 | 96.5 | 96.6 | 1.9 | 79.6 | 47.9 | 15.6 | 28.7 | 21.2 | 24.9 |
| Jabalpur | 30.4 | 7.2 | 94.7 | 100.0 | 0.0 | 77.8 | 74.1 | 27.8 | 18.0 | 26.4 | 31.3 |
| Jhabua | 16.0 | 36.5 | 92.9 | 90.3 | 7.1 | 71.6 | 58.8 | 29.2 | 49.3 | 17.9 | 41.7 |
| Katni | 32.5 | 17.2 | 91.8 | 96.8 | 3.0 | 64.1 | 50.8 | 18.1 | 49.5 | 21.8 | 44.0 |
| Khandwa (East Nimar) | 27.9 | 10.8 | 93.2 | 93.1 | 2.0 | 71.1 | 64.8 | 21.7 | 38.4 | 20.7 | 35.3 |
| Khargone (West Nimar) | 27.2 | 13.3 | 92.8 | 94.6 | 2.7 | 75.0 | 62.4 | 16.7 | 31.4 | 27.4 | 44.0 |

| District | Women (15-49 years) | | | | | | | | Children below 5 years of age | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | With 10 or more years of schooling | Aged 20-24 years married before 18 years of age | Who had last delivery in an institution | Whose last birth registered | Whose last birth was 3rd and higher order birth | Using a modern family planning method | Who are sterilised | With low BMI | Stunted | Wasted | Underweight |
| Mandla | 30.5 | 15.0 | 87.6 | 97.7 | 2.2 | 74.3 | 64.0 | 26.8 | 32.1 | 15.9 | 33.0 |
| Mandsaur | 24.1 | 34.8 | 99.4 | 98.0 | 0.4 | 64.8 | 48.1 | 29.4 | 30.9 | 13.1 | 22.9 |
| Morena | 25.6 | 27.8 | 94.8 | 93.3 | 4.5 | 51.8 | 42.5 | 22.3 | 40.0 | 10.1 | 29.6 |
| Narsinghpur | 31.4 | 19.6 | 91.4 | 98.1 | 3.4 | 70.4 | 63.4 | 25.1 | 32.0 | 19.6 | 28.1 |
| Neemuch | 27.9 | 29.3 | 97.5 | 99.6 | 1.2 | 66.3 | 48.9 | 18.8 | 33.0 | 13.1 | 27.7 |
| Panna | 24.0 | 22.8 | 84.0 | 87.5 | 5.0 | 57.8 | 47.0 | 26.8 | 45.1 | 23.2 | 39.2 |
| Raisen | 34.6 | 12.6 | 96.0 | 95.4 | 3.1 | 72.6 | 53.7 | 20.5 | 30.4 | 21.1 | 25.4 |
| Rajgarh | 21.3 | 46.0 | 91.7 | 90.5 | 3.1 | 59.7 | 42.7 | 28.0 | 27.6 | 22.4 | 26.8 |
| Ratlam | 23.8 | 31.3 | 95.2 | 97.3 | 2.1 | 68.3 | 51.6 | 23.4 | 29.0 | 16.2 | 28.6 |
| Rewa | 23.1 | 28.2 | 80.4 | 93.8 | 5.5 | 59.9 | 46.7 | 16.5 | 37.0 | 18.7 | 31.5 |
| Sagar | 32.9 | 21.4 | 86.9 | 93.6 | 3.2 | 60.9 | 47.5 | 22.8 | 42.7 | 15.2 | 35.8 |
| Satna | 31.5 | 12.9 | 85.5 | 95.1 | 5.7 | 61.2 | 52.1 | 21.3 | 49.4 | 16.8 | 31.2 |
| Sehore | 28.2 | 21.7 | 94.7 | 91.7 | 2.1 | 51.5 | 34.6 | 27.1 | 21.9 | 20.3 | 27.6 |
| Seoni | 33.0 | 11.2 | 94.8 | 98.4 | 2.7 | 74.5 | 65.0 | 26.6 | 23.5 | 21.1 | 31.1 |
| Shahdol | 30.7 | 27.5 | 85.6 | 98.4 | 2.5 | 58.3 | 47.1 | 28.3 | 44.0 | 20.4 | 39.2 |
| Shajapur | 19.6 | 24.4 | 98.1 | 96.3 | 1.9 | 71.8 | 53.4 | 23.1 | 27.8 | 23.4 | 27.6 |
| Sheopur | 15.9 | 39.5 | 84.2 | 86.2 | 4.1 | 63.5 | 51.8 | 30.5 | 45.8 | 16.2 | 37.7 |
| Shivpuri | 21.2 | 32.5 | 94.5 | 88.1 | 3.7 | 55.5 | 49.1 | 26.7 | 39.2 | 18.4 | 36.1 |
| Sidhi | 27.1 | 23.0 | 83.8 | 96.2 | 3.0 | 58.6 | 41.9 | 22.9 | 39.1 | 16.6 | 32.8 |
| Singrauli | 29.9 | 24.7 | 69.9 | 91.9 | 4.2 | 50.0 | 42.1 | 25.6 | 37.3 | 25.2 | 36.0 |
| Tikamgarh | 25.8 | 32.6 | 89.8 | 96.4 | 2.2 | 71.0 | 66.0 | 21.3 | 27.5 | 19.7 | 34.9 |
| Ujjain | 29.0 | 33.4 | 97.1 | 96.4 | 1.6 | 72.9 | 56.1 | 21.1 | 34.7 | 29.8 | 36.2 |
| Umaria | 26.4 | 21.2 | 92.2 | 97.0 | 4.3 | 60.5 | 49.6 | 21.1 | 45.3 | 15.5 | 36.6 |
| Vidisha | 21.7 | 22.8 | 90.6 | 96.7 | 4.9 | 64.6 | 44.7 | 23.1 | 36.5 | 16.6 | 34.4 |

Source: Government of India (*no date*).

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# Profiles of Fertility in Districts of India, 2019-2021

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## Abstract

This paper presents estimates of total fertility rate (TFR) for 707 districts of the India based on the data available from the National Family Health Survey, 2019-2021. The paper also classifies 707 districts into the profiles of fertility depending upon the total marital fertility rate (TMFR) and proportion of reproductive age women who are married in a district relative to the TMFR and the proportion of married women of reproductive age in the country. The paper highlights the variation in TFR across the districts of the country. In 326 of the 707 districts of the country, the TFR is estimated to be below the replacement level, although there are 67 districts in which TFR is estimated to be very high, at least 3 births per woman of reproductive age. The paper reveals that 707 districts of the country can be classified into six fertility profiles depending upon the level of TMFR and the proportion of reproductive age women who are married.

## Introduction

Direct estimates of fertility for the districts of India are not available from any source. The registration of births in India is mandatory by the Registration of Births and Deaths Act of 1969 (Government of India, 1969), yet according to the latest round of the National Family Health Survey (2019-2021), birth of only around 89 per cent of children below 5 years of age in the country was found to be registered under the official civil registration system and this proportion varies widely across the districts of the country (Government of India, 2022). The Registration of Births and Deaths Act, 1969 provides for the registration of births on the *de-facto* basis rather than on the *de-jure* basis and, therefore, it is not possible to estimate fertility from the births registered under the civil registration system. The estimation of fertility also requires estimates of population by age and sex which are also not available through the civil registration system. The only source of information about the population of the district by age and sex in India is the decennial population census. The last decennial population census in India was conducted way back in 2011. There was no decennial population census in the country in 2021 so that estimates of the population of the district by age and sex at the recent date are not available. Direct estimation of fertility in the districts of the country based on the data available from the National Family Health Survey is not reliable because the size of the sample of households surveyed in a district is too small to provide reliable estimates of fertility in the districts of the country.

In the absence of direct estimates, attempts have been made to estimate district fertility through the application of indirect methods of fertility estimation. Different indirect methods of fertility estimation have been proposed. The most common of these methods is the P/F ratio method first proposed by Brass and its many refinements (Brass, 1968; 1975; Hobcraft et al, 1982; Moultrie et al, 2013). Cho and others (1986), on the other hand, have proposed the own children method based on the reverse survival technique while Rele (1967) has used the stable population method which has been modified by Swamy and others (1992). Regression-based methods have also been proposed (Mauldin and Ross, 1991; Jain, 1997, Singh et al, 2012). The mean duration of the interval between successive live births has also been used to estimate fertility (Srinivasan, 1980; Yadav and Kumar, 2002). Yadava and others (2009) have proposed a method based on the weighted average of the proportionate distribution of live births by birth order whereas Yadava and others (2009) have used the proportion of women having a live birth during the five years preceding the survey. Tiwari and others (2020) have used the proportion of childless women of reproductive age to explain the variation in TFR.

United Nations (1967) has suggested a simple approach to estimate total marital fertility rate (TMFR) from the average parity of currently married women of the younger age group. This method is based on the hypothesis that in populations that employ little birth control the ratio of the average parity of currently married women at the end of the child-bearing period to the average parity of currently married women of a younger age group is closely related to the relative average parity of currently married women early and late in their twenties. If the average number of children ever born (average parity) to women aged l5-19 years is $P_1$; average parity of currently married women aged 20-24 years is $P_2$, and so on, so that the average parity of currently married women aged 45-50 years is $P_7$, then this hypothesis means that.

$$\frac{TMFR}{P_3} \approx \frac{P_3}{P_2} \tag{1}$$

or

$$TMFR \approx \frac{P_3^2}{P_2} \tag{2}$$

If the equation (1) holds empirically, then TMFR can be approximated as

$$TMFR = \alpha + \beta * (P_3^2/P_2) \tag{3}$$

where $\alpha$ and $\beta$ are constants to be determined.

Yadava and Tiwari (2007) have modified the approach suggested by the United Nations (1967) by considering the extent of family planning use as a predictor of TFR. Gupta, and others (2014), on the other hand, have argued that with the increase in the age at marriage, there is a shift in fertility towards higher ages. They have, therefore, suggested that.

$$\frac{TFR}{Q_4} \approx \frac{Q_4}{Q_3} \tag{4}$$

where $Q$ denotes the average parity of all women in a given age group, not the average parity of currently married women. The TFR may now be calculated as

$$TFR = \gamma + \delta * (Q_4^2/Q_3) \quad (5)$$

where $\gamma$ and $\delta$ are constants to be determined. Singh and others (2022), on the other hand, have suggested that

$$\frac{TMFR}{P_5} \approx \frac{P_5}{P_4} \quad (6)$$

which means that TMFR may be estimated as

$$TMFR = \mu + \rho * (P_5^2/P_4) \quad (7)$$

Singh and others (2022) have also tested the stability or the robustness of the regression model (7) by estimating the shrinkage or the decrease in the coefficient of determination which is attributed to the application of the regression model to a new data set. It is well known in the regression analysis that a fitted relationship performs less well on a new data set than the data set used for fitting the model (Everitt, 2002). The robustness of the regression model implies that the regression model can be applied to dataset other than the one that is used to establish the relationship between the dependent and the independent variables and there is no loss of information.

Using the indirect methods of fertility estimation, there have been attempts in the past to estimate fertility in the districts of the country. The Registrar General and Census Commissioner of India has produced estimates of different indicators of fertility for the districts of the country based on the children ever born data collected during the 1981, 1991 decennial population censuses through the application of Brass PF Ratio method (Government of India, 1988; 1997). Similar exercise has, however, not been carried out by the Registrar General and Census Commissioner of India based on the data collected in 2001 and 2011 decennial population censuses. District level estimates of fertility using data from decennial population censuses have also been prepared by Mishra and others (1994), Guilmoto and Rajan (2002; 2013) and Kumar and Sathyanarayana (2012) using different indirect methods of fertility estimation. There has, however, been no decennial population census in India after 2011 so that census-based estimates of fertility for the districts of the country are not available after 2011.

The Government of India had also instituted the Annual Health Survey Programme in 2010 to generate estimates of key demographic indicators for the districts annually (Government of India, 2011). This survey, however, did not cover all districts of the country and was discontinued after 2013. The fourth round of the National Family Health Survey (2015-2016) provided district level data which have been used by many authors to estimate fertility in the districts of the country (Singh et al, 2022; Mohanty et al, 2016; Chatterjee and Mohanty, 2021; Jayachandran and Ram, 2019). have estimated indicators of fertility rate in 640 districts of the country as they existed at the time of the 2011 decennial population census. There, however, appears to be little attempt to estimate fertility in the districts of the country from the data available from the fifth round of the National Family Health Survey (2015-2016).

This paper presents estimates of total fertility rate (TFR) for the 707 districts of the country based on the data available from the fifth round of the National Family Health Survey (2019-2021). The method proposed by Singh and others (2022) has been used to estimate TFR at the district level. The estimate of TFR for the country based on the method proposed by Singh and others (2022) is found to be very close to the estimate of TFR based on the full birth history data. The paper also attempts to classify districts into fertility profiles which are characterised by the level of the fertility of married women of reproductive age and the proportion of women of reproductive age who were married at the time of the survey in the district relative to the national average. The analysis reveals that 707 districts can be classified into six fertility profiles depending upon the direction of the difference in marital fertility and proportion of married among between the district and the national average.

## The Method

Using the data from the official sample registration system of India for the period 1986 through 2015, Singh and others (2022) have established the following empirical relationship

$$TMFR = 0.9409 * P_5^2/P_4 + 0.1738 \tag{8}$$

where TMFR is the total fertility rate, $P_5$ is the average number of children ever born to women aged 35-39 years and $P_4$ is the average number of children ever born to women aged 30-34 years. The coefficient of determination ($R^2$) was 99.74 per cent while the cross-validity prediction power (CVPP) was 0.99. The CVPP reflects the robustness of the model or model stability over populations (Herzberg, 1969). Once TMFR is estimated using equation (8), total fertility rate (TFR) can be estimated by multiplying TMFR with the proportion of women in the reproductive age group who are married.

Application of the model (8) to the data available from the fifth round of the National Family Health Survey (2019-2021) suggests a TMFR of 3.1 births per married woman of reproductive age for the country. The data available from the National Family Health Survey also suggests that around 71 per cent women of reproductive age in India were married at the time of the survey. This means that TFR in the country was around 2.2 births per woman of reproductive age. This estimate of TFR for the country is very close to the estimate of around 2.1 births per women of reproductive age which is estimated from the full birth history data collected at the fifth round of the National Family Health Survey, 2019-2021. This proximity of the two estimates of TFR provides credence to estimating district TFR using model (8).

If $f$ denotes the total fertility rate (TFR), $g$ denotes the total marital fertility rate (TMFR) and $m$ denotes the proportion of married women, then.

$$f = g \times m \tag{9}$$

Let $f_d$ denotes the TFR of district $d$ while $fc$ denotes the fertility of the country. Then the difference between the TFR of the district and the TFR of the country can be decomposed as

$$\nabla f_d = f_d - f_c = (g_d \times m_d) - (g_c \times m_c) \tag{10}$$

Now

$$\nabla f_d = \frac{f_d - f_c}{\ln\left(\frac{f_d}{f_c}\right)} \times \ln\left(\frac{f_d}{f_c}\right) = L_{dc} \times \ln\left(\frac{f_d}{f_c}\right) \tag{11}$$

where

$$L_{dc} = \frac{f_d - f_c}{\ln\left(\frac{f_d}{f_c}\right)}$$

is the logarithmic mean of $f_d$ and $f_c$. Now

$$\ln\left(\frac{f_d}{f_c}\right) = \ln\left(\frac{g_d}{g_c}\right) + \ln\left(\frac{m_d}{m_c}\right) \tag{12}$$

so that

$$\nabla f_d = \left(L_{dc} \times \ln\left(\frac{g_d}{g_c}\right)\right) + \left(L_{dc} \times \ln\left(\frac{m_d}{m_c}\right)\right) = \partial g_d + \partial m_d \tag{13}$$

where

$$\partial g_d = \left(L_{dc} \times \ln\left(\frac{g_d}{g_c}\right)\right) \tag{14}$$

and

$$\partial m_d = \left(L_{dc} \times \ln\left(\frac{m_d}{m_c}\right)\right) \tag{15}$$

Equation (13) shows that the difference between TFR of a district and TFR of the country can be decomposed into the difference attributed to the difference in TMFR and the difference attributed to the difference between the proportion of the women of reproductive age who are married. This decomposition serves as a useful framework for constructing district fertility profile which has implications for planning and programming for fertility regulation in the district.

Based on equation (13), a district can be classified into one of the following mutually exclusive yet exhaustive 11 fertility profiles depending upon the direction of the difference in $\partial g_d$, $\partial m_d$ and $\nabla f_d$ as defined above:

$$\begin{aligned}
&Profile\ 1: \partial g_d > 0, \partial m_d > 0, \nabla f_d > 0\\
&Profile\ 2: \partial g_d > 0, \partial m_d < 0, \nabla f_d > 0\\
&Profile\ 3: \partial g_d > 0, \partial m_d < 0, \nabla f_d < 0\\
&Profile\ 4: \partial g_d < 0, \partial m_d < 0, \nabla f_d < 0\\
&Profile\ 5: \partial g_d < 0, \partial m_d > 0, \nabla f_d < 0\\
&Profile\ 6: \partial g_d < 0, \partial m_d > 0, \nabla f_d > 0\\
&Profile\ 7: \partial g_d = 0, \partial m_d = 0, \nabla f_d = 0\\
&Profile\ 8: \partial g_d = 0, \partial m_d > 0, \nabla f_d > 0\\
&Profile\ 9: \partial g_d = 0, \partial m_d < 0, \nabla f_d < 0\\
&Profile\ 10: \partial g_d > 0, \partial m_d = 0, \nabla f_d > 0\\
&Profile\ 11: \partial g_d < 0, \partial m_d = 0, \nabla f_d < 0
\end{aligned} \tag{16}$$

The 11 fertility profiles described above are mutually exclusive and exhaustive. Each fertility profile has a unique characterisation of fertility which has policy and programme implications. For example, fertility profile 2 suggests that higher than country TFR in districts having this profile is due to higher TMFR whereas fertility profile 6 suggests that higher TFR of districts of this profile is due to higher proportion of reproductive age women who are married. Policy and programme implications for pursuing fertility transition in the two categories of districts are obviously different.

## Inter-district Variation in TFR

Estimates of TFR for the 707 districts of the country as they existed at the time of the National Family Health Survey, 2019-2021 are given in the appendix table along with estimates of TMFR and proportion of women of reproductive age who were married at the time of the survey. The inter-district variation in TFR is depicted in figure 1 while the distribution of districts by the level of fertility in different states and Union Territories of the country are presented in table 1. There are 326 (46.1 per cent) districts in the country where fertility was estimated to be below the replacement level (TFR of less than 2.1 births per woman of reproductive age) according to the information available from the National Family Health Survey, 2019-2021. However, in 281 districts of the country, fertility was above the replacement level at the time of the survey and, in 63 districts of the country fertility was very high at the time of the survey as TFR was at least 3 births per woman of reproductive age. It is also estimated that in 16 districts of the country, fertility was exceptionally high as the TFR, in these districts, was at least 3.5 births per woman of reproductive age at the time of the survey. The estimation exercise also suggests that there are 199 (28.1 per cent) districts where fertility was moderately higher than the replacement level as TFR ranged between 2.1-2.5 births per woman of reproductive age in these districts. At the same time, there are 119 (16.8 per cent) districts where fertility was markedly higher than the replacement level at the time of the survey as the TFR ranged between 2.5-3.0 births per woman of reproductive age in these districts. District South Goa in Goa had the lowest fertility among the 707 districts of the country that existed at the time of the survey as the TFR in the district is estimated to be 1.21 births per woman of reproductive age. On the other hand, the TFR was estimated to be 4.7 births per woman of reproductive age in district West Khasi Hills of Meghalaya, which was the highest among the 707 districts,

Regional pattern in fertility is also very marked as may be seen from the figure 1. Most of the districts having above replacement fertility are located in the central part of the country comprising of the states of Rajasthan, Uttar Pradesh, Madhya Pradesh, Bihar, and Jharkhand whereas in the north western part of the country and in the southern part fertility is below replacement level in most of the districts. In the north eastern part of the country, the scenario is mixed. Among 63 districts where fertility was very high (TFR at least 3 births per woman of reproductive age) 29 are in Bihar while 13 are in Uttar Pradesh. Among 16 districts where TFR is at least 3.5 births per woman of reproductive age, 8 are in Bihar, 3 each in Meghalaya and Uttar Pradesh, and 1 each in Haryana and Madhya Pradesh. There is no district in other states and Union Territories of the country where fertility was exceptionally high at the time of the National Family Health Survey, 2019-2021.

On the other hand, there is no district in 8 states/Union Territories of the country where fertility was above the replacement level at the time of the survey. In Tamil Nadu, fertility was estimated to be below the replacement level in 31 of the 32 districts of the state, In Kerala, fertility was below the replacement level in 13 of the 14 districts of the state. In Punjab, fertility was below the replacement level in 20 of the 22 districts of the state whereas in Himachal Pradesh fertility was below the replacement level in 9 of the 12 districts of the state. On the contrary, Bihar is the only state in the country where there is no district where fertility was below the replacement level at the time of the survey. In Lakshadweep also fertility was estimated to be above the replacement level at the time of the survey.

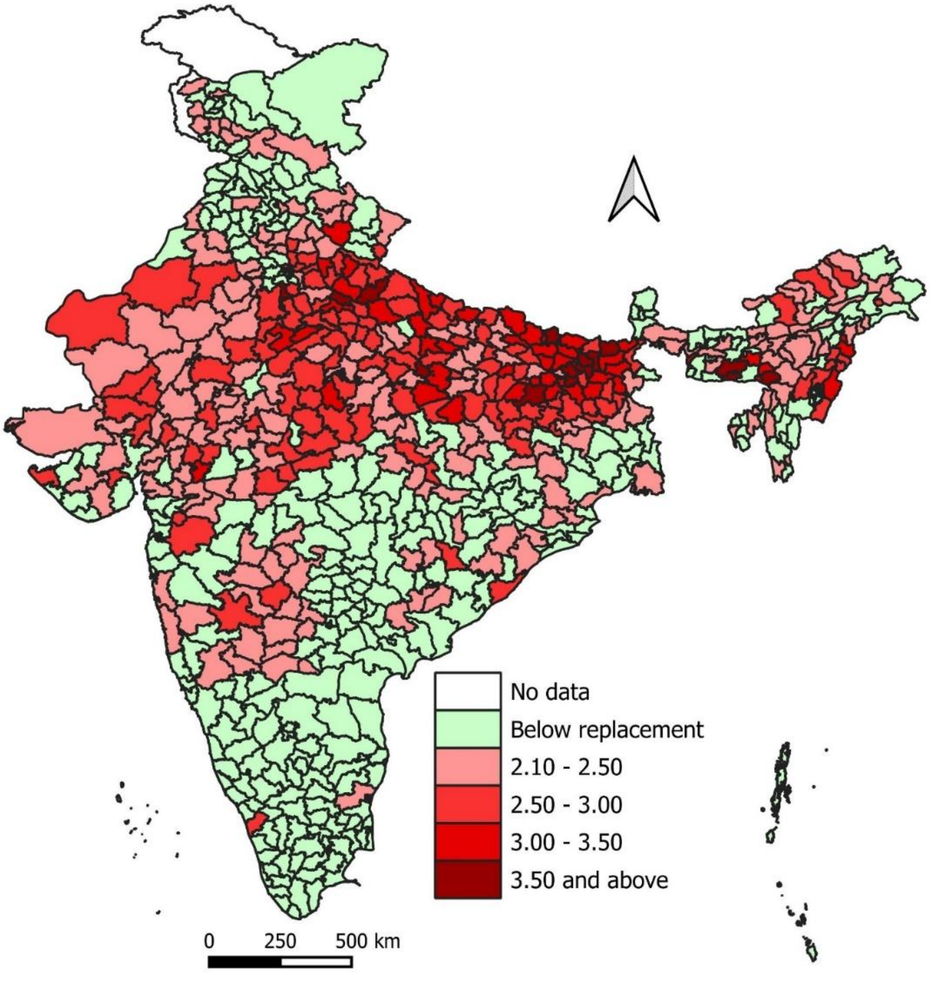


Figure 1: Inter-district variation in total fertility rate (TFR) in India, 2019-2021.
Source: Authors

Table 1: Variation in TFR across districts of different states and Union Territories of India, 2019-2021.

| Country/State/Union Territory | Total fertility rate | | | | | Total |
|---|---|---|---|---|---|---|
| | < 2.1 | 2.1-2.5 | 2.5-3.0 | 3.0-3.5 | ≥3.5 | |
| Andaman & Nicobar Islands | 3 | 0 | 0 | 0 | 0 | 3 |
| Andhra Pradesh | 13 | 0 | 0 | 0 | 0 | 13 |
| Arunachal Pradesh | 6 | 10 | 4 | 0 | 0 | 20 |
| Assam | 13 | 18 | 1 | 1 | 0 | 33 |
| Bihar | 0 | 1 | 8 | 21 | 8 | 38 |
| Chandigarh | 1 | 0 | 0 | 0 | 0 | 1 |
| Chhattisgarh | 15 | 11 | 1 | 0 | 0 | 27 |
| Dadra & Nagar Haveli, Daman & Diu | 3 | 0 | 0 | 0 | 0 | 3 |
| Delhi | 6 | 4 | 1 | 0 | 0 | 11 |
| Goa | 2 | 0 | 0 | 0 | 0 | 2 |
| Gujarat | 12 | 14 | 7 | 0 | 0 | 33 |
| Haryana | 11 | 9 | 1 | 0 | 1 | 22 |
| Himachal Pradesh | 9 | 3 | 0 | 0 | 0 | 12 |
| Jammu & Kashmir | 12 | 8 | 0 | 0 | 0 | 20 |
| Jharkhand | 3 | 6 | 14 | 1 | 0 | 24 |
| Karnataka | 23 | 7 | 0 | 0 | 0 | 30 |
| Kerala | 13 | 0 | 1 | 0 | 0 | 14 |
| Ladakh | 2 | 0 | 0 | 0 | 0 | 2 |
| Lakshadweep | 0 | 1 | 0 | 0 | 0 | 1 |
| Madhya Pradesh | 9 | 18 | 20 | 3 | 1 | 51 |
| Maharashtra | 21 | 12 | 3 | 0 | 0 | 36 |
| Manipur | 5 | 0 | 3 | 1 | 0 | 9 |
| Meghalaya | 5 | 1 | 0 | 2 | 3 | 11 |
| Mizoram | 6 | 2 | 0 | 0 | 0 | 8 |
| Nagaland | 3 | 3 | 3 | 2 | 0 | 11 |
| Odisha | 19 | 10 | 1 | 0 | 0 | 30 |
| Puducherry | 4 | 0 | 0 | 0 | 0 | 4 |
| Punjab | 20 | 2 | 0 | 0 | 0 | 22 |
| Rajasthan | 2 | 17 | 12 | 2 | 0 | 33 |
| Sikkim | 4 | 0 | 0 | 0 | 0 | 4 |
| Tamil Nadu | 31 | 1 | 0 | 0 | 0 | 32 |
| Telangana | 27 | 4 | 0 | 0 | 0 | 31 |
| Tripura | 5 | 3 | 0 | 0 | 0 | 8 |
| Uttar Pradesh | 1 | 22 | 36 | 13 | 3 | 75 |
| Uttarakhand | 5 | 5 | 2 | 1 | 0 | 13 |
| West Bengal | 12 | 7 | 1 | 0 | 0 | 20 |
| India | 326 | 199 | 119 | 47 | 16 | 707 |

Source: Authors' calculations.

## Profiles of Fertility

The difference between the TFR of a district from the TFR of the country is determined by the difference in TMFR and the difference in the proportion of reproductive age women who are married in conjunction with equations (14) and (15). Based on the magnitude and direction of these contributions, a district may be classified into one of the possible 11 mutually exclusive and exhaustive fertility profiles as defined by equation (16). This exercise suggests that 707 districts of the country can be classified into 6 fertility profiles. There is no district which is classified in the remaining 5 fertility profiles. The distribution of districts according to fertility profile and the level of fertility is presented in table 2. There are 326 districts in the country where fertility was below the replacement level, but the fertility profile of these districts is different. In 144 of these districts, both districts TMFR and district proportion of reproductive age women who were married was less than the corresponding TMFR and the proportion of reproductive age women who are married in the country (Profile 4). In addition, in 151 of these districts, districts TMFR was lower than the national TMFR but the proportion of reproductive age women who were married at the time of the survey was higher than the corresponding proportion at the national level (Profile 5). Finally, there are 31 districts where fertility was below the replacement fertility level, but district TMFR was higher than the national TMFR and district proportion of reproductive age women who were married at the time of the survey was lower than the national average (Profile 3).

On the other hand, there are 132 districts where both district TMFR and district proportion of reproductive age women who were married at the time of the survey are higher than those at the national level and in none of these districts, fertility was below the replacement level at the time of the survey (Profile 1). In addition, there are 182 districts where fertility was above the replacement level and in all these districts, TMFR was higher than the national TMFR, but the proportion of reproductive age women who were married was less than the national proportion of reproductive age women who were married (Profile 2). Fertility, in these 314 districts, however, varies widely. Lastly, there are 26 districts where TMFR of the district was lower than the TMFR of the country, but the proportion of reproductive age women who were married in the district was higher than the corresponding proportion in the country (Profile 6). Fertility in all these districts is above the replacement level.

Table 2: District cross-classified by the level of TFR and the fertility profile, 2019-2021.

| Fertility profile | Total fertility rate | | | | | Total |
|---|---|---|---|---|---|---|
| | <2.1 | 2.1-2.5 | 2.5-3.0 | 3.0.3.5 | ≥3.5 | |
| 1: $\partial g_d > 0, \partial m_d > 0, \nabla f_d > 0$ | 0 | 43 | 53 | 26 | 10 | 132 |
| 2: $\partial g_d > 0, \partial m_d < 0, \nabla f_d > 0$ | 0 | 89 | 66 | 21 | 6 | 182 |
| 3: $\partial g_d > 0, \partial m_d < 0, \nabla f_d < 0$ | 31 | 16 | 0 | 0 | 0 | 47 |
| 4: $\partial g_d < 0, \partial m_d < 0, \nabla f_d < 0$ | 144 | 4 | 0 | 0 | 0 | 148 |
| 5: $\partial g_d < 0, \partial m_d > 0, \nabla f_d < 0$ | 151 | 21 | 0 | 0 | 0 | 172 |
| 6: $\partial g_d < 0, \partial m_d > 0, \nabla f_d > 0$ | 0 | 26 | 0 | 0 | 0 | 26 |
| Total | 326 | 199 | 119 | 47 | 16 | 707 |

Source: Authors' calculations

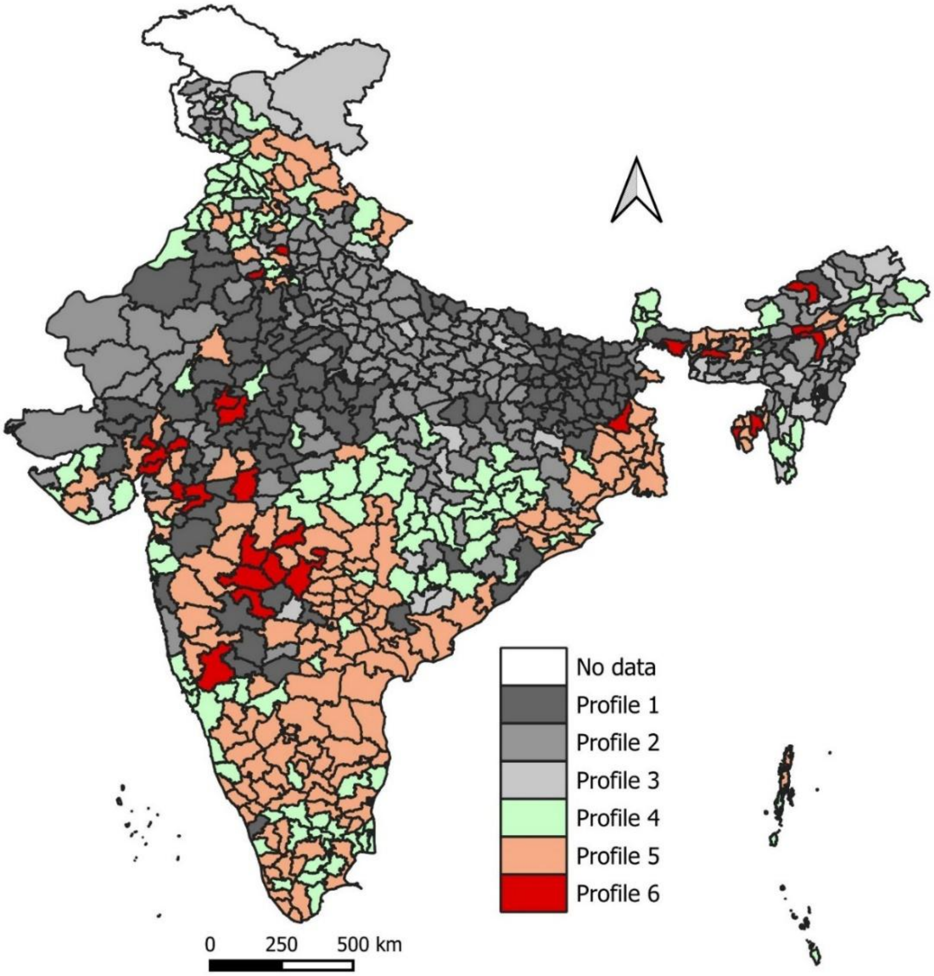


Figure 2: Profiles of fertility in India, 2019-2021.

Remarks:

Profile 1: $\partial g_d > 0, \partial m_d > 0, \nabla f_d > 0$
Profile 2: $\partial g_d > 0, \partial m_d < 0, \nabla f_d > 0$
Profile 3: $\partial g_d > 0, \partial m_d < 0, \nabla f_d < 0$
Profile 4: $\partial g_d < 0, \partial m_d < 0, \nabla f_d < 0$
Profile 5: $\partial g_d < 0, \partial m_d > 0, \nabla f_d < 0$
Profile 6: $\partial g_d < 0, \partial m_d > 0, \nabla f_d > 0$

Source: Authors

Table 3: Distribution of districts by states/Union Territories and fertility profiles.

| India/State/Union Territory | Fertility profile | | | | | | Total |
|---|---|---|---|---|---|---|---|
| | 1<br>$\partial g_d>0$<br>$\partial g_d>0$<br>$\nabla f_d > 0$ | 2<br>$\partial g_d>0$<br>$\partial g_d<0$<br>$\nabla f_d > 0$ | 3<br>$\partial g_d>0$<br>$\partial g_d<0$<br>$\nabla f_d < 0$ | 4<br>$\partial g_d>0$<br>$\partial g_d<0$<br>$\nabla f_d < 0$ | 5<br>$\partial g_d<0$<br>$\partial g_d>0$<br>$\nabla f_d < 0$ | 6<br>$\partial g_d<0$<br>$\partial g_d>0$<br>$\nabla f_d > 0$ | |
| Andaman & Nicobar Islands | 0 | 0 | 0 | 2 | 1 | 0 | 3 |
| Andhra Pradesh | 0 | 0 | 0 | 1 | 12 | 0 | 13 |
| Arunachal Pradesh | 2 | 9 | 4 | 4 | 0 | 1 | 20 |
| Assam | 9 | 6 | 1 | 5 | 9 | 3 | 33 |
| Bihar | 30 | 8 | 0 | 0 | 0 | 0 | 38 |
| Chandigarh | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Chhattisgarh | 0 | 10 | 5 | 12 | 0 | 0 | 27 |
| Dadra & Nagar Haveli, Daman & Diu | 0 | 0 | 1 | 0 | 2 | 0 | 3 |
| Delhi | 0 | 2 | 4 | 5 | 0 | 0 | 11 |
| Goa | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| Gujarat | 8 | 4 | 1 | 6 | 9 | 5 | 33 |
| Haryana | 4 | 4 | 1 | 6 | 5 | 2 | 22 |
| Himachal Pradesh | 0 | 1 | 0 | 3 | 8 | 0 | 12 |
| Jammu & Kashmir | 0 | 6 | 8 | 6 | 0 | 0 | 20 |
| Jharkhand | 13 | 8 | 1 | 1 | 1 | 0 | 24 |
| Karnataka | 3 | 1 | 1 | 7 | 17 | 1 | 30 |
| Kerala | 1 | 0 | 0 | 2 | 11 | 0 | 14 |
| Ladakh | 0 | 0 | 2 | 0 | 0 | 0 | 2 |
| Lakshadweep | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Madhya Pradesh | 23 | 14 | 0 | 8 | 3 | 3 | 51 |
| Maharashtra | 5 | 1 | 0 | 7 | 16 | 7 | 36 |
| Manipur | 0 | 4 | 4 | 1 | 0 | 0 | 9 |
| Meghalaya | 0 | 6 | 5 | 0 | 0 | 0 | 11 |
| Mizoram | 0 | 1 | 2 | 5 | 0 | 0 | 8 |
| Nagaland | 1 | 7 | 3 | 0 | 0 | 0 | 11 |
| Odisha | 2 | 4 | 1 | 12 | 11 | 0 | 30 |
| Puducherry | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| Punjab | 0 | 1 | 0 | 16 | 5 | 0 | 22 |
| Rajasthan | 18 | 11 | 0 | 3 | 1 | 0 | 33 |
| Sikkim | 0 | 0 | 0 | 4 | 0 | 0 | 4 |
| Tamil Nadu | 0 | 0 | 0 | 16 | 16 | 0 | 32 |
| Telangana | 2 | 0 | 0 | 4 | 25 | 0 | 31 |
| Tripura | 1 | 0 | 0 | 0 | 5 | 2 | 8 |
| Uttar Pradesh | 6 | 67 | 2 | 0 | 0 | 0 | 75 |
| Uttarakhand | 1 | 5 | 1 | 3 | 3 | 0 | 13 |
| West Bengal | 3 | 1 | 0 | 2 | 12 | 2 | 20 |
| India | 132 | 182 | 47 | 148 | 172 | 26 | 707 |

Source: Authors' calculations

The regional distribution of districts by their fertility profile is apparent from table 3 and figure 2. In Bihar 30 of the 38 districts, the fertility profile is 1 while in the remaining 8 districts, the fertility profile is 2. In Jharkhand, 13 of the 24 districts, the fertility profile is 1 while in 8 districts, the fertility profile is 2. In Madhya Pradesh, the fertility profile of 23 of the 51 districts is 1 while the fertility profile of 14 districts is 2. Similarly, the fertility profile of 18 of the 33 districts of Rajasthan is 1 while that of 11 districts is 2. In Uttar Pradesh, the fertility profile is 1 in only 6 of the 75 districts but profile is 2 in 67 districts. On the other hand, the fertility profile in 12 of the 13 districts of Andhra Pradesh and 25 of the 31 districts of Telangana is 5. Similarly, in majority of the districts in Karnataka, Kerala, Maharashtra, Tamil Nadu and West Bengal, the fertility profile is 5. In these districts, the fertility of married women of reproductive age is lower than the fertility of married women of reproductive age in the country but the proportion of reproductive age women who are married is higher than the proportion of reproductive age women in the country who are married.

There are 26 districts in the country where fertility in the district was higher than the national average fertility not because the TMFR of the district was higher than the average TMFR of the country but because the proportion of reproductive age women who were married in the district at the time of the survey was higher than the corresponding proportion at the national level. Among these 26 districts, 7 are in Maharashtra, 5 in Gujarat and 3 each in Assam and Madhya Pradesh and 2 each in Himachal Pradesh, Tripura and West Bengal, In Arunachal Pradesh and Karnataka also, there is one district where the proportion of reproductive age women who were married at the time of the survey is estimated to be higher than the national average. Reduction in this proportion can contribute to reducing fertility below the replacement level in these districts as TMFR in these districts is already lower than the national level.

## Conclusions

This paper highlights the variation in fertility, as measured by TFR, across the districts of the country. Fertility appears to have decreased to below replacement level in 326 or less than half of the districts of the country as they existed at the time of the National Family Health Survey, 2019-2021. In majority of the districts of the country, fertility appears to be above the replacement level. Nearly all but a few districts where fertility is above the replacement level are located in the central region of the country comprising of the states of Gujarat, Rajasthan, Madhya Pradesh, Uttar Pradesh and Bihar. Fertility also appears to be above the replacement level in many districts in the north-eastern region of the country. In the southern region of the country, comprising of the states of Maharashtra, Andhra Pradesh, Karnataka, Kerala, Tamil Nadu and Telangana, fertility appears to be below the replacement level, although there are districts where fertility remains above the replacement level. It appears that there are district-specific factors that play a dominating role in deciding the level of fertility in the district.

Fertility in India is confined entirely within the institution of marriage. This means that the TFR in a district is determined by the fertility of married women and the proportion of reproductive age women who are married. This means that the difference between the TFR of a district and the TFR of the country can be decomposed into two factors, one attributed to the difference in the fertility of married women and the other attributed to the difference in the proportion of reproductive age women who are married. This decomposition permits 11 possible profiling of fertility depending upon the relative difference of a district in the fertility of married women and in the proportion of married women in the reproductive age group relative to the national average. The decomposition of the difference in TFR between the district and the country reveals that the 707 districts of the country can be classified into six fertility profiles which are mutually exclusive. There are districts where fertility of married women of reproductive age is lower than the fertility of married women of reproductive age in the country but the total fertility rate in these districts is higher than the total fertility rate in the country because the proportion of reproductive age women who are married is higher in the district relative to the proportion at the national level. Similarly, there are districts where fertility of married women of reproductive age is higher than the national average but the TFR in the district is lower than TFR of the country because the proportion of reproductive age women who are married is lower in the district relative to the proportion at the national level.

The profiling of fertility of the district has implications for fertility transition in those districts where TFR remains above the replacement level. It is important to understand whether TFR in the district in access to the replacement level fertility is due to high fertility of married women of reproductive age or is due to a higher proportion of reproductive age women who are married. This distinction is important as the factors that influence fertility of married women are different from the factors that influence the proportion of reproductive age women who are married. For example, a reduction in maternal mortality may lead to an increase in the proportion of reproductive age women who are married but may not have any impact on the fertility of married women. Similarly, an increase in the prevalence of breastfeeding may contribute to a decrease in the fertility of married women of reproductive age but may not have any impact on the proportion of women who are married.

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Appendix Table: Total fertility rate (TFR), total marital fertility rate (TMFR), proportion of reproductive age women married and the profile of fertility in districts of India, 2019-2021.

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| Andaman & Nicobar Islands | | | | | |
| | Nicobars | 2.145 | 64.205 | 1.377 | 4 |
| | North & Middle Andaman | 2.408 | 74.074 | 1.784 | 5 |
| | South Andaman | 1.882 | 70.522 | 1.327 | 4 |
| Andhra Pradesh | | | | | |
| | Anantapur | 2.223 | 79.780 | 1.774 | 5 |
| | Chittoor | 2.137 | 76.331 | 1.631 | 5 |
| | East Godavari | 2.513 | 75.533 | 1.898 | 5 |
| | Guntur | 2.123 | 77.804 | 1.652 | 5 |
| | Krishna | 2.273 | 72.592 | 1.650 | 5 |
| | Kurnool | 2.540 | 76.205 | 1.936 | 5 |
| | Prakasam | 2.150 | 79.255 | 1.704 | 5 |
| | Sri Potti Sriramulu Nellore | 2.086 | 73.554 | 1.534 | 5 |
| | Srikakulam | 2.175 | 71.957 | 1.565 | 4 |
| | Visakhapatnam | 2.100 | 73.311 | 1.540 | 5 |
| | Vizianagaram | 2.466 | 75.110 | 1.852 | 5 |
| | West Godavari | 2.331 | 76.923 | 1.793 | 5 |
| | Y.S.R. | 2.567 | 77.308 | 1.985 | 5 |
| Arunachal Pradesh | | | | | |
| | Anjaw | 2.581 | 70.525 | 1.820 | 4 |
| | Changlang | 2.988 | 69.282 | 2.070 | 4 |
| | Dibang Valley | 3.027 | 66.514 | 2.013 | 3 |
| | East Kameng | 3.533 | 71.528 | 2.527 | 2 |
| | East Siang | 2.818 | 64.105 | 1.807 | 4 |
| | Kra Daadi | 2.950 | 77.757 | 2.294 | 6 |
| | Kurung Kumey | 3.553 | 66.052 | 2.347 | 2 |
| | Lohit | 3.418 | 64.736 | 2.213 | 2 |
| | Longding | 3.515 | 65.781 | 2.312 | 2 |
| | Lower Dibang Valley | 3.249 | 65.055 | 2.114 | 3 |
| | Lower Subansiri | 3.150 | 65.634 | 2.067 | 3 |
| | Namsai | 3.851 | 72.968 | 2.810 | 1 |
| | Papum Pare | 3.576 | 63.855 | 2.283 | 2 |
| | Siang | 3.930 | 63.750 | 2.506 | 2 |
| | Tawang | 3.506 | 66.943 | 2.347 | 2 |
| | Tirap | 3.491 | 70.958 | 2.477 | 2 |
| | Upper Siang | 3.154 | 70.865 | 2.235 | 2 |
| | Upper Subansiri | 3.643 | 75.045 | 2.734 | 1 |
| | West Kameng | 2.565 | 66.401 | 1.703 | 4 |
| | West Siang | 3.030 | 70.947 | 2.150 | 3 |
| Assam | | | | | |
| | Baksa | 2.455 | 75.334 | 1.850 | 5 |
| | Barpeta | 3.293 | 75.146 | 2.475 | 1 |
| | Biswanath | 2.952 | 74.575 | 2.201 | 6 |
| | Bongaigaon | 2.704 | 76.174 | 2.060 | 5 |
| | Cachar | 3.381 | 71.578 | 2.420 | 2 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Charaideo | 2.885 | 67.711 | 1.954 | 4 |
| | Chirang | 2.701 | 75.273 | 2.033 | 5 |
| | Darrang | 3.190 | 77.022 | 2.457 | 1 |
| | Dhemaji | 3.049 | 77.809 | 2.372 | 1 |
| | Dhubri | 3.428 | 80.611 | 2.763 | 1 |
| | Dibrugarh | 3.015 | 69.476 | 2.095 | 4 |
| | Dima Hasao | 3.244 | 66.017 | 2.142 | 3 |
| | Goalpara | 3.012 | 73.015 | 2.199 | 6 |
| | Golaghat | 2.911 | 75.326 | 2.193 | 6 |
| | Hailakandi | 3.420 | 70.990 | 2.428 | 2 |
| | Hojai | 3.279 | 72.560 | 2.379 | 1 |
| | Jorhat | 2.581 | 72.940 | 1.882 | 5 |
| | Kamrup | 2.671 | 73.675 | 1.968 | 5 |
| | Kamrup Metropolitan | 2.049 | 68.884 | 1.411 | 4 |
| | Karbi Anglong | 3.441 | 68.869 | 2.370 | 2 |
| | Karimganj | 3.521 | 70.270 | 2.474 | 2 |
| | Kokrajhar | 2.572 | 75.945 | 1.953 | 5 |
| | Lakhimpur | 2.495 | 75.730 | 1.889 | 5 |
| | Majuli | 3.322 | 73.604 | 2.445 | 1 |
| | Morigaon | 3.168 | 76.744 | 2.431 | 1 |
| | Nagaon | 3.355 | 74.077 | 2.486 | 1 |
| | Nalbari | 2.371 | 74.774 | 1.773 | 5 |
| | Sivasagar | 2.571 | 73.925 | 1.901 | 5 |
| | Sonitpur | 3.453 | 71.650 | 2.474 | 2 |
| | South Salmara Mancachar | 3.979 | 77.076 | 3.067 | 1 |
| | Tinsukia | 2.480 | 69.149 | 1.715 | 4 |
| | Udalguri | 3.012 | 71.696 | 2.159 | 4 |
| | West Karbi Anglong | 3.135 | 70.710 | 2.217 | 2 |
| Bihar | | | | | |
| | Araria | 4.688 | 79.011 | 3.704 | 1 |
| | Arwal | 3.985 | 73.105 | 2.913 | 1 |
| | Aurangabad | 4.622 | 71.791 | 3.318 | 2 |
| | Banka | 4.107 | 79.912 | 3.282 | 1 |
| | Begusarai | 4.921 | 76.106 | 3.745 | 1 |
| | Bhagalpur | 4.243 | 75.385 | 3.198 | 1 |
| | Bhojpur | 3.940 | 74.068 | 2.919 | 1 |
| | Buxar | 4.713 | 70.337 | 3.315 | 2 |
| | Darbhanga | 4.287 | 73.578 | 3.154 | 1 |
| | Gaya | 4.837 | 72.971 | 3.529 | 1 |
| | Gopalganj | 4.355 | 69.447 | 3.025 | 2 |
| | Jamui | 3.967 | 80.735 | 3.202 | 1 |
| | Jehanabad | 4.029 | 75.044 | 3.024 | 1 |
| | Kaimur (Bhabua) | 3.777 | 71.500 | 2.701 | 2 |
| | Katihar | 4.311 | 77.101 | 3.324 | 1 |
| | Khagaria | 4.785 | 79.774 | 3.817 | 1 |
| | Kishanganj | 5.153 | 67.797 | 3.493 | 2 |
| | Lakhisarai | 4.927 | 76.531 | 3.771 | 1 |
| | Madhepura | 4.325 | 81.651 | 3.532 | 1 |
| | Madhubani | 4.460 | 75.399 | 3.363 | 1 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Munger | 3.737 | 75.044 | 2.804 | 1 |
| | Muzaffarpur | 4.205 | 75.042 | 3.155 | 1 |
| | Nalanda | 4.401 | 73.942 | 3.254 | 1 |
| | Nawada | 4.671 | 72.490 | 3.386 | 1 |
| | Pashchim Champaran | 4.306 | 75.620 | 3.256 | 1 |
| | Patna | 3.381 | 73.454 | 2.483 | 1 |
| | Purba Champaran | 4.138 | 76.632 | 3.171 | 1 |
| | Purnia | 4.419 | 79.015 | 3.491 | 1 |
| | Rohtas | 4.255 | 69.474 | 2.956 | 2 |
| | Saharsa | 4.260 | 83.080 | 3.539 | 1 |
| | Samastipur | 4.207 | 79.530 | 3.345 | 1 |
| | Saran | 4.065 | 71.910 | 2.923 | 2 |
| | Sheikhpura | 4.643 | 74.732 | 3.470 | 1 |
| | Sheohar | 4.396 | 73.998 | 3.253 | 1 |
| | Sitamarhi | 4.986 | 74.497 | 3.715 | 1 |
| | Siwan | 4.164 | 65.108 | 2.711 | 2 |
| | Supaul | 3.671 | 80.602 | 2.959 | 1 |
| | Vaishali | 4.375 | 77.025 | 3.370 | 1 |
| Chandigarh | | | | | |
| | Chandigarh | 2.586 | 64.744 | 1.675 | 4 |
| Chhattisgarh | | | | | |
| | Balod | 2.356 | 66.216 | 1.560 | 4 |
| | Baloda Bazar | 3.368 | 66.807 | 2.250 | 2 |
| | Balrampur | 3.521 | 70.037 | 2.466 | 2 |
| | Bastar | 3.347 | 69.196 | 2.316 | 2 |
| | Bemetara | 3.418 | 68.790 | 2.351 | 2 |
| | Bijapur | 2.842 | 65.439 | 1.860 | 4 |
| | Bilaspur | 3.030 | 65.181 | 1.975 | 3 |
| | Dantewada | 3.020 | 65.753 | 1.985 | 4 |
| | Dhamtari | 2.638 | 66.442 | 1.753 | 4 |
| | Durg | 2.693 | 67.196 | 1.810 | 4 |
| | Gariyaband | 2.675 | 69.338 | 1.855 | 4 |
| | Janjgir - Champa | 2.797 | 66.937 | 1.872 | 4 |
| | Jashpur | 2.921 | 70.866 | 2.070 | 4 |
| | Kabeerdham | 3.214 | 67.989 | 2.185 | 2 |
| | Kodagaon | 3.628 | 61.172 | 2.219 | 2 |
| | Korba | 3.418 | 63.789 | 2.180 | 2 |
| | Koriya | 3.025 | 68.969 | 2.086 | 3 |
| | Mahasamund | 2.601 | 67.385 | 1.753 | 4 |
| | Mungeli | 4.301 | 65.825 | 2.831 | 2 |
| | Narayanpur | 3.533 | 60.804 | 2.148 | 3 |
| | Raigarh | 2.947 | 64.251 | 1.893 | 4 |
| | Raipur | 3.045 | 66.860 | 2.036 | 3 |
| | Rajnandgaon | 2.718 | 66.228 | 1.800 | 4 |
| | Sukma | 3.335 | 64.839 | 2.163 | 3 |
| | Surajpur | 3.145 | 70.626 | 2.221 | 2 |
| | Surguja | 3.318 | 68.047 | 2.258 | 2 |
| | Uttar Bastar Kanker | 2.985 | 62.585 | 1.868 | 4 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| Dadra & Nagar Haveli and Daman and Diu | | | | | |
| | Dadra & Nagar Haveli | 2.687 | 72.031 | 1.935 | 5 |
| | Daman | 2.761 | 73.724 | 2.036 | 5 |
| | Diu | 3.601 | 55.300 | 1.991 | 3 |
| Delhi | | | | | |
| | Central | 2.468 | 64.167 | 1.584 | 4 |
| | East | 2.734 | 66.966 | 1.831 | 4 |
| | New Delhi | 3.192 | 71.785 | 2.291 | 2 |
| | North | 3.714 | 69.661 | 2.587 | 2 |
| | North East | 3.194 | 66.007 | 2.108 | 3 |
| | North West | 2.898 | 69.077 | 2.002 | 4 |
| | Shahdara | 3.158 | 62.766 | 1.982 | 3 |
| | South | 3.171 | 67.081 | 2.127 | 3 |
| | South East | 2.868 | 63.278 | 1.815 | 4 |
| | South West | 2.185 | 71.353 | 1.559 | 4 |
| | West | 3.158 | 66.517 | 2.101 | 3 |
| Goa | | | | | |
| | North Goa | 1.871 | 66.239 | 1.239 | 4 |
| | South Goa | 2.006 | 60.094 | 1.206 | 4 |
| Gujarat | | | | | |
| | Ahmadabad | 2.723 | 72.824 | 1.983 | 5 |
| | Amreli | 3.088 | 69.495 | 2.146 | 3 |
| | Anand | 2.815 | 79.206 | 2.229 | 6 |
| | Aravali | 3.519 | 74.248 | 2.613 | 1 |
| | Banas Kantha | 3.689 | 74.712 | 2.756 | 1 |
| | Bharuch | 3.057 | 71.992 | 2.201 | 2 |
| | Bhavnagar | 2.980 | 69.192 | 2.062 | 4 |
| | Botad | 3.603 | 70.761 | 2.549 | 2 |
| | Chhota Udaipur | 3.154 | 74.651 | 2.355 | 1 |
| | Devbhumi Dwarka | 3.559 | 71.324 | 2.538 | 2 |
| | Dohad | 3.993 | 73.409 | 2.931 | 1 |
| | Gandhinagar | 2.882 | 78.248 | 2.255 | 6 |
| | Gir Somnath | 2.995 | 67.221 | 2.013 | 4 |
| | Jamnagar | 2.660 | 67.901 | 1.806 | 4 |
| | Junagadh | 2.727 | 73.394 | 2.002 | 5 |
| | Kachchh | 3.390 | 68.904 | 2.336 | 2 |
| | Kheda | 2.852 | 76.964 | 2.195 | 6 |
| | Mahesana | 3.643 | 75.186 | 2.739 | 1 |
| | Mahisagar | 3.005 | 79.301 | 2.383 | 6 |
| | Morbi | 2.538 | 71.354 | 1.811 | 4 |
| | Narmada | 2.935 | 75.813 | 2.225 | 6 |
| | Navsari | 2.425 | 69.238 | 1.679 | 4 |
| | Panch Mahals | 2.911 | 74.394 | 2.165 | 5 |
| | Patan | 3.271 | 72.420 | 2.369 | 1 |
| | Porbandar | 2.742 | 70.242 | 1.926 | 4 |
| | Rajkot | 2.975 | 72.647 | 2.161 | 5 |
| | Sabar Kantha | 2.915 | 74.419 | 2.170 | 5 |
| | Surat | 2.826 | 72.169 | 2.039 | 5 |
| | Surendranagar | 3.234 | 73.077 | 2.363 | 1 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Tapi | 2.521 | 72.163 | 1.820 | 5 |
| | The Dangs | 3.312 | 77.155 | 2.555 | 1 |
| | Vadodara | 2.502 | 75.026 | 1.877 | 5 |
| | Valsad | 2.116 | 73.229 | 1.550 | 5 |
| Haryana | | | | | |
| | Ambala | 2.557 | 68.622 | 1.755 | 4 |
| | Bhiwani | 3.250 | 71.635 | 2.328 | 2 |
| | Charkhi Dadri | 3.011 | 74.579 | 2.245 | 6 |
| | Faridabad | 2.980 | 69.686 | 2.077 | 4 |
| | Fatehabad | 2.588 | 70.151 | 1.815 | 4 |
| | Gurgaon | 2.686 | 74.708 | 2.007 | 5 |
| | Hisar | 2.809 | 72.203 | 2.028 | 5 |
| | Jhajjar | 2.688 | 71.923 | 1.933 | 4 |
| | Jind | 3.074 | 69.363 | 2.132 | 3 |
| | Kaithal | 3.117 | 73.431 | 2.289 | 1 |
| | Karnal | 3.394 | 70.458 | 2.391 | 2 |
| | Kurukshetra | 2.639 | 74.210 | 1.958 | 5 |
| | Mahendragarh | 3.055 | 77.075 | 2.355 | 1 |
| | Mewat | 5.027 | 72.027 | 3.621 | 1 |
| | Palwal | 4.133 | 72.313 | 2.989 | 1 |
| | Panchkula | 3.180 | 68.862 | 2.190 | 2 |
| | Panipat | 2.946 | 74.304 | 2.189 | 6 |
| | Rewari | 2.692 | 75.402 | 2.030 | 5 |
| | Rohtak | 2.858 | 69.267 | 1.980 | 4 |
| | Sirsa | 3.122 | 69.894 | 2.182 | 2 |
| | Sonipat | 2.641 | 73.917 | 1.953 | 5 |
| | Yamunanagar | 2.686 | 71.878 | 1.930 | 4 |
| Himachal Pradesh | | | | | |
| | Bilaspur | 2.619 | 76.291 | 1.998 | 5 |
| | Chamba | 2.936 | 73.750 | 2.166 | 5 |
| | Hamirpur | 2.633 | 76.222 | 2.007 | 5 |
| | Kangra | 2.521 | 69.472 | 1.751 | 4 |
| | Kinnaur | 2.718 | 75.620 | 2.055 | 5 |
| | Kullu | 2.542 | 74.351 | 1.890 | 5 |
| | Lahul & Spiti | 2.648 | 79.708 | 2.111 | 5 |
| | Mandi | 2.509 | 78.603 | 1.972 | 5 |
| | Shimla | 2.502 | 71.032 | 1.777 | 4 |
| | Sirmaur | 3.461 | 71.956 | 2.490 | 2 |
| | Solan | 2.649 | 73.077 | 1.936 | 5 |
| | Una | 2.928 | 71.704 | 2.099 | 4 |
| Jammu & Kashmir | | | | | |
| | Anantnag | 3.296 | 55.862 | 1.841 | 3 |
| | Badgam | 3.387 | 57.210 | 1.938 | 3 |
| | Bandipore | 3.538 | 53.187 | 1.882 | 3 |
| | Baramula | 3.486 | 56.003 | 1.952 | 3 |
| | Doda | 3.347 | 67.218 | 2.250 | 2 |
| | Ganderbal | 3.499 | 60.092 | 2.102 | 3 |
| | Jammu | 2.287 | 65.330 | 1.494 | 4 |
| | Kathua | 2.672 | 62.602 | 1.673 | 4 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Kishtwar | 2.970 | 62.915 | 1.868 | 4 |
| | Kulgam | 3.320 | 59.164 | 1.964 | 3 |
| | Kupwara | 3.922 | 57.870 | 2.270 | 2 |
| | Pulwama | 3.015 | 58.109 | 1.752 | 4 |
| | Punch | 3.477 | 61.482 | 2.137 | 3 |
| | Rajouri | 3.374 | 65.094 | 2.196 | 2 |
| | Ramban | 3.577 | 63.525 | 2.272 | 2 |
| | Reasi | 3.197 | 68.007 | 2.174 | 2 |
| | Samba | 2.801 | 67.607 | 1.894 | 4 |
| | Shupiyan | 3.499 | 59.522 | 2.083 | 3 |
| | Srinagar | 2.544 | 58.124 | 1.479 | 4 |
| | Udhampur | 3.361 | 66.303 | 2.228 | 2 |
| Jharkhand | | | | | |
| | Bokaro | 3.043 | 75.431 | 2.296 | 1 |
| | Chatra | 3.730 | 75.226 | 2.806 | 1 |
| | Deoghar | 3.510 | 82.184 | 2.885 | 1 |
| | Dhanbad | 3.169 | 72.593 | 2.300 | 1 |
| | Dumka | 3.353 | 79.568 | 2.668 | 1 |
| | Garhwa | 3.993 | 73.156 | 2.921 | 1 |
| | Giridih | 3.282 | 79.587 | 2.612 | 1 |
| | Godda | 3.445 | 79.123 | 2.726 | 1 |
| | Gumla | 3.831 | 67.828 | 2.599 | 2 |
| | Hazaribagh | 3.364 | 76.190 | 2.563 | 1 |
| | Jamtara | 3.118 | 80.538 | 2.511 | 1 |
| | Khunti | 3.305 | 67.081 | 2.217 | 2 |
| | Kodarma | 3.533 | 74.866 | 2.645 | 1 |
| | Latehar | 4.052 | 70.364 | 2.851 | 2 |
| | Lohardaga | 3.523 | 66.016 | 2.326 | 2 |
| | Pakur | 3.435 | 75.407 | 2.590 | 1 |
| | Palamu | 3.784 | 70.796 | 2.679 | 2 |
| | Pashchimi Singhbhum | 3.303 | 69.132 | 2.284 | 2 |
| | Purbi Singhbhum | 2.828 | 70.367 | 1.990 | 4 |
| | Ramgarh | 4.131 | 71.623 | 2.959 | 2 |
| | Ranchi | 3.128 | 64.784 | 2.027 | 3 |
| | Sahibganj | 4.068 | 77.902 | 3.169 | 1 |
| | Saraikela-Kharsawan | 2.726 | 72.095 | 1.965 | 5 |
| | Simdega | 3.554 | 64.384 | 2.288 | 2 |
| Karnataka | | | | | |
| | Bagalkot | 3.043 | 72.185 | 2.197 | 1 |
| | Bangalore | 1.998 | 73.807 | 1.475 | 5 |
| | Bangalore Rural | 2.266 | 75.126 | 1.703 | 5 |
| | Belgaum | 3.019 | 72.638 | 2.193 | 6 |
| | Bellary | 2.646 | 68.527 | 1.813 | 4 |
| | Bidar | 3.105 | 69.687 | 2.164 | 3 |
| | Bijapur | 3.297 | 74.638 | 2.461 | 1 |
| | Chamarajanagar | 2.423 | 73.790 | 1.788 | 5 |
| | Chikkaballapura | 2.362 | 76.612 | 1.810 | 5 |
| | Chikmagalur | 2.176 | 73.744 | 1.605 | 5 |
| | Chitradurga | 2.207 | 76.694 | 1.693 | 5 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Dakshina Kannada | 2.605 | 67.867 | 1.768 | 4 |
| | Davanagere | 2.347 | 72.579 | 1.703 | 5 |
| | Dharwad | 2.135 | 69.746 | 1.489 | 4 |
| | Gadag | 2.875 | 70.664 | 2.032 | 4 |
| | Gulbarga | 2.904 | 72.613 | 2.109 | 5 |
| | Hassan | 2.122 | 72.052 | 1.529 | 5 |
| | Haveri | 2.438 | 73.431 | 1.790 | 5 |
| | Kodagu | 2.251 | 73.434 | 1.653 | 5 |
| | Kolar | 2.403 | 75.000 | 1.802 | 5 |
| | Koppal | 2.602 | 73.255 | 1.906 | 5 |
| | Mandya | 2.231 | 72.500 | 1.618 | 5 |
| | Mysore | 2.497 | 72.682 | 1.815 | 5 |
| | Raichur | 3.246 | 72.340 | 2.348 | 1 |
| | Ramanagara | 2.292 | 71.604 | 1.641 | 4 |
| | Shimoga | 2.036 | 72.460 | 1.476 | 5 |
| | Tumkur | 2.245 | 77.014 | 1.729 | 5 |
| | Udupi | 2.187 | 68.750 | 1.503 | 4 |
| | Uttara Kannada | 2.353 | 68.358 | 1.608 | 4 |
| | Yadgir | 3.074 | 71.418 | 2.196 | 2 |
| Kerala | | | | | |
| | Alappuzha | 1.967 | 74.017 | 1.456 | 5 |
| | Ernakulam | 2.067 | 72.449 | 1.498 | 5 |
| | Idukki | 2.238 | 73.270 | 1.640 | 5 |
| | Kannur | 2.241 | 77.333 | 1.733 | 5 |
| | Kasaragod | 2.669 | 75.129 | 2.006 | 5 |
| | Kollam | 2.039 | 73.507 | 1.499 | 5 |
| | Kottayam | 2.195 | 72.110 | 1.583 | 5 |
| | Kozhikode | 2.440 | 74.736 | 1.823 | 5 |
| | Malappuram | 3.253 | 77.800 | 2.531 | 1 |
| | Palakkad | 2.413 | 75.111 | 1.812 | 5 |
| | Pathanamthitta | 2.009 | 69.423 | 1.395 | 4 |
| | Thiruvananthapuram | 1.974 | 74.425 | 1.469 | 5 |
| | Wayanad | 2.726 | 73.174 | 1.995 | 5 |
| Ladakh | | | | | |
| | Kargil | 3.642 | 57.603 | 2.098 | 3 |
| | Leh(Ladakh) | 3.239 | 59.715 | 1.934 | 3 |
| Lakshadweep | | | | | |
| | Lakshadweep | 3.186 | 68.492 | 2.182 | 2 |
| Madhya Pradesh | | | | | |
| | Agar Malwa | 3.219 | 79.491 | 2.558 | 1 |
| | Alirajpur | 4.357 | 73.675 | 3.210 | 1 |
| | Anuppur | 3.257 | 70.734 | 2.303 | 2 |
| | Ashoknagar | 3.714 | 76.680 | 2.848 | 1 |
| | Balaghat | 2.521 | 68.433 | 1.725 | 4 |
| | Barwani | 3.315 | 74.537 | 2.471 | 1 |
| | Betul | 2.881 | 67.753 | 1.952 | 4 |
| | Bhind | 3.702 | 74.032 | 2.741 | 1 |
| | Bhopal | 2.713 | 66.017 | 1.791 | 4 |
| | Burhanpur | 3.218 | 70.370 | 2.265 | 2 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Chhatarpur | 3.236 | 72.432 | 2.344 | 1 |
| | Chhindwara | 2.749 | 65.969 | 1.813 | 4 |
| | Damoh | 3.678 | 75.201 | 2.766 | 1 |
| | Datia | 3.648 | 72.594 | 2.648 | 1 |
| | Dewas | 3.053 | 75.676 | 2.310 | 1 |
| | Dhar | 2.658 | 76.406 | 2.031 | 5 |
| | Dindori | 3.596 | 71.012 | 2.554 | 2 |
| | Guna | 3.768 | 74.249 | 2.797 | 1 |
| | Gwalior | 3.384 | 70.971 | 2.402 | 2 |
| | Harda | 3.799 | 73.680 | 2.799 | 1 |
| | Hoshangabad | 3.799 | 70.535 | 2.680 | 2 |
| | Indore | 2.680 | 75.450 | 2.022 | 5 |
| | Jabalpur | 2.519 | 68.880 | 1.735 | 4 |
| | Jhabua | 4.644 | 76.000 | 3.529 | 1 |
| | Katni | 3.254 | 71.311 | 2.321 | 2 |
| | Khandwa (East Nimar) | 3.607 | 71.611 | 2.583 | 2 |
| | Khargone (West Nimar) | 2.949 | 74.579 | 2.199 | 6 |
| | Mandla | 3.004 | 70.071 | 2.105 | 4 |
| | Mandsaur | 2.973 | 76.460 | 2.273 | 6 |
| | Morena | 3.936 | 75.680 | 2.979 | 1 |
| | Narsimhapur | 2.931 | 73.795 | 2.163 | 5 |
| | Neemuch | 3.019 | 74.531 | 2.250 | 6 |
| | Panna | 3.499 | 70.561 | 2.469 | 2 |
| | Raisen | 4.090 | 68.354 | 2.796 | 2 |
| | Rajgarh | 3.067 | 76.930 | 2.359 | 1 |
| | Ratlam | 3.048 | 78.335 | 2.388 | 1 |
| | Rewa | 4.438 | 69.254 | 3.073 | 2 |
| | Sagar | 3.910 | 74.808 | 2.925 | 1 |
| | Satna | 3.828 | 70.933 | 2.716 | 2 |
| | Sehore | 3.927 | 74.179 | 2.913 | 1 |
| | Seoni | 2.915 | 69.856 | 2.036 | 4 |
| | Shahdol | 2.742 | 70.460 | 1.932 | 4 |
| | Shajapur | 3.282 | 75.982 | 2.493 | 1 |
| | Sheopur | 3.327 | 75.185 | 2.502 | 1 |
| | Shivpuri | 3.684 | 75.164 | 2.769 | 1 |
| | Sidhi | 4.059 | 70.426 | 2.859 | 2 |
| | Singrauli | 4.612 | 72.418 | 3.340 | 1 |
| | Tikamgarh | 3.331 | 76.204 | 2.538 | 1 |
| | Ujjain | 3.148 | 76.361 | 2.404 | 1 |
| | Umaria | 3.529 | 69.417 | 2.450 | 2 |
| | Vidisha | 3.943 | 71.064 | 2.802 | 2 |
| Maharashtra | | | | | |
| | Ahmadnagar | 2.462 | 75.626 | 1.862 | 5 |
| | Akola | 2.732 | 74.176 | 2.026 | 5 |
| | Amravati | 2.384 | 71.442 | 1.703 | 4 |
| | Aurangabad | 2.668 | 78.508 | 2.095 | 5 |
| | Bhandara | 2.441 | 73.147 | 1.785 | 5 |
| | Bid | 2.795 | 78.361 | 2.190 | 6 |
| | Buldana | 2.492 | 75.468 | 1.881 | 5 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Chandrapur | 2.522 | 72.987 | 1.841 | 5 |
| | Dhule | 3.064 | 78.535 | 2.406 | 1 |
| | Gadchiroli | 2.284 | 73.197 | 1.672 | 5 |
| | Gondiya | 2.449 | 72.899 | 1.786 | 5 |
| | Hingoli | 2.772 | 76.603 | 2.123 | 5 |
| | Jalgaon | 2.675 | 77.193 | 2.065 | 5 |
| | Jalna | 2.930 | 79.943 | 2.342 | 6 |
| | Kolhapur | 2.355 | 76.205 | 1.795 | 5 |
| | Latur | 3.240 | 77.519 | 2.512 | 1 |
| | Mumbai | 2.179 | 67.742 | 1.476 | 4 |
| | Mumbai Suburban | 1.966 | 67.459 | 1.326 | 4 |
| | Nagpur | 2.379 | 68.785 | 1.636 | 4 |
| | Nanded | 2.956 | 75.489 | 2.232 | 6 |
| | Nandurbar | 2.949 | 73.784 | 2.176 | 6 |
| | Nashik | 3.392 | 76.742 | 2.603 | 1 |
| | Osmanabad | 2.867 | 80.704 | 2.314 | 6 |
| | Palghar | 2.685 | 69.371 | 1.863 | 4 |
| | Parbhani | 2.809 | 80.536 | 2.262 | 6 |
| | Pune | 2.232 | 73.749 | 1.646 | 5 |
| | Raigarh | 3.025 | 72.785 | 2.202 | 1 |
| | Ratnagiri | 3.153 | 69.378 | 2.187 | 2 |
| | Sangli | 1.769 | 77.387 | 1.369 | 5 |
| | Satara | 2.845 | 75.716 | 2.154 | 5 |
| | Sindhudurg | 1.927 | 68.997 | 1.330 | 4 |
| | Solapur | 3.580 | 76.644 | 2.744 | 1 |
| | Thane | 2.736 | 68.506 | 1.874 | 4 |
| | Wardha | 2.180 | 74.411 | 1.622 | 5 |
| | Washim | 2.970 | 78.537 | 2.333 | 6 |
| | Yavatmal | 2.371 | 73.849 | 1.751 | 5 |
| Manipur | | | | | |
| | Bishnupur | 3.052 | 65.319 | 1.993 | 3 |
| | Chandel | 4.185 | 66.248 | 2.772 | 2 |
| | Churachandpur | 3.256 | 61.806 | 2.012 | 3 |
| | Imphal East | 2.937 | 64.689 | 1.900 | 4 |
| | Imphal West | 3.136 | 64.540 | 2.024 | 3 |
| | Senapati | 4.258 | 64.883 | 2.762 | 2 |
| | Tamenglong | 3.690 | 69.899 | 2.579 | 2 |
| | Thoubal | 3.140 | 63.816 | 2.004 | 3 |
| | Ukhrul | 4.734 | 63.624 | 3.012 | 2 |
| Meghalaya | | | | | |
| | East Garo Hills | 3.670 | 63.060 | 2.314 | 2 |
| | East Jantia Hills | 6.333 | 61.224 | 3.877 | 2 |
| | East Khasi Hills | 3.852 | 54.474 | 2.098 | 3 |
| | North Garo Hills | 3.142 | 59.420 | 1.867 | 3 |
| | Ribhoi | 5.219 | 58.941 | 3.076 | 2 |
| | South Garo Hills | 3.059 | 67.701 | 2.071 | 3 |
| | South West Garo Hills | 3.130 | 63.248 | 1.980 | 3 |
| | South West Khasi Hills | 5.537 | 65.566 | 3.630 | 2 |
| | West Garo Hills | 3.112 | 67.336 | 2.095 | 3 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | West Jaintia Hills | 5.764 | 60.269 | 3.474 | 2 |
| | West Khasi Hills | 6.754 | 69.601 | 4.701 | 2 |
| Mizoram | | | | | |
| | Aizawl | 3.436 | 48.818 | 1.677 | 3 |
| | Champhai | 2.833 | 60.073 | 1.702 | 4 |
| | Kolasib | 2.896 | 61.033 | 1.767 | 4 |
| | Lawngtlai | 3.406 | 62.743 | 2.137 | 3 |
| | Lunglei | 2.601 | 53.049 | 1.380 | 4 |
| | Mamit | 3.488 | 63.747 | 2.224 | 2 |
| | Saiha | 2.645 | 62.636 | 1.657 | 4 |
| | Serchhip | 2.758 | 55.724 | 1.537 | 4 |
| Nagaland | | | | | |
| | Dimapur | 3.190 | 57.372 | 1.830 | 3 |
| | Kiphire | 3.564 | 72.896 | 2.598 | 1 |
| | Kohima | 4.035 | 48.778 | 1.968 | 3 |
| | Longleng | 4.294 | 69.989 | 3.006 | 2 |
| | Mokokchung | 3.400 | 55.395 | 1.884 | 3 |
| | Mon | 3.644 | 60.958 | 2.222 | 2 |
| | Peren | 3.929 | 62.540 | 2.457 | 2 |
| | Phek | 4.624 | 55.032 | 2.545 | 2 |
| | Tuensang | 4.973 | 60.628 | 3.015 | 2 |
| | Wokha | 3.716 | 59.824 | 2.223 | 2 |
| | Zunheboto | 4.659 | 58.259 | 2.714 | 2 |
| Odisha | | | | | |
| | Anugul | 2.680 | 73.353 | 1.966 | 5 |
| | Balangir | 2.929 | 68.020 | 1.993 | 4 |
| | Baleshwar | 2.710 | 78.863 | 2.137 | 5 |
| | Bargarh | 2.332 | 70.833 | 1.652 | 4 |
| | Baudh | 2.351 | 73.154 | 1.720 | 5 |
| | Bhadrak | 2.813 | 72.250 | 2.032 | 5 |
| | Cuttack | 2.046 | 72.598 | 1.485 | 5 |
| | Debagarh | 2.560 | 70.692 | 1.810 | 4 |
| | Dhenkanal | 2.939 | 73.333 | 2.155 | 5 |
| | Gajapati | 2.978 | 66.596 | 1.983 | 4 |
| | Ganjam | 3.111 | 73.001 | 2.271 | 1 |
| | Jagatsinghapur | 2.396 | 72.642 | 1.740 | 5 |
| | Jajapur | 2.904 | 73.812 | 2.143 | 5 |
| | Jharsuguda | 2.720 | 65.164 | 1.773 | 4 |
| | Kalahandi | 2.858 | 70.526 | 2.016 | 4 |
| | Kandhamal | 3.487 | 69.628 | 2.428 | 2 |
| | Kendrapara | 2.892 | 71.228 | 2.060 | 4 |
| | Kendujhar | 3.326 | 71.167 | 2.367 | 2 |
| | Khordha | 2.049 | 71.696 | 1.469 | 4 |
| | Koraput | 2.757 | 66.182 | 1.825 | 4 |
| | Malkangiri | 3.045 | 70.599 | 2.150 | 3 |
| | Mayurbhanj | 2.603 | 75.485 | 1.965 | 5 |
| | Nabarangapur | 3.750 | 72.857 | 2.732 | 1 |
| | Nayagarh | 2.761 | 78.712 | 2.174 | 5 |
| | Nuapada | 3.216 | 69.990 | 2.251 | 2 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Puri | 2.346 | 73.327 | 1.720 | 5 |
| | Rayagada | 3.168 | 71.901 | 2.278 | 2 |
| | Sambalpur | 2.408 | 64.769 | 1.559 | 4 |
| | Subarnapur | 2.586 | 70.389 | 1.820 | 4 |
| | Sundargarh | 2.551 | 65.329 | 1.666 | 4 |
| Puducherry | | | | | |
| | Karaikal | 2.260 | 65.279 | 1.475 | 4 |
| | Mahe | 2.399 | 70.344 | 1.688 | 4 |
| | Puducherry | 2.422 | 66.667 | 1.615 | 4 |
| | Yanam | 2.390 | 69.940 | 1.671 | 4 |
| Punjab | | | | | |
| | Amritsar | 2.693 | 71.233 | 1.918 | 4 |
| | Barnala | 2.383 | 72.753 | 1.734 | 5 |
| | Bathinda | 2.695 | 72.885 | 1.964 | 5 |
| | Faridkot | 2.696 | 73.033 | 1.969 | 5 |
| | Fatehgarh Sahib | 2.510 | 72.128 | 1.811 | 5 |
| | Fazilka | 3.010 | 70.416 | 2.120 | 4 |
| | Firozpur | 2.719 | 71.951 | 1.956 | 4 |
| | Gurdaspur | 2.474 | 71.884 | 1.778 | 4 |
| | Hoshiarpur | 2.768 | 66.917 | 1.852 | 4 |
| | Jalandhar | 2.915 | 67.517 | 1.968 | 4 |
| | Kapurthala | 2.784 | 66.865 | 1.862 | 4 |
| | Ludhiana | 3.234 | 69.141 | 2.236 | 2 |
| | Mansa | 2.943 | 69.409 | 2.043 | 4 |
| | Moga | 2.604 | 70.084 | 1.825 | 4 |
| | Muktsar | 2.773 | 71.795 | 1.991 | 4 |
| | Pathankot | 2.633 | 71.113 | 1.872 | 4 |
| | Patiala | 2.750 | 71.702 | 1.972 | 4 |
| | Rupnagar | 2.906 | 67.751 | 1.969 | 4 |
| | Sahibzada Ajit Singh Nagar | 2.343 | 75.426 | 1.767 | 5 |
| | Sangrur | 2.765 | 69.956 | 1.934 | 4 |
| | Shahid Bhagat Singh Nagar | 2.512 | 65.755 | 1.652 | 4 |
| | Tarn Taran | 2.957 | 69.265 | 2.048 | 4 |
| Rajasthan | | | | | |
| | Ajmer | 2.900 | 73.131 | 2.121 | 5 |
| | Alwar | 3.723 | 74.693 | 2.781 | 1 |
| | Banswara | 3.198 | 70.840 | 2.266 | 2 |
| | Baran | 3.132 | 72.288 | 2.264 | 1 |
| | Barmer | 3.568 | 68.761 | 2.454 | 2 |
| | Bharatpur | 4.217 | 70.136 | 2.958 | 2 |
| | Bhilwara | 3.602 | 75.198 | 2.709 | 1 |
| | Bikaner | 3.323 | 75.826 | 2.520 | 1 |
| | Bundi | 3.401 | 72.534 | 2.467 | 1 |
| | Chittaurgarh | 3.038 | 77.628 | 2.358 | 1 |
| | Churu | 3.441 | 73.177 | 2.518 | 1 |
| | Dausa | 3.812 | 72.117 | 2.749 | 1 |
| | Dhaulpur | 4.107 | 73.660 | 3.025 | 1 |
| | Dungarpur | 3.299 | 70.940 | 2.340 | 2 |
| | Ganganagar | 2.794 | 71.975 | 2.011 | 4 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Hanumangarh | 3.360 | 72.586 | 2.439 | 1 |
| | Jaipur | 3.111 | 73.213 | 2.278 | 1 |
| | Jaisalmer | 3.675 | 71.228 | 2.618 | 2 |
| | Jalor | 3.597 | 71.479 | 2.571 | 2 |
| | Jhalawar | 3.086 | 75.000 | 2.314 | 1 |
| | Jhunjhunun | 3.191 | 68.300 | 2.180 | 2 |
| | Jodhpur | 3.141 | 71.941 | 2.260 | 2 |
| | Karauli | 4.492 | 72.586 | 3.260 | 1 |
| | Kota | 2.953 | 68.604 | 2.026 | 4 |
| | Nagaur | 3.298 | 70.110 | 2.312 | 2 |
| | Pali | 3.465 | 67.705 | 2.346 | 2 |
| | Pratapgarh | 3.548 | 74.166 | 2.631 | 1 |
| | Rajsamand | 3.002 | 71.189 | 2.137 | 4 |
| | Sawai Madhopur | 4.007 | 74.295 | 2.977 | 1 |
| | Sikar | 3.324 | 72.273 | 2.402 | 1 |
| | Sirohi | 4.225 | 69.292 | 2.927 | 2 |
| | Tonk | 3.512 | 72.836 | 2.558 | 1 |
| | Udaipur | 3.361 | 72.319 | 2.430 | 1 |
| Sikkim | | | | | |
| | East District | 2.268 | 62.544 | 1.418 | 4 |
| | North District | 2.359 | 67.995 | 1.604 | 4 |
| | South District | 1.972 | 70.604 | 1.392 | 4 |
| | West District | 2.326 | 63.384 | 1.474 | 4 |
| Tamil Nadu | | | | | |
| | Ariyalur | 2.524 | 75.669 | 1.910 | 5 |
| | Chennai | 2.072 | 67.564 | 1.400 | 4 |
| | Coimbatore | 1.927 | 72.914 | 1.405 | 5 |
| | Cuddalore | 2.135 | 72.109 | 1.540 | 5 |
| | Dharmapuri | 2.316 | 73.950 | 1.712 | 5 |
| | Dindigul | 2.291 | 76.715 | 1.758 | 5 |
| | Erode | 2.264 | 71.574 | 1.621 | 4 |
| | Kancheepuram | 2.454 | 70.034 | 1.719 | 4 |
| | Kanniyakumari | 2.019 | 75.446 | 1.523 | 5 |
| | Karur | 2.127 | 71.567 | 1.523 | 4 |
| | Krishnagiri | 2.657 | 76.696 | 2.038 | 5 |
| | Madurai | 2.159 | 70.104 | 1.513 | 4 |
| | Nagapattinam | 2.397 | 68.010 | 1.630 | 4 |
| | Namakkal | 2.058 | 71.031 | 1.462 | 4 |
| | Perambalur | 2.722 | 74.459 | 2.027 | 5 |
| | Pudukkottai | 2.774 | 72.277 | 2.005 | 5 |
| | Ramanathapuram | 2.291 | 75.216 | 1.723 | 5 |
| | Salem | 2.581 | 73.429 | 1.895 | 5 |
| | Sivaganga | 2.172 | 71.778 | 1.559 | 4 |
| | Thanjavur | 2.211 | 71.545 | 1.582 | 4 |
| | The Nilgiris | 2.261 | 69.803 | 1.578 | 4 |
| | Theni | 2.463 | 75.915 | 1.870 | 5 |
| | Thiruvallur | 2.269 | 74.235 | 1.685 | 5 |
| | Thiruvannamalai | 2.335 | 70.537 | 1.647 | 4 |
| | Thiruvarur | 2.493 | 69.212 | 1.725 | 4 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Thoothukkudi | 2.769 | 68.608 | 1.900 | 4 |
| | Thrissur | 1.988 | 70.929 | 1.410 | 4 |
| | Tiruchirappalli | 2.343 | 71.226 | 1.669 | 4 |
| | Tirunelveli | 2.142 | 73.737 | 1.580 | 5 |
| | Tiruppur | 2.256 | 71.409 | 1.611 | 4 |
| | Vellore | 2.725 | 73.467 | 2.002 | 5 |
| | Viluppuram | 2.906 | 72.368 | 2.103 | 5 |
| | Virudhunagar | 2.244 | 69.381 | 1.557 | 4 |
| Telangana | | | | | |
| | Adilabad | 3.286 | 74.030 | 2.433 | 1 |
| | Bhadradri Kothagudem | 2.196 | 72.439 | 1.591 | 5 |
| | Hyderabad | 2.678 | 66.549 | 1.782 | 4 |
| | Jagitial | 2.337 | 75.163 | 1.757 | 5 |
| | Jangoan | 2.378 | 76.556 | 1.821 | 5 |
| | Jayashankar Bhupalapally | 2.275 | 76.637 | 1.743 | 5 |
| | Jogulamba Gadwal | 2.773 | 77.527 | 2.150 | 5 |
| | Kamareddy | 2.320 | 76.101 | 1.766 | 5 |
| | Karimnagar | 1.959 | 74.946 | 1.469 | 5 |
| | Khammam | 2.228 | 73.774 | 1.643 | 5 |
| | Komaram Bheem Asifabad | 2.408 | 73.140 | 1.761 | 5 |
| | Mahabubabad | 2.194 | 74.362 | 1.631 | 5 |
| | Mahabubnagar | 2.801 | 74.904 | 2.098 | 5 |
| | Mancherial | 2.089 | 71.544 | 1.495 | 4 |
| | Medak | 2.636 | 75.255 | 1.984 | 5 |
| | Medchal-Malkajgiri | 2.570 | 72.626 | 1.866 | 5 |
| | Nagarkurnool | 2.483 | 72.860 | 1.809 | 5 |
| | Nalgonda | 2.344 | 76.138 | 1.784 | 5 |
| | Nirmal | 2.147 | 74.497 | 1.600 | 5 |
| | Nizamabad | 2.200 | 74.684 | 1.643 | 5 |
| | Peddapalli | 2.136 | 73.168 | 1.563 | 5 |
| | Rajanna Sircilla | 2.594 | 75.940 | 1.970 | 5 |
| | Ranga Reddy | 2.720 | 73.503 | 1.999 | 5 |
| | Sangareddy | 3.107 | 73.970 | 2.298 | 1 |
| | Siddipet | 2.369 | 77.111 | 1.827 | 5 |
| | Suryapet | 2.392 | 77.614 | 1.857 | 5 |
| | Vikarabad | 2.849 | 74.395 | 2.120 | 5 |
| | Wanaparthy | 2.733 | 70.629 | 1.930 | 4 |
| | Warangal Rural | 2.300 | 78.596 | 1.808 | 5 |
| | Warangal Urban | 2.395 | 74.252 | 1.778 | 5 |
| | Yadadri Bhuvanagiri | 2.503 | 71.821 | 1.798 | 4 |
| Tripura | | | | | |
| | Dhalai | 2.907 | 78.322 | 2.277 | 6 |
| | Gomati | 2.207 | 81.709 | 1.803 | 5 |
| | Khowai | 2.084 | 80.068 | 1.669 | 5 |
| | North Tripura | 2.642 | 72.643 | 1.919 | 5 |
| | Sepahijala | 2.724 | 81.481 | 2.220 | 6 |
| | South Tripura | 2.199 | 81.525 | 1.793 | 5 |
| | Unakoti | 3.249 | 75.879 | 2.465 | 1 |
| | West Tripura | 2.096 | 81.159 | 1.701 | 5 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| Uttar Pradesh | | | | | |
| | Agra | 4.237 | 69.447 | 2.942 | 2 |
| | Aligarh | 3.494 | 70.858 | 2.476 | 2 |
| | Allahabad | 4.736 | 67.259 | 3.186 | 2 |
| | Ambedkar Nagar | 4.816 | 60.455 | 2.911 | 2 |
| | Amethi | 4.828 | 65.598 | 3.167 | 2 |
| | Auraiya | 4.156 | 70.893 | 2.946 | 2 |
| | Azamgarh | 3.628 | 63.290 | 2.296 | 2 |
| | Baghpat | 3.766 | 67.960 | 2.559 | 2 |
| | Bahraich | 4.175 | 74.494 | 3.110 | 1 |
| | Ballia | 3.615 | 65.321 | 2.361 | 2 |
| | Balrampur | 4.030 | 72.253 | 2.912 | 1 |
| | Banda | 4.257 | 69.089 | 2.941 | 2 |
| | Bara Banki | 4.694 | 64.434 | 3.025 | 2 |
| | Bareilly | 4.596 | 63.870 | 2.935 | 2 |
| | Basti | 3.532 | 65.621 | 2.318 | 2 |
| | Bijnor | 4.097 | 60.707 | 2.487 | 2 |
| | Budaun | 4.981 | 67.980 | 3.386 | 2 |
| | Bulandshahr | 3.642 | 71.715 | 2.612 | 2 |
| | Chandauli | 3.473 | 70.456 | 2.447 | 2 |
| | Chitrakoot | 3.591 | 69.376 | 2.491 | 2 |
| | Deoria | 3.159 | 67.243 | 2.124 | 3 |
| | Etah | 5.068 | 67.882 | 3.440 | 2 |
| | Etawah | 3.757 | 69.315 | 2.604 | 2 |
| | Faizabad | 3.506 | 66.552 | 2.333 | 2 |
| | Farrukhabad | 4.460 | 66.565 | 2.969 | 2 |
| | Fatehpur | 4.261 | 66.125 | 2.817 | 2 |
| | Firozabad | 4.145 | 71.234 | 2.953 | 2 |
| | Gautam Buddha Nagar | 3.178 | 69.263 | 2.201 | 2 |
| | Ghaziabad | 3.695 | 68.449 | 2.529 | 2 |
| | Ghazipur | 3.926 | 67.941 | 2.667 | 2 |
| | Gonda | 4.130 | 67.826 | 2.801 | 2 |
| | Gorakhpur | 3.943 | 66.251 | 2.612 | 2 |
| | Hamirpur | 3.697 | 67.661 | 2.501 | 2 |
| | Hapur | 3.713 | 69.842 | 2.593 | 2 |
| | Hardoi | 4.586 | 67.442 | 3.093 | 2 |
| | Jalaun | 3.424 | 71.967 | 2.464 | 2 |
| | Jaunpur | 3.398 | 66.585 | 2.263 | 2 |
| | Jhansi | 3.236 | 71.501 | 2.314 | 2 |
| | Jyotiba Phule Nagar | 4.835 | 62.953 | 3.044 | 2 |
| | Kannauj | 4.448 | 66.568 | 2.961 | 2 |
| | Kanpur Dehat | 3.615 | 69.165 | 2.500 | 2 |
| | Kanpur Nagar | 3.392 | 67.283 | 2.282 | 2 |
| | Kanshiram Nagar | 5.331 | 70.742 | 3.771 | 2 |
| | Kaushambi | 5.585 | 67.451 | 3.767 | 2 |
| | Kheri | 3.985 | 68.704 | 2.738 | 2 |
| | Kushinagar | 3.448 | 68.553 | 2.364 | 2 |
| | Lalitpur | 4.149 | 76.420 | 3.171 | 1 |
| | Lucknow | 3.136 | 65.742 | 2.062 | 3 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Mahamaya Nagar | 3.680 | 68.818 | 2.532 | 2 |
| | Mahoba | 4.171 | 66.714 | 2.783 | 2 |
| | Mahrajganj | 3.426 | 71.018 | 2.433 | 2 |
| | Mainpuri | 4.446 | 66.463 | 2.955 | 2 |
| | Mathura | 4.151 | 72.252 | 2.999 | 1 |
| | Mau | 4.054 | 62.055 | 2.516 | 2 |
| | Meerut | 4.430 | 66.191 | 2.932 | 2 |
| | Mirzapur | 3.430 | 71.887 | 2.466 | 2 |
| | Moradabad | 4.042 | 63.008 | 2.547 | 2 |
| | Muzaffarnagar | 3.688 | 67.213 | 2.479 | 2 |
| | Pilibhit | 3.806 | 68.855 | 2.621 | 2 |
| | Pratapgarh | 4.257 | 66.145 | 2.816 | 2 |
| | Rae Bareli | 4.362 | 64.752 | 2.824 | 2 |
| | Rampur | 5.714 | 61.224 | 3.499 | 2 |
| | Saharanpur | 3.377 | 65.444 | 2.210 | 2 |
| | Sambhal | 4.182 | 67.299 | 2.814 | 2 |
| | Sant Kabir Nagar | 3.530 | 66.025 | 2.330 | 2 |
| | Sant Ravidas Nagar (Bhadohi) | 3.573 | 71.768 | 2.564 | 2 |
| | Shahjahanpur | 5.185 | 70.774 | 3.670 | 2 |
| | Shamli | 3.978 | 64.919 | 2.582 | 2 |
| | Shrawasti | 4.348 | 79.389 | 3.452 | 1 |
| | Siddharthnagar | 4.495 | 69.862 | 3.140 | 2 |
| | Sitapur | 3.760 | 69.842 | 2.626 | 2 |
| | Sonbhadra | 3.534 | 72.699 | 2.569 | 1 |
| | Sultanpur | 4.679 | 65.476 | 3.064 | 2 |
| | Unnao | 3.624 | 66.125 | 2.396 | 2 |
| | Varanasi | 3.389 | 67.819 | 2.298 | 2 |
| Uttarakhand | | | | | |
| | Almora | 2.488 | 67.213 | 1.672 | 4 |
| | Bageshwar | 2.766 | 73.044 | 2.020 | 5 |
| | Chamoli | 2.716 | 71.190 | 1.934 | 4 |
| | Champawat | 3.744 | 69.880 | 2.616 | 2 |
| | Dehradun | 2.900 | 66.488 | 1.928 | 4 |
| | Garhwal | 3.102 | 65.160 | 2.021 | 3 |
| | Hardwar | 4.705 | 68.366 | 3.217 | 2 |
| | Nainital | 3.231 | 68.921 | 2.227 | 2 |
| | Pithoragarh | 2.925 | 72.000 | 2.106 | 5 |
| | Rudraprayag | 3.218 | 72.014 | 2.317 | 1 |
| | Tehri Garhwal | 3.194 | 70.231 | 2.243 | 2 |
| | Udham Singh Nagar | 3.634 | 69.921 | 2.541 | 2 |
| | Uttarkashi | 2.894 | 73.429 | 2.125 | 5 |
| West Bengal | | | | | |
| | Bankura | 2.565 | 79.539 | 2.040 | 5 |
| | Birbhum | 2.741 | 80.202 | 2.198 | 6 |
| | Dakshin Dinajpur | 2.512 | 77.787 | 1.954 | 5 |
| | Darjiling | 2.379 | 70.686 | 1.681 | 4 |
| | Haora | 2.021 | 74.608 | 1.507 | 5 |
| | Hugli | 1.838 | 78.585 | 1.444 | 5 |
| | Jalpaiguri | 3.165 | 72.297 | 2.288 | 1 |

| State/Union Territory | District | TMFR | Proportion married | TFR | Fertility profile |
|---|---|---|---|---|---|
| | Koch Bihar | 2.922 | 79.893 | 2.334 | 6 |
| | Kolkata | 1.877 | 68.483 | 1.285 | 4 |
| | Maldah | 3.051 | 77.257 | 2.357 | 1 |
| | Murshidabad | 2.696 | 79.304 | 2.138 | 5 |
| | Nadia | 2.352 | 80.805 | 1.901 | 5 |
| | North Twenty Four Parganas | 2.279 | 77.736 | 1.772 | 5 |
| | Paschim Barddhaman | 2.519 | 74.125 | 1.867 | 5 |
| | Paschim Medinipur | 2.431 | 82.673 | 2.010 | 5 |
| | Purba Barddhaman | 2.471 | 80.927 | 2.000 | 5 |
| | Purba Medinipur | 1.969 | 83.219 | 1.639 | 5 |
| | Puruliya | 3.279 | 75.135 | 2.464 | 1 |
| | South Twenty Four Parganas | 2.592 | 81.341 | 2.108 | 5 |
| | Uttar Dinajpur | 3.539 | 71.690 | 2.537 | 2 |

Source: Authors' calculations

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# India's Progress in SDG3 – Good Health and Well-Being Some Insights

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## Abstract

The Government of India has constructed and released a composite SDG India Index to monitor the progress in Sustainable Development Goals (SDGs) in the country and in its States and Union Territories since 2018. In this paper, we highlight some of the limitations of the SDG India Index released by the Government of India through a detailed exposition of the Index with reference to SDG3 – Good health and Well-being. In view of the limitations of the SDG3 India Index, we also suggest two alternative, data-driven, approaches to construct a composite index to measure the progress in SDG3. We also show that the rank of states/Union Territories vis-à-vis progress in SDG3 changes significantly when the alternative, data-driven approach is used for the construction of the composite index of progress in SDG3. The paper calls for adopting a more appropriate set of indicators and a more refined methodology for the construction of SDG3 India Index in particular and SDG India Index in general.

## Introduction

The United Nations 2030 Agenda for Sustainable Development calls for safeguarding our future through economic growth, social inclusion, and social protection and to ensure that no one is left behind (United Nations, 2015). The core of the agenda is a set of 17 goals popularly known as Sustainable Development Goals (SDGs) to be achieved by the year 2030 – 1) No poverty; 2) Zero hunger; 3) Good health and well-being; 4) Quality education and lifelong learning; 5) Clean water and sanitation; 6) Gender equality; 7) Affordable and clean energy; 8) Decent work and economic growth; 9) Industry motivation and infrastructure; 10) Reduced inequalities; 11) Sustainable cities and communities; 12) Responsible consumption and production; 13) Climatic action; 14) Life below water; 15) Life on land; 16) Peace, justice and strong institutions; and 17) Partnerships for the Goals. These goals, apart from being ideal and multidimensional, also reinforce each other. India has endorsed the United Nations 2030 Agenda for Sustainable Development and is committed to achieving SDGs. This commitment is reflected in the country contextualization of SDGs and construction of the SDG India Index (SII) to monitor the progress towards SDGs in the country and in its states and Union Territories. The first SII was released by the Government of India in 2018 and served as the benchmark to chart the progress towards SDGs (Government of India, 2018).

Subsequently, SII has been released in 2019, 2020-2021 and 2023-2024 (Government of India, 2019; 2021; 2024). The change in SII reflects how the country and its states/Union Territories are progressing in terms of SDGs.

The SII for different years is, however, not strictly comparable because of data limitations including non-availability of data related to some indicators, quality of data, varied sources, some being schemes and not outcome indicators. The first SII, released in 2018, was based on 62 indictors and 39 targets related to 13 SDGs; the second SII, released in 2019, was based on 100 indicators and 54 targets related to 16 SDGs; the third SII, released in 2021, was based on 115 indicators and 70 targets related to 16 SDGs; and the fourth and the latest SII, released in 2024 is based on 113 indicators and 70 targets related to 16 goals (Government of India, 2024).

Given the many limitations of SII, there is a need to explore alternative approaches to construct an index to monitor the progress in different SDGs. In this paper, we propose alternative, data-driven approaches for the construction of a composite index to reflect the progress in SDG3 – good health and well-being. We have found that the rank of a state/Union Territory in terms of the progress in SDG3 based on alternative approaches proposed in this paper is different from the rank based on the SDG3 India Index (S3II) released by the Government of India. Since any index reflecting good health and well-being is essentially multidimensional in its construct, we also emphasise that there is a need for giving careful consideration to the indicators used for the construction of the composite index as different set of indicators may reflect different progress towards SDG3.

There are many limitations of the SII because of which it depicts a distorted picture of progress towards SDGs in the states and Union Territories of the country. These limitations are related to both data used and the methodology adopted. The time reference of different indicators used to construct the SII is not the same. For example, out of the 115 indicators used for the construction of SII 2021-2021, only 26 has the reference period 2020-2021 while 31 indicators date to the period 2019-2020; 34 to the period 2018-2019; and 24 to the period before 2018 (Government of India, 2021).

Another problem with the SII is the methodology adopted for computing goal of score for each of the first 16 SDGs. The goal score for SDG17 has not been computed. The goal score for each SDG has been obtained by working out the simple average of the normalised values of the indicators used in the construction of the index, implying equal weight to all indicators under each SDG. The goal scores in different SDGs are then averaged to obtain the SII (Government of India, 2022a). There are, however, many states and Union Territories for which data related to the indicators used in the construction of the composite index for different SDGs are not available. In such a situation, the average is computed for only those indicators for which the data are available or the 'non-null' indicators. This means that the goal scores for different states and Union Territories for the same SDG are not comparable as they are based on different set of indicators in different states and Union Territories. Since the goal scores of different states and Union Territories for the same SDG are not comparable, the rank of a state or Union Territory based on these goal scores is misleading.

## Objectives

This paper has two objectives. The first is to highlight the limitations of the SDG3 India Index (S3II) in ranking the states and Union Territories of the country in terms of progress towards SDG3. These limitations are related to the indicators used in the construction of the index and to the methodology adopted for eliciting 'goal-scores' towards the assessment of progress or performance in SDG3. The second objective of the paper, on the other hand, is to rank states and Union Territories of the country using an alternative set of indicators and a different methodology. The study shows that if the indicators used and the methodology adopted for the construction of the index are changed, the rank of states and Union Territories also changes significantly. The paper, therefore, calls for adopting a more appropriate set of indicators and a more refined methodology for the construction of SII.

## SDG3 India Index

The SDG3 aims at improving mother and child health, tackling HIV/AIDS, tuberculosis, malaria, and other communicable and non-communicable diseases in the quest towards good health and wellbeing of the people. The SDG India Index Report highlights complexities and interconnectedness between good health and well-being and stresses that achieving SDG3 will lead to reduction in burdens on family and public resources thereby strengthening societies (Government of India, 2022a). The report also mentions that several initiatives taken by the country like Ayushman Bharat Yojana, Pradhan Mantri Bhartiya Janaushdhi Pariyojana, Poshan and Amenia Mukt Bharat have contributed towards accelerating the progress in SDG3. The SDG3 India Index is based on a set of 10 indicators (Table 1). The SDG3 India Index (S3II) is the average of the normalised values of the indicators.

Table 1: The list of indicators used by the Government of India for the construction of SDG3 India Index (S3II).

| SDG3 Indicator | Name | Definition of the Indicator |
|---|---|---|
| 3.1 | MMR | Maternal mortality ratio per 100 thousand live births |
| 3.2 | CMR | Under 5 mortality rate per 1000 live births |
| 3.3 | IMM | Children aged 1-2 years fully immunised |
| 3.4 | TBR | Tuberculosis infection rate per 100 thousand population |
| 3.5 | HIV | HIV infected persons per 1000 population |
| 3.6 | SUR | Suicide rate per 100 thousand population |
| 3.7 | DRT | Death rate due to road traffic accidents per 100 thousand population |
| 3.8 | IDL | Percentage of institutional deliveries out of total deliveries |
| 3.9 | OPE | Monthly per capita out-of-pocket expenditure on health as the proportion of monthly per capita consumption expenditure (MPCE) |
| 3.10 | PNM | Total number of physicians, nurses, and mid-wives per ten thousand population |

Source: Government of India (2022b).

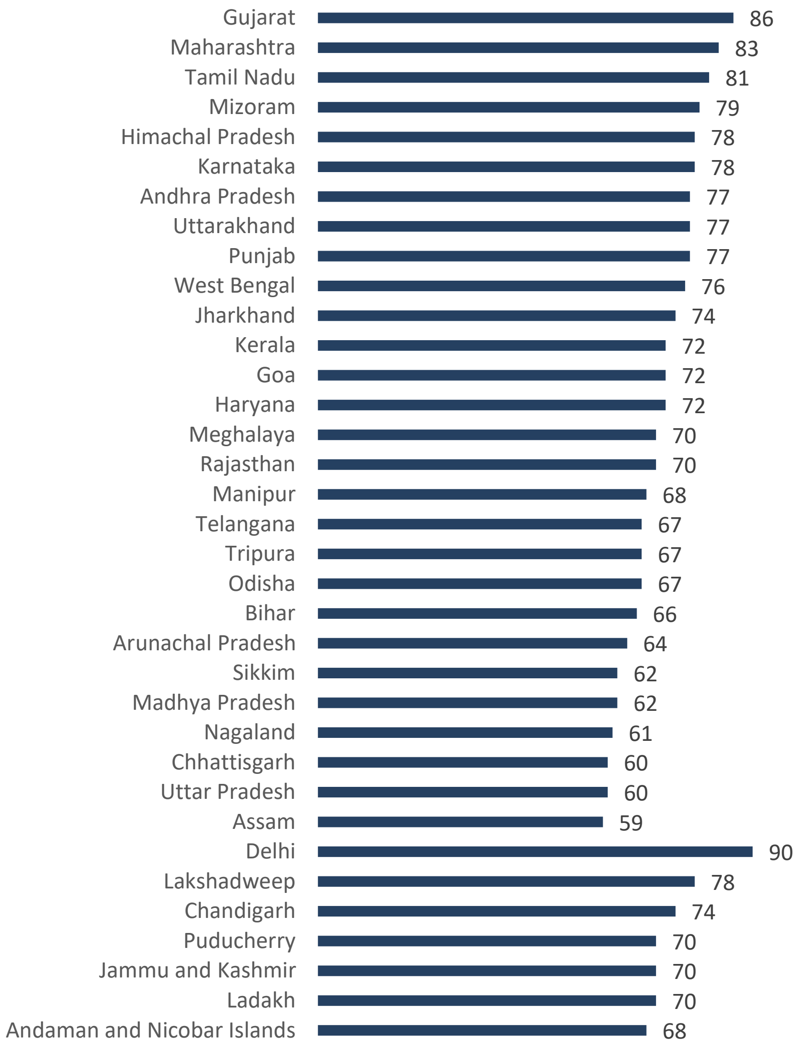


Figure 1: SDG3 India Index (S3II) for states and Union Territories of India, 2020-2021.
Source: Government of India (2022b)

The S3II for India is estimated to be 74 in 2023-2024 against the maximum possible value of 100. The Index varies widely across states and Union Territories. There are only 11 states and 2 Union Territories in which the S3II is higher than the national average (Figure 1). Gujarat ranks first among the 28 states while Assam ranks the last in S3II. Among Union Territories, Delhi ranks first while Andaman and Nicobar Islands ranks last. Combining states and Union Territories, Delhi ranks first while Assam ranks the last in S3II.

The ranking of states and Union Territories based on the S3II, however, is at odds with the ranking of states and Union Territories with respect to the life expectancy at birth, the most popularly used indicator of population health. Estimates available from the Global Data Lab suggest that the life expectancy at birth was the highest in Kerala in 2022 but the lowest in Uttar Pradesh. Kerala, however, ranks 14 in terms of S3II even lower than Jharkhand. Similarly, Delhi ranks first in terms of S3II but 18 in terms of the life expectancy at birth while Gujarat ranks second in terms of S3II but 21 in terms of the life expectancy at birth. In some states and Union Territories of the country, however, the rank in terms of S3II and the rank in terms of the life expectancy at birth is quite similar. For example, Uttar Pradesh ranks 32 in terms of S3II and 33 in terms of the life expectancy at birth while Madhya Pradesh ranks 29 in terms of S3II and 32 in terms of the life expectancy at birth. This raises concern about the relevance of S3II in monitoring progress towards SDG3 across states and Union Territories of the country.

There are many reasons why S3II depicts a distorted picture of the progress in good health and well-being across states and Union Territories of the country. These limitations are related to both data used and the methodology adopted. S3II is the average of the normalised values of 10 indicators (Table 1) but estimates of all the 10 indicators are available for only 19 states of the country only. In the remaining 18 states and Union Territories, the S3II is calculated as the average of the normalised values of only those indicators for which estimates are available. For example, S3II for Lakshadweep is the simple average of the normalised values of only 6 indicators whereas the S3II for Dadra & Nagar Haveli and Daman & Diu, Puducherry and Sikkim is the simple average of 7 indicators. This means that S3II is comparable for only those 19 states of the country for which estimates of all the 10 indicators are available. In 9 states and Union Territories, S3II is the simple average of 8 indicators whereas in 3 states and Union Territories, it is the simple average of 9 indicators.

Another problem with S3II is that it has been obtained by working out the simple average of the normalised values of the indicators, implying equal weight to all the indicators. The S3II, therefore, is associated with the problem of perfect substitutability which means that slow progress in terms of any one of the 10 indicators is fully compensated by the rapid progress in other indicators. In many states, the normalised values of some indicators is 1 which is associated with very low normalised values of other indicators but this inequality in progress in different indicators is not reflected in S3II. From policy and programme perspective, S3II should have given more weight to that indicator in which the progress is slow as compared to the indicator in which progress is fast so that more attention could be paid to that aspect of good health and well-being in which the progress is comparatively poor. There are many states and Union Territories in which the normalised values of some of the indicators has been set equal to 1 in the construction of S3II as these states and Union Territories have already achieved the target. This means that any further improvement in these indicators do not contribute at all to the improvement in the S3II.

There are data problems also. In Jammu & Kashmir and in Ladakh, the per centage of fully immunised children aged 9-11 months is estimated to be more than 100 per cent which is not possible. There is, however, no discussion on the quality of the data in the construction of S3II. Given all these limitations, we argue that S3II is not suitable to rank states and Union Territories of the country to reflect the progress towards SDG3–good health and well-being. There is a need of more refined methodology to construct a composite index that better reflects the progress towards SDG3 in the states and Union Territories of the country.

## Alternative SDG3 India Index

For the sake of comparison, we have used the same set of 10 indicators and the same dataset that are used in the construction of S3II to construct an alternative SDG3 India Index ($S3II_A$). The approach followed by us to construct the alternative $S3II_A$ is summarised in the following steps:

1. The raw scores of the 10 indicators have been normalised by calculating the z-score. The z-score has been calculated different for indicators in which an increase reflects the progress and for indicators in which a decrease reflects the progress. If $r_{kj}$ is the raw score of indicator $k$ in state/Union Territory $j$, then the z-score for the indicator $k$ in state/Union Territory $j$ in which the increase reflects the progress is calculated as

   $$z_{kj} = \frac{r_{kj} - \overline{r_k}}{\sigma_k}$$

   where $\overline{r_k}$ is the arithmetic mean and $\sigma_k$ is the standard deviation of $r_{kj}$ over all $j$. On the other hand, the z-score for the indicator in which the decrease reflects the progress is calculated as

   $$z_{kj} = \frac{\overline{r_k} - r_{kj}}{\sigma_k}$$

   Using z-score for normalisation obviates the need of setting targets for the construction of goal scores.

2. The principal component analysis (Harman, 1960) has been used to calculate the weight for each of the 10 indicators to calculate the alternative SDG3 India Index. The $S3II_A$ is not the simple average of the normalised values of the indicators. Instead, it is the weighted sum of the 10 indicators with weights determined through the principal component analysis. The method proposed by Nicoletti et al (2000) has been used for the estimation of weights of different indicators.

3. If $w_k$ is the weight for the indicator $k$, obtained through principal component analysis, then S3IIA for state/Union Territory $j$ is calculated as

   $$S3II_A = \sum w_k \times z_{kj}$$

Results of the principal component analysis are presented in table 2. The K-M-O measure of sampling adequacy was found to be 0.592 while the Bartlett's test of sphericity was 85.220 which is statistically significant. This means that the principal component analysis was appropriate to group the 10 indicators into three components which accounted for almost 73 per cent of the variation in the original data set. The table also gives the weight assigned to each of the 10 indicators in the construction of S3IIA on the basis of the principal component analysis which have been used for the construction of the alternative $S3II_A$.

Table 2: Results of the principal component analysis of 10 indicators used in the construction of $S3II_A$.

| Indicator | SDG target | Component 1 | Component 2 | Component 3 | Communalities | Weight |
|---|---|---|---|---|---|---|
| MMR | 3.1 | 0.809 | 0.117 | -0.145 | 0.689 | 0.0994 |
| CMR | 3.2 | 0.806 | 0.347 | 0.006 | 0.770 | 0.0987 |
| IMM | 3.3 | 0.184 | 0.372 | -0.832 | 0.863 | 0.1299 |
| TBR | 3.4 | 0.318 | 0.607 | -0.097 | 0.479 | 0.0772 |
| HIV | 3.5 | 0.040 | 0.536 | 0.656 | 0.719 | 0.0807 |
| SUR | 3.6 | -0.753 | 0.341 | 0.242 | 0.742 | 0.0861 |
| DRR | 3.7 | -0.432 | 0.787 | 0.061 | 0.810 | 0.1300 |
| IDL | 3.8 | 0.821 | -0.359 | 0.115 | 0.816 | 0.1023 |
| OPE | 3.9 | 0.025 | -0.750 | 0.027 | 0.563 | 0.1179 |
| PNM | 3.10 | -0.651 | -0.007 | 0.282 | 0.832 | 0.0778 |
| Eigen Values | | 3.382 | 2.368 | 1.534 | | |

Extraction method: Principal component
Number of components extracted are based on Kaiser criterion (Harman, 1960)
Rotation Varimax
Source: Authors, based on data from Government of India (2022b)

The principal component analysis has revealed that the 10 indicators used to construct the S3II can be grouped into three components or factors. The first component or factor has high component loading in five indicators – maternal mortality ratio (MMR), child mortality rate (CMR), suicide rate (SUR), institutional deliveries as proportion to total deliveries (IDL) and physicians, nurses, and mid-wives per 10 thousand population (PNM). These five indicators are highly correlated. The second principal component, on the other hand, has high component loading in tuberculosis detection rate (TBR), death rate due to road traffic accidents (DRR) and share of per capita out-of-pocket expenditure on health (OPE) to the total per capita consumption expenditure which means that these three indicators are highly correlated. Finally, the third principal component has high loading in children aged 9-11 months fully immunised (IMM) and HIV infection rate (HIV) which suggests that the two indicators are highly correlated. Out of the total variation explained by the three principal components, the variation explained by the first principal component accounts for 46 per cent of the total variation, the second principal component accounts for 33 per cent of the total variation while the third principal component accounts for 21 per cent of the total variation explained by the three principal components.

Table 3 gives estimates of S3II and S3IIA for states and Union Territories along with their rank. $S3II_A$ could be computed for only 19 states for which data on all the 10 indicators are available. For the remaining states and Union Territories, $S3II_A$ could not be calculated whereas S3II has been calculated based on a reduced set of indicators so ranking does not make any sense.

Table 3: S3II and S3II$_A$ in states and Union Territories of India and rank of states/Union Territories in terms of S3II and S3II$_A$.

| SN | State | S3II | | | S3II$_A$ | |
|---|---|---|---|---|---|---|
| | | Value | Rank1 | Rank 2 | Value | Rank |
| 1 | Andhra Pradesh | 77 | 7 | 5 | 0.180 | 8 |
| 2 | Arunachal Pradesh | 64 | 22 | | na | na |
| 3 | Assam | 59 | 28 | 19 | -0.326 | 17 |
| 4 | Bihar | 66 | 21 | 15 | -0.008 | 11 |
| 5 | Chhattisgarh | 60 | 26 | 17 | -0.227 | 15 |
| 6 | Goa | 72 | 13 | | na | na |
| 7 | Gujarat | 86 | 1 | 1 | 0.248 | 6 |
| 8 | Haryana | 72 | 14 | 11 | -0.214 | 14 |
| 9 | Himachal Pradesh | 78 | 5 | | na | na |
| 10 | Jharkhand | 74 | 11 | 9 | 0.230 | 7 |
| 11 | Karnataka | 78 | 6 | 4 | 0.266 | 4 |
| 12 | Kerala | 72 | 12 | 10 | 0.490 | 1 |
| 13 | Madhya Pradesh | 62 | 24 | 16 | -0.432 | 19 |
| 14 | Maharashtra | 83 | 2 | 2 | 0.316 | 3 |
| 15 | Manipur | 68 | 17 | | na | na |
| 16 | Meghalaya | 70 | 15 | | na | na |
| 17 | Mizoram | 79 | 4 | | na | na |
| 18 | Nagaland | 61 | 25 | | na | na |
| 19 | Odisha | 67 | 20 | 13 | -0.100 | 12 |
| 20 | Punjab | 77 | 9 | 5 | 0.054 | 9 |
| 21 | Rajasthan | 70 | 16 | 12 | -0.276 | 16 |
| 22 | Sikkim | 62 | 23 | | na | na |
| 23 | Tamil Nadu | 81 | 3 | 3 | 0.391 | 2 |
| 24 | Telangana | 67 | 18 | 13 | -0.134 | 13 |
| 25 | Tripura | 67 | 19 | | na | na |
| 26 | Uttar Pradesh | 60 | 27 | 17 | -0.416 | 18 |
| 27 | Uttarakhand | 77 | 8 | 5 | 0.041 | 10 |
| 28 | West Bengal | 76 | 10 | 8 | 0.256 | 5 |
| 29 | Andaman & Nicobar Islands | 68 | 7 | | na | na |
| 30 | Chandigarh | 74 | 3 | | na | na |
| 31 | Dadra & Nagar Haveli | 74 | 14 | | na | na |
| 32 | Dam & Diu | 80 | 5 | | na | na |
| 33 | Delhi | 90 | 1 | | na | na |
| 34 | Jammu & Kashmir | 70 | 5 | | na | na |
| 35 | Ladakh | 70 | 6 | | na | na |
| 36 | Lakshadeep | 78 | 2 | | na | na |
| 37 | Puducherry | 70 | 4 | | na | na |

Source: Estimates of S3II have been taken from the Government of India (2022b). The S3II has been calculated by the authors by using the same indicators and the same dataset that has been used for estimating S3II$_A$ but using different methodology as described in the text.

Perusal of table 3 reveals that rank of many states regarding progress in SDG3 is different when based on S3II as compared to the rank based on S3II$_A$. For example, Kerala ranks among 19 states in terms of S3II$_A$ whereas it ranks 8 in terms of S3II$_A$. Similarly, Gujarat ranks 1 among 19 states in terms of S3II but 6 in terms of S3II$_A$. Madhya Pradesh ranks the last among 19 states in terms of S3II$_A$, but its rank is better than the rank of Assam, Chhattisgarh and Uttar Pradesh in terms of S3II.

The S3II$_A$ is calculated using the same dataset that has been used for the calculation of S3II but with a different, more refined, methodology of construction of the composite index. The ranking of states/Union Territories based on S3II$_A$ shows that the ranking of states/Union Territories is influenced by the method used for the construction of the composite index. The S3II uses the simple arithmetic mean as to aggregate the normalised values of the indicators which have been termed as the goal score for SDG3. The limitations of the simple arithmetic mean as aggregation function in the construction of composite indexes is well-known and have been widely discussed and debated, especially, in the construction of the human development index. The main problem in using the simple arithmetic mean as the aggregation function is that the simple arithmetic mean is associated with the problem of perfect substitutability which means that a low normalised value of any one of the 10 indicators is compensated fully by high normalised value of other indicators. Another problem associated with the arithmetic mean is less reliable when the variation in the normalised values of the indicators is large. A third problem associated with the simple arithmetic mean as the aggregation function is that the interpretation of the simple arithmetic mean is difficult when the normalised values of the indicators are not statistically normally distributed across states and Union Territories of the country. variation in the goal scores across the 10 indicators is not statistically normally distributed and it is difficult to assume that the normalised values of the indicators across states and Union Territories of the country are statistically normally distributed. Moreover, if the normalised value of any one of the 10 indicators is exceptionally high relative to the normalised values of other indicators, then the simple arithmetic mean of the normalised values of the 10 indicators will be high even if goal scores of one or more of the remaining indicators is low which implies a high goal score. The geometric mean is recommended in place of the simple arithmetic mean as the aggregation function, but the geometric mean is biased towards indicators having low normalised values. In the extreme case, if the normalise value of any indicator is zero then the geometric mean of the 10 indicators is always zero irrespective of the normalised values of the other 9 indicators. When the normalisation is done using maximum and minimum values, then the normalised value of any indicator is zero for at least one state or Union Territory. This means that the geometric mean of 10 indicators will always be zero for that state/Union Territory.

## New SDG3 India Index

It may be pointed out that the SDG3 of the United Nations 2030 Sustainable Development Agenda is directed towards promoting "good health and wellbeing" of the people. However, a perusal of the 10 indicators used by the Government of India in the construction of S3II suggests that all the 10 indicators are related to the health of the people only. There is no indicator which refers to the wellbeing dimension of SDG3. As such, the set of 10 indicators used by the Government of India for calculating S3II is incomplete and, for this reason, S3II may not be relevant to monitoring the progress in the wellbeing of the people. There is, therefore, a need to select a new set of indicators that reflect both health and wellbeing of the people and then calculating a new SDG3 India Index ($S3II_N$) following the alternative methodology used in this paper that more appropriately reflects the health and wellbeing of the people and that can be used for monitoring the progress towards SDG3 of the United Nations 2030 Sustainable Development Agenda.

Table 4 presents the new list of indicators that has been used to construct $S3II_N$ for India and its states and Union Territories. This new list of indicators includes indicators reflecting the health as well as wellbeing of the people. The selection of these 10 new indicators is based on scanning the correlation-matrix for all the 115 indicators of the national indicator framework adopted by the Government of India and preliminary factorial investigations. A justification of selecting the new set of indicators for the construction of $S3II_N$ is given below.

The United Nations 2030 Sustainable Development Agenda calls for reducing poverty by half of the proportions of men, women and children of all ages living in poverty in all its dimensions according to national definitions. Accordingly, the Government of India has targeted to reduce the proportion of population living below the national poverty line to around 10 per cent by the year 2030. According to the Tendulkar Committee Report, the population below the national poverty line was estimated to be around 28 per cent in 2011-12. According to the National Family Health Survey, the proportion of population living below the national poverty line was around 29 per cent in 2015-16 (Government of India, 2022a).

Table 4: List of new indicators for the calculation of $S3II_N$.

| SDG goal | Indicator | Definition |
|---|---|---|
| 3.1 | MMR | Maternal mortality ratio per 100 thousand live births |
| 3.2 | CMR | Under 5 mortality rate per 1000 live births |
| 1.1 | BPL | Percentage of population living below national poverty line |
| 1.2 | MPI | Percentage of population multidimensionally poor |
| 2.2 | CUW | Percentage of children (< 5 years) low weight-for-age |
| 4.3 | GER | Gross enrolment ratio in higher secondary |
| 6.7 | GWA | Percentage of ground water withdrawal against availability |
| 7.2 | LPG | Percentage of household having LPG+PNG connection |
| 9.6 | MOB | Number of mobile connections per 100 persons |
| 10.1 | WQL | Percentage of population in the lowest two wealth quintiles |

Source: Authors

Alleviation and eradication of poverty have always been the primary objective along with socioeconomic development and inequalities reduction in the Indian planning process. Methodologies for estimation of poverty line comprising of food and non-food baskets of essential items have undergone several modifications over the years. In the recent past, there has been an increase in the public expenditure on social services which has not been captured by the Consumer Expenditure Surveys conducted by the Government of India and, therefore, is neglected in the estimation of the poverty line. A detailed overview of methodological and data issues considered by various expert groups (Alagh Committee, 1979; Lakdawala Committee, 1993; Tendulkar Committee, 2005; Rangarajan Committee, 2014) constituted by the erstwhile Planning Commission for the estimation of the poverty line is given elsewhere (Naik and Tiwari, 2023). Obviating several limitations in the methodologies adopted by earlier expert groups, Rangarajan Committee Report recommended a per capita average monthly expenditure of Rs 972 for the rural areas and Rs 1407 for the urban areas as the poverty line (Government of India, 2014) taking into consideration the normative nutritional requirements of calories, proteins, fats and non-food essentials like clothing, rent, conveyance and education and other increasing government expenditures on social services. According to the Rangarajan Committee report, the population below the poverty line in the country has declined from 39.6 per cent in 2009-10 to 30.9 per cent in 2011-12 in the rural India and from 35.1 per cent to 26.4 per cent in the urban India so that the all-India poverty ratio fell from 38.2 per cent to 29.5 per cent. The Committee estimated that around 91.6 million people were lifted out of poverty during this period. On the other hand, according to the household expenditure survey 2022-2023, less than 5 per cent of the population of the country was living below the poverty line which suggests that around 248 million people have escaped poverty in last nine years.

The Government of India has also estimated the multidimensional poverty index (MPI) following the United Nations multidimensional poverty framework to drive policy reforms towards poverty reduction and improvements in wellbeing of the people. The national MPI retains all the ten indicators from the global MPI framework and incorporates two additional indicators – maternal health and bank accounts – in line with national priorities (Chand, 2023). The 10 indicators used to construct the global MPI are grouped into three equally weighted dimensions – health, education, and standard of living – following the approach adopted in the construction of the human development index (Government of India, 2022a). There are two indicators related to the health dimension, two indicators related to the education dimension and six indicators related to the standard of living dimension. The construction of MPI uses a nested weighting structure – equal weight to the three dimensions and equals weighting of the indicators related to different dimension. The MPI constructed by the Government of India, however, adjusts the MPI by the extent of deprivation (Chand, 2023).

Results of the principal component analysis based on the new set of indicators are presented in table 5. Perusal of the table reveals that 10 indicators can be grouped into two principal components which account for more than 80 per cent of the total variation in the data. The first principal has high loading in 8 indicators while the second principal component has high loading in two indicators. The K-M-O measure of sampling adequacy is found to be 0.593 whereas Bartlett's test of sphericity is found to be 193.03 which show the adequacy of the principal component model. The first principal component accounts for more than 55 per cent of the total variation explained by the two principal components whereas the second principal components accounts for about 44 per cent of the total variation explained.

Table 5: Principal component analysis of the new set of indicators adopted for the construction of $S3II_N$.

| Indicator | SDG Goal | Component 1 | Component 2 | Communalities | Weight |
|---|---|---|---|---|---|
| MMR | 3.1 | 0.068 | 0.944 | 0.896 | 0.2364 |
| CMR | 3.2 | 0.286 | 0.880 | 0.856 | 0.2056 |
| BPL | 1.1 | 0.786 | 0.537 | 0.907 | 0.0770 |
| MPI | 1.2 | 0.716 | 0.658 | 0.945 | 0.0638 |
| CUW | 2.2 | 0.701 | 0.408 | 0.658 | 0.0613 |
| GER | 4.3 | 0.600 | 0.584 | 0.702 | 0.0449 |
| GWA | 6.7 | -0.799 | 0.074 | 0.643 | 0.0795 |
| LPG | 7.2 | 0.831 | 0.235 | 0.745 | 0.0860 |
| MOB | 9.6 | 0.753 | 0.585 | 0.909 | 0.0707 |
| WQL | 10.1 | 0.775 | 0.565 | 0.919 | 0.0748 |
| Eigen Values | | 4.564 | 3.616 | | |

Extraction Method: Principal Component
Number of Components Based on Kaiser Criterion (Harman, 1960)
Rotation Varimax
Source: Authors, based on data from Government of India (2022b).

Based on the results of the principal component analysis, $S3II_N$ that accounts for both good health and well-being for all states/Union Territories has been worked out and is presented table 6 for 18 states along with the rank of the state/Union Territory. The $S3II_N$ for the remaining states and Union Territories could not be calculated because of data gaps. We find that Kerala ranks first among the 18 states in terms of $S3II_N$ also while Madhya Pradesh ranks the last. Perusal of tables 3 and 6 reveals that the rank of states in terms of $S3II_A$ and in terms of $S3II_N$ is very similar. This comparison again shows that the methodology of the construction of the composite index reflecting the progress in SDG3 matters and different methodologies may depict different picture of progress. The S3II depicts a different picture of progress in SDG3 across states and Union Territories of the country compared to S3IIA and $S3II_N$ because the original SDG3 India Index is based on the methodology which has many limitations and weaknesses. When a more refined, data-driven methodology is used, the ranking of states is different even if different set of indicators is used for the construction of the index. Selection of the appropriate methodology for the construction of the composite index reflecting progress in SDGs is important. If the methodology of construction is imperfect, then the resulting composite index will depict a distorted picture.

## Conclusions

This paper highlights the complexities involved in constructing a composite index to monitor the progress towards SDGs. The composite index of progress may change markedly depending upon the method used for normalising indicators and for aggregating normalised values of indicators even if the dataset used to construct the composite index remains the same.

Table 6: S3II and S3II$_N$ in the states and Union Territories of the country and rank of states/Union Territories in terms of S3II and S3II$_N$.

| SN | State | S3II | | S3II$_N$ | |
|---|---|---|---|---|---|
| | | Value | Rank | Value | Rank |
| 1 | Andhra Pradesh | 77 | 5 | 0.317 | 5 |
| 2 | Arunachal Pradesh | 64 | | na | na |
| 3 | Assam | 59 | 19 | -1.057 | 14 |
| 4 | Bihar | 66 | 15 | -1.101 | 15 |
| 5 | Chhattisgarh | 60 | 17 | -1.110 | 17 |
| 6 | Goa | 72 | | na | na |
| 7 | Gujarat | 86 | 1 | 0.127 | 9 |
| 8 | Haryana | 72 | 11 | 0.153 | 8 |
| 9 | Himachal Pradesh | 78 | | na | na |
| 10 | Jharkhand | 74 | 9 | -0.589 | 11 |
| 11 | Karnataka | 78 | 4 | 0.193 | 7 |
| 12 | Kerala | 72 | 10 | 1.176 | 1 |
| 13 | Madhya Pradesh | 62 | 16 | -1.286 | 18 |
| 14 | Maharashtra | 83 | 2 | 0.602 | 3 |
| 15 | Manipur | 68 | | na | na |
| 16 | Meghalaya | 70 | | na | na |
| 17 | Mizoram | 79 | | na | na |
| 18 | Nagaland | 61 | | na | na |
| 19 | Odisha | 67 | 13 | -0.868 | 13 |
| 20 | Punjab | 77 | 5 | 0.340 | 4 |
| 21 | Rajasthan | 70 | 12 | -0.620 | 12 |
| 22 | Sikkim | 62 | | na | na |
| 23 | Tamil Nadu | 81 | 3 | 0.790 | 2 |
| 24 | Telangana | 67 | 13 | na | na |
| 25 | Tripura | 67 | | na | na |
| 26 | Uttar Pradesh | 60 | 17 | -1.103 | 16 |
| 27 | Uttarakhand | 77 | 5 | 0.311 | 6 |
| 28 | West Bengal | 76 | 8 | 0.006 | 10 |
| 29 | Andaman & Nicobar Islands | 68 | | na | na |
| 30 | Chandigarh | 74 | | na | na |
| 31 | Dadra & Nagar Haveli | 74 | | na | na |
| 32 | Dam & Diu | 80 | | na | na |
| 33 | Delhi | 90 | | na | na |
| 34 | Jammu & Kashmir | 70 | | na | na |
| 35 | Ladakh | 70 | | na | na |
| 36 | Lakshadeep | 78 | | na | na |
| 37 | Puducherry | 70 | | na | na |

Source: S3II is taken from the Government of India (2022b). The S3II$_N$ has been calculated by the authors by using a new set of indicators and different methodology used for the construction of the as discussed in the text. Estimates of S3II$_N$ are not available for some states and Union Territories.

There is no universally agreed method to construct a composite index out of a set of indicators for the purpose of monitoring the progress. The composite index is always a multidimensional construct. A description of different methods of construction of composite index and their strengths and weaknesses is given elsewhere (Narda et al, 2005). The selection of indicators for the construction of the composite index, although very important, is always arbitrary and depends primarily upon the availability of necessary data. There is no universally agreed protocol for the selection of indicators and different set of indicators by default lead to different composite indexes and, therefore, ranking of populations in terms of progress.

Dealing with missing values in the dataset is a major issue in the construction of composite indexes. There are different methods of data imputation. The most common one is to use the mean value of the indicator, but this may seriously distort the composite index. If the number of indicators used in the construction of the composite index is not the same for all populations, then the composite indexes are not comparable across population. Composite index must be based on those indicators only which are available for all the populations so as to ensure the comparability of the composite index across populations. This is a major limitation of the original SDG3 India Index as it is based on different number of indicators for different states and Union Territories.

Unlike the selection of indicators, there are different approaches for normalising the values of the indicators as the first step for the calculation of the composite index. The most common approach is the normalisation based on the variation of the indicator across populations as reflect through the range (maximum – minimum). Other approach of normalisation is calculation of the z-score based on the arithmetic mean and standard deviation of the distribution of the indicator values across populations. Both these approaches are based on the assumption that the distribution of the indicator values across populations are statistically normally distributed. If the distribution is not statistically normal, then the interpretation of the normalised values becomes difficult. One approach may be normalisation based on median of the distribution. Other approach may be normalisation based on some transformation of the indicator such as the logarithmic transformation. In any case, it is important to test the normality of the distribution of indicator values before normalisation.

Similarly, due considerations need to be given to the selection of the aggregation function for aggregating the normalised values of different indicators into a single composite index. The simple arithmetic mean is the most commonly used as has been used by the Government of India for the construction of SDG3 Index. The limitations of the arithmetic mean as the aggregation function are well-known particularly when there is wide variation in the normalised values of different indicators. The arithmetic mean gets influenced more by high or very high normalised values of some indicators at the cost of low to very low normalised values of other indicators as it is associated with the problem of perfect substitutability. The arithmetic mean is the most suited as the aggregation function when the underlying distribution is a statistically normal distribution. The reliability of the arithmetic mean decreases with the increase in variability. The geometric mean has been proposed as the alternative to the arithmetic mean in the construction of the composite index, but the geometric mean is influenced more by those indicators which have low or very low normalised values. In the extreme case when the normalised value of any one indicator is zero, the geometric mean is always zero irrespective of the normalised values of other indictors. Similarly, when the normalised value of any indicator is 1, then it has no impact on the geometric mean. Because of this reason, the geometric mean cannot be used as the aggregation function when the normalisation is done based on the range of the variation in the values of the indicators. A third alternative is to use the generalised mean or the power mean. The arithmetic mean and the geometric mean are the special cases of the generalised mean. The challenge with the use of generalised mean is that the selection of the power of the generalised mean is, at best, arbitrary and the value of the composite mean changes with the change in the power of the mean. However, by selecting a suitable value of the power of the mean, it is possible to give more weight to that indicator in which the progress lags as compared to that indicator in which the progress is advanced.

There are statistical approaches also to construct the composite index like SDG3 Index. In this paper, we have used the principal component analysis to construct a composite index. The advantage of the approach is that it is entirely data-driven and makes no assumption regarding normalisation and aggregation. The approach also takes into consideration the correlation among the indicators used for the construction of the composite index. This approach also gives different weights to different indicators used in the construction of the index. The limitation of this approach, however, is that the weights given to different indicators are data-dependency in the sense that they are changed when new dataset is used for the principal component analysis. They are not constant across datasets and, therefore, any composite index based on the principal component analysis is not strictly comparable over time and across populations.

Taking different issues associated with the construction of a composite index into consideration, we recommend that construction of any composite index for monitoring the progress towards SDGs should be based on the following approach:

1. Due considerations should be given to the selection of indicators to reflect for multidimensional wellbeing as ranking in terms of the progress depends upon the indicators selected for the construction of the index.
2. The normalisation of raw data or the values of the indicators should be done based on arithmetic mean and standard deviation rather than range (maximum – minimum) or a variation of it (target - minimum) or (minimum – target). Using arithmetic mean and standard deviation for normalisation will obviate the need of setting up the target for different indicators.
3. Goal scores for different SDGs should be elicited using the principal component analysis method which take into consideration the correlation that exists among the indicators used for the construction of the index.
4. The goal scores of different indicators should be aggregated into the composite index using the eigen values obtained through the principal component analysis. This approach of aggregation gives different weights to different indicators used in the construction of the composite index. The weight of the indicator depends upon the extent of variation of the indicator across the states and Union Territories of the country.

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Appendix table 1: Descriptive statistics of the 10 indicators used for constructing original SDG3 India Index.

| SDG target | | N | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|---|---|
| 3.1 | MMR | 19 | 43 | 215 | 112.58 | 51.43 |
| 3.2 | CMR | 23 | 10 | 56 | 31.61 | 11.04 |
| 3.3 | IMM | 37 | 54 | 109 | 86.11 | 13.39 |
| 3.4 | TBR | 37 | 23 | 606 | 189.86 | 113.97 |
| 3.5 | HIV | 36 | 0 | 1 | 0.12 | 0.22 |
| 3.6 | SUR | 37 | 0 | 46 | 12.54 | 9.95 |
| 3.7 | DRT | 37 | 0 | 19 | 10.25 | 4.78 |
| 3.8 | IDL | 37 | 60 | 100 | 94.69 | 7.54 |
| 3.9 | OPE | 36 | 5 | 19 | 11.89 | 3.57 |
| 3.10 | PNM | 32 | 1 | 115 | 35.06 | 25.89 |

Appendix table 2: Descriptive statistics of the 10 indicators used for constructing alternative SDG3 India Index.

| SDG target | | N | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|---|---|
| 3.1 | MMR | 19 | 43 | 215 | 112.58 | 51.43 |
| 3.2 | CMR | 23 | 10 | 56 | 31.61 | 11.04 |
| 3.3 | IMM | 37 | 54 | 100 | 85.62 | 12.69 |
| 3.4 | TBR | 37 | 23 | 606 | 189.86 | 113.97 |
| 3.5 | HIV | 36 | 0 | 1 | 0.12 | 0.22 |
| 3.6 | SUR | 37 | 0 | 46 | 12.54 | 9.95 |
| 3.7 | DRT | 37 | 0 | 19 | 10.25 | 4.78 |
| 3.8 | IDL | 37 | 60 | 100 | 94.69 | 7.54 |
| 3.9 | OPE | 36 | 5 | 19 | 11.89 | 3.57 |
| 3.10 | PNM | 32 | 1 | 115 | 35.06 | 25.89 |

Appendix table 3: Descriptive statistics of 10 indicators used for constructing new SDG3 India Index.

| SDG target | | N | Minimum | Maximum | Mean | Standard deviation |
|---|---|---|---|---|---|---|
| 3.1 | MMR | 19 | 43 | 215 | 112.58 | 51.43 |
| 3.2 | CMR | 23 | 10 | 56 | 31.61 | 11.04 |
| 1.1 | BPL | 36 | 1 | 40 | 18.26 | 11.34 |
| 1.2 | MPI | 37 | 1 | 52 | 19.52 | 13.79 |
| 2.2 | CUW | 31 | 11 | 43 | 26.11 | 9.17 |
| 4.3 | GER | 37 | 5.5 | 54 | 28.17 | 11.60 |
| 6.7 | GWA | 37 | 0 | 100 | 46.05 | 31.12 |
| 7.2 | LPG | 37 | 48 | 100 | 92.33 | 11.93 |
| 9.6 | MOB | 37 | 51 | 100 | 85.34 | 14.87 |
| 10.1 | WOL | 37 | 1 | 75 | 30.73 | 21.14 |