

Progress on Sustainable Development Goal indicators in 707 districts of India: a quantitative mid-line assessment using the National Family Health Surveys, 2016 and 2021

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Summary

Background India has committed itself to accomplishing the Sustainable Development Goals (SDGs) by 2030. Meeting these goals would require prioritizing and targeting specific areas within India. We provide a mid-line assessment of the progress across 707 districts of India for 33 SDG indicators related to health and social determinants of health.

Methods We used data collected on children and adults from two rounds of the National Family Health Survey (NFHS) conducted in 2016 and 2021. We identified 33 indicators that cover 9 of the 17 official SDGs. We used the goals and targets outlined by the Global Indicator Framework, Government of India and World Health Organization (WHO) to determine SDG targets to be met by 2030. Using precision-weighted multilevel models, we estimated district mean for 2016 and 2021, and using these values, computed the Annual Absolute Change (AAC) for each indicator. Using the AAC and targets, we classified India and each district as: Achieved-I, Achieved-II, On-Target and Off-Target. Further, when a district was Off-Target on a given indicator, we further identified the calendar year in which the target will be met post-2030.

Findings India is not On-Target for 19 of the 33 SDGs indicators. The critical Off-Target indicators include Access to Basic Services, Wasting and Overweight Children, Anaemia, Child Marriage, Partner Violence, Tobacco Use, and Modern Contraceptive Use. For these indicators, more than 75% of the districts were Off-Target. Because of a worsening trend observed between 2016 and 2021, and assuming no course correction occurs, many districts will never meet the targets on the SDGs even well after 2030. These Off-Target districts are concentrated in the states of Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar, and Odisha. Finally, it does not appear that Aspirational Districts, on average, are performing better in meeting the SDG targets than other districts on majority of the indicators.

Interpretation A mid-line assessment of districts' progress on SDGs suggests an urgent need to increase the pace and momentum on four SDG goals: No Poverty (SDG 1), Zero Hunger (SDG 2), Good Health and Well-Being (SDG 3) and Gender Equality (SDG 5). Developing a strategic roadmap at this time will help India ensure success with regards to meeting the SDGs. India's emergence and sustenance as a leading economic power depends on meeting some of the more basic health and social determinants of health-related SDGs in an immediate and equitable manner.

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Research in context**Evidence before this study**

We searched PubMed and Web of Science to identify empirical studies that conducted quantitative analysis on the progress of Sustainable Development Goal (SDG) indicators in India. We used structured combinations of keywords: “Sustainable Development Goals” OR “SDGs” OR “SDG indicators” AND (“Progress” OR “Monitoring and Evaluation” OR “Surveillance”) AND “India”, starting January 1, 2015. The search yielded 1042 studies. We screened the titles of each of these papers and found 62 papers that were relevant to the scope of our study. After removing duplicates, we reviewed the abstracts of 39 papers for the following: use of empirical data; use of data for at least two time periods; and whether the study was sub-national (state or district). We found nine studies that provided information on one or more SDG indicator at a subnational level for two time periods. Five of these papers did not entail any assessment of the progress related to SDGs, and were simply descriptive studies of an indicator that also happens to be a SDG indicator. Four studies provided a progress assessment; however these were all at the state-level. Further, the assessment was using data prior to the adoption of SDGs. While one study claimed to provide an assessment at the district-level on the progress related to neonatal and under-5 mortality, the analysis assumed all districts within a state to have the same levels of neonatal and under-5 mortality. We also identified five state-level reports by the Government of India using only one time period.

Added value of this study

Our study provides the first systematic midline assessment of the progress that 707 districts of India are making in achieving SDGs related to health and social determinants of health. Our analysis is comprehensive in that the 33 SDG indicators considered for assessment cover 9 of the 17 SDGs with emphasis on SDGs related to No Poverty (1), Zero Hunger (2), Good Health and Well-being (3), and Gender Equality (5). Our study provides for the first time an empirical assessment of the Aspirational Districts program that India launched in 2016 prioritizing 112 districts for faster rate of development on SDG indicators using an independent survey data source. Lastly, as a part of this study, we developed an online interactive dashboard (<https://geographicinsights.iq.harvard.edu/District-SDG-Progress>) as a resource for relevant stakeholders to see the progress each district is making on SDGs considered in our study.

Implications of all the available evidence

India needs to urgently conduct an appraisal of the policies and programs that relate to SDGs, especially those that relate to SDG targets: No Poverty, Zero Hunger, Good Health and Well-being and Gender Equality. With eight more years to go, and a majority of the districts not on course to meeting the SDGs (or at the risk of never meeting their targets) on critical indicators of health and social determinants of health, there is a need for a greater degree of precision in identifying and prioritizing districts for intervention.

Introduction

The first systematic effort to identify and set global targets for realizing critical goals related to population health and well-being started with the establishment of the Millennium Development Goals (MDGs) in 2000, with the goals to be met by 2015.¹ The progress that countries made, especially those from Low- and Middle-Income Countries (LMICs) while substantial,² fell considerably short of accomplishing the MDGs. Notwithstanding the successes and shortfalls, the MDG framework highlighted that the establishment of global goals and targets can be a catalyst for countries to develop and strengthen policies aimed at achieving important health and well-being objectives that matter for their populations. The momentum generated by the MDGs led to the creation and adoption of the Sustainable Development Goals (SDGs) in 2015 with targets to be accomplished by 2030.³ The SDGs, agreed upon by 195 countries, substantially expanded the goals to include indicators related to economic development, social welfare and environmental sustainability.³

As countries approach the half-way mark on the timeline to meet SDG targets, the progress at the global level would depend on the extent of progress that India makes.^{2,4} With a population more than 1.4 billion, India will become the world's most populous country in 2023,⁵ accounting for nearly one-sixth of humanity.⁵ Notably, India accounts for 18.0% of world's 0–14 population.⁵ The young demographic profile of India is a potential strength in its aspiration to becoming a trillion dollar economy by 2024–25,⁷ and the third-largest economy in the world by 2027.⁸ In order for India to be a leading economic engine for the prosperity and well-being of its own population and for the world, it is critical that the strength in *quantity* that India has with regards to its population size (especially its younger population) is matched urgently with strength in terms of the *quality* of its human resources, especially with regards to the education and health of its population. In this regard, India's commitment to implementing new policies and aligning existing ones to realize SDGs assumes critical significance.⁹

Any assessment of India is incomplete – and potentially misleading – without explicitly recognizing the variation in distribution of natural resources, as well as differences in development histories of the various regions of the country.^{10,11} For instance, the Infant Mortality Rate in 2020 varied between 3 per 1000 live births in Nagaland to 46 per 1000 in Madhya Pradesh¹²; a gap that is about as large as between the least and most developed nations on this crucial SDG indicator.¹³ Similarly, in 2021, availability of basic sanitation services and female literacy varied from 49.5% and 55.0% in Bihar to 95.0% and 94.0% in Mizoram, respectively.¹⁴ While national assessments are helpful, considering the variation within India is extremely critical for intrinsic reasons. For instance, states oversee policy development for sectors such as public health and sanitation, transport and communication, agriculture, water and irrigation. They also share responsibility (with the Centre) for sectors such as energy, social security, employment and education. Thus, a substantial component of state differences in India can be linked to policy process that operates uniquely at the state level.

Role of districts in the policy landscape of India

For administrative purposes, each State/Union Territory in India is divided into distinct units called “*districts*”. The number of districts has evolved over time from 310 districts in 1951¹⁵ to a current count of 763 districts.¹⁶ States have the power to “create” new districts, often with the rationale of improving governance. Each district includes an administration responsible for directing and implementing development programs in addition to revenue administration, and is led by a District Collector (DC) or a District Magistrate (DM), usually from the Indian Administrative Service (IAS) of the all-India services of the Government of India (GOI), who essentially functions as the “*chief executive officer*” for the district.¹⁷ The DC/DM oversees the programs of the GOI (state/Centre) at the local level, ensures that programs and financial resources are employed effectively to reach the target population in a timely manner.^{17,18} Thus, the district is where the administration comes into direct contact with the population and customizes its initiatives to suit the local needs of the communities.¹⁹ India’s progress on development goals, therefore, is intrinsically tied to the performance of its districts in delivering development goals. Indeed, the GOI’s SDG implementation strategy has been tied to District Planning Committees or other district-level structures headed by the DC/DM.⁹

A district level monitoring of the progress of SDG indicators, therefore, is critical to gain a comprehensive picture of where India stands, and what policies and programs need to be newly created, modified, or better prioritized to successfully target existing needs at the district level. While the 73rd Constitutional Amendment of 1993 requires devolution of powers and

responsibilities to more geographically granular units such as Blocks and Villages *within* a district,¹⁸ a focus on districts brings a meaningful degree of precision to the public policy landscape, especially considering district administrations are extremely powerful, with a substantial degree of autonomy to advance the well-being of the population it serves.

Underscoring the policy importance of districts, in 2018, the GOI launched the Aspirational Districts (ADs) program. The motivation was to “*quickly and effectively transform 112 most under-developed districts across the country*”.²⁰ The program identifies areas for immediate improvement and monitors the progress of these districts under five broad themes of *Health and Nutrition; Education; Agriculture and Water Resources; Financial Inclusion & Skill Development; and Infrastructure*. Monitoring the ADs offers a unique opportunity to learn whether an explicit area-focused program can help districts gain momentum in realizing the identified goals.

Aim and scope of the study

Effectively tracking the progress of districts on SDG indicators and drawing reliable statistical inference on their status requires having information on an *observed* change in SDG indicators for a district over a recent time period. Projecting a recent observed rate of change for a district indicator into the future allows us to project whether a given indicator target will be met by 2030. We are not aware of any study that provides a comprehensive and systematic assessment of the progress districts of India are making with regards to SDGs.

Using the 2016 and 2021 National Family Health Surveys, we provide an assessment for 707 districts of India on their status with regards to meeting the SDGs on 33 indicators related to the domains of population health and social determinants of health. We also provide an assessment of the progress that is occurring among ADs. Notably, the first survey period of 2015–16 coincides with the global ratification of the Sustainable Development Agenda, and thereby providing an approximation of a timely baseline for the assessment. The indicators covered in this mid-line assessment touch upon 9 from a total of 17 SDGs, with a substantial number of indicators linked to 6 SDGs (No Poverty, Zero Hunger, Good Health and Well-Being, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy) (Table 1).

Methods

Data

We used data collected for individuals, men, and women of reproductive age groups, and children aged 5 years or below from the fourth (2015–16, hereafter, 2016) and fifth (2019–21, hereafter 2021) rounds of the National Family Health Survey (NFHS-4 and NFHS-5).^{14,21,22} The NFHS is part of the Demographic

SDG Indicator number	SDG Indicator name	SDG Indicator short name	SDG Target	NFHS-4 Sample size (2016)	NFHS-5 Sample size (2021)
Goal 1: End poverty in all its forms everywhere					
1.2.2	Proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions	Multidimensional Poverty	13.95%	2,801,958	2,795,894
1.3.1	Proportion of population covered by social protection floors/systems, by sex, distinguishing children, unemployed persons, older persons, persons with disabilities, pregnant women, newborns, work-injury victims and the poor and the vulnerable	Health Insurance (Women) Health Insurance (Men)	99%	Women: 699,686 Men: 112,122	Women: 724,115 Men: 101,839
1.4.1	Proportion of population living in households with access to basic services	Access to Basic Services	99%	2,720,930	2,775,120
Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture					
2.2.1	Prevalence of stunting (height for age <-2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age	Stunting	40% reduction is 23.05%	232,440	206,407
2.2.2	Prevalence of malnutrition (weight for height >+2 or <-2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)	Wasting and Overweight	5%	232,440	202,059
2.2.3	Prevalence of anaemia in women aged 15–49 years, by pregnancy status (percentage)	Anaemia (Women) Anaemia (Pregnant Women) Anaemia (Non-Pregnant Women)	50% reduction All Women: 26.55% Pregnant: 25.20% Non-Pregnant: 26.61%	All Women: 684,913 Pregnant: 31,848 Non-Pregnant: 653,065	All Women: 690,153 Pregnant: 27,317 Non-Pregnant: 662,836
Goal 3: Ensure healthy lives and promote well-being for all at all ages					
3.1.2	Proportion of births attended by skilled health personnel	Skilled Birth Attendants	99%	259,469	232,920
3.2.1	Under 5 mortality rate	Under 5 Mortality	2.5 per 100 live births	259,627	232,920
3.2.2	Neonatal mortality rate	Neonatal Mortality	1.2 per 100 live births	259,627	232,920
3.7.1	Proportion of women of reproductive age (aged 15–49 years) who have their need for family planning satisfied with modern methods	Modern Contraceptive Use	99%	332,076	400,066
3.7.2	Adolescent birth rate (aged 10–14 years; aged 15–19 years) per 1000 women in that age group	Adolescent Pregnancy (10–14) Teenage Pregnancy (15–19)	0.5%	10–14 years: 124,878 15–19 years: 124,878	10–14 years: 122,480 15–19 years: 122,480
3.a.1	Age-standardized prevalence of current tobacco use among persons aged 15 years and older	Tobacco Use (Women) Tobacco Use (Men)	5%	Women: 699,686 Men: 112,122	Women: 724,115 Men: 101,839
3.b.1	Proportion of the target population covered by all vaccines included in their national programme	Full Vaccination (Card)	99%	98,368	87,622
Goal 5: Achieve gender equality and empower all women and girls					
5.2.1	Proportion of ever-partnered women and girls aged 15 years and older subjected to physical, sexual or psychological violence by a current or former intimate partner in the previous 12 months, by form of violence and by age	Partner Violence (Physical) Partner Violence (Sexual) Partner Violence (Physical or Sexual)	0.5%	Physical: 66,013 Sexual: 66,013 Physical or Sexual: 66,013	Physical: 63,851 Sexual: 63,851 Physical or Sexual: 63,851
5.3.1	Proportion of women aged 20–24 years who were married or in a union before age 15 and before age 18	Child Marriage Girl (<15) Child Marriage Girl (<18)	0.5%	Before 15: 122,955 Before 18: 122,955	Before 15: 118,700 Before 18: 118,700
5.b.1	Proportion of individuals who own a mobile telephone, by sex	Own Mobile Phone (Women)	99%	Women: 122,351	Women: 108,785
Goal 6: Ensure availability and sustainable management of water and sanitation for all					
6.1.1	Proportion of population using safely managed drinking water services	Improved Water	99%	2,801,958	2,795,894
6.2.1	Proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water	a) Improved Sanitation b) Hand-washing Facility	99%	a) 2,801,958 b) 2,795,221	a) 2,795,887 b) 2,775,127
Goal 7: Ensure access to affordable, reliable, sustainable and modern energy for all					
7.1.1	Proportion of population with access to electricity	Electricity Access	99%	2,801,958	2,795,894
7.1.2	Proportion of population with primary reliance on clean fuels and technology	Clean Fuel for Cooking	99%	2,801,958	2,795,894

(Table 1 continues on next page)

SDG Indicator number	SDG Indicator name	SDG Indicator short name	SDG Target	NFHS-4 Sample size (2016)	NFHS-5 Sample size (2021)
(Continued from previous page)					
Goal 8: Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all					
8.10.2	Proportion of adults (15 years and older) with an account at a bank or other financial institution or with a mobile-money-service provider	Have Bank Account (Women)	99%	2,801,958	2,795,894
Goal 16: Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels					
16.2.3	Proportion of young women and men aged 18–29 years who experienced sexual violence by age 18	Teenage Sexual Violence	0.5%	79,729	72,320
16.9.1	Proportion of children under 5 years of age whose births have been registered with a civil authority, by age	Birth Registration	99%	255,751	227,995
Goal 17: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development					
17.8.1	Proportion of individuals using the Internet	Internet Use	99%	2,801,958	2,795,894
1.2.2 – Using Oxford's MPI Methodology and SDG Target is coming from NITI Aayog's State SDG Targets; 1.3.1 – Shows Health Insurance Coverage Only; 1.4.1 – Included Household Variables applied to all individuals and did not include Family Planning using Modern Methods; 3.7.2 – Changed to Teenage Pregnancy instead of calculating the Fertility Rate; 3.b.1 – Only included if on Vaccine Card; 6.1.1 – Applied Household Status to all Individuals within the Household; 6.2.1 – Applied Household Status to all Individuals within the Household; 7.1.1 – Applied Household Status to all Individuals within the Household; 7.1.2 – Applied Household Status to all Individuals within the Household; 16.2.3 – This only includes Women.					
Table 1: Sustainable Development Goal (SDG) indicators, targets, and sample size from the 2016 and 2021 National Family Health Surveys (NFHS).					

and Health Surveys (DHS) Program,^{22,23} and employs a multi-stage, stratified cluster sampling design. The urban and rural samples were drawn separately. Further, stratification was done based on population size, proportion of scheduled caste and tribe (SC/ST) population, and female literacy. In each round, households were selected randomly from primary sampling units (PSUs), consisting of villages in rural areas and census enumeration blocks in urban areas. The households were selected after a complete mapping of PSU. The 2016 and 2021 NFHS were designed to be representative at the district level (640 (in 2016) and 707 (in 2021) districts) from 36 states/Union Territories of India. The main focus of NFHS is on themes related health (with special emphasis on maternal and child health), population, nutrition, and socioeconomic well-being.¹⁴

Study population

The sample population for 2021 NFHS consisted of 2,843,917 individuals: 724,115 women (aged 15–49 years), 101,839 men (aged 15–54 years), and 289,369 children aged 5 years or below. For 2016 NFHS, we used records of 2,869,043 individuals: 699,686 women (aged 15–49 years), 112,122 men (aged 15–54 years), and 320,613 children aged 5 years or below. Depending on study population and the response rate for specific questions, the sample size differed for each variable considered (Table 1).

Outcome measures

Using lists provided by DHS and the National Institution for Transforming India (NITI) Aayog, we selected 24 sub-SDGs.^{24,25} These 24 sub-SDGs translate to 33 indicators that were available in both 2016 and 2021

NFHS datasets.²² We followed the indicator definitions as provided in SDG Global Indicator Framework (GIF),²⁶ and adopted their targets for 30 indicators (Table 1). We also followed the standard “Leave no one behind” objective of the SDGs,²⁷ to set upper (99%) or lower limits (0.5%) for targets that were not explicitly identified in the GIF.²⁸ For Multidimensional Poverty, we used NITI Aayog's SDG Goal,²⁹ and for Stunting, Wasting and Overweight, we used the World Health Organization (WHO)'s target.³⁰

For the analysis we considered the following 33 SDG indicators across 9 of the 17 SDGs that broadly relate to population health and social determinants of health (Table 1): Multidimensional Poverty, Health Insurance (Women), Health Insurance (Men), Access to Basic Services, Stunting, Wasting and Overweight, Anaemia (Women), Anaemia (Pregnant Women), Anaemia (Non-Pregnant Women), Skilled Birth Attendants, Under 5 Mortality, Neonatal Mortality, Modern Contraceptive Use, Adolescent Pregnancy (10–14), Teenage Pregnancy (15–19), Tobacco Use (Women), Tobacco Use (Men), Full Vaccination (Card), Partner Violence (Physical), Partner Violence (Sexual), Partner Violence (Physical or Sexual), Child Marriage Girl (<15), Child Marriage Girl (<18), Own Mobile Phone (Women), Improved Water, Improved Sanitation, Hand-washing Facility, Electricity Access, Clean Fuel for Cooking, Have Bank Account (Women), Teenage Sexual Violence, Birth Registration, and Internet Use.

Analysis

Creating linkages between 2016 clusters and 2021 districts
The sampling frame used in the 2016 NFHS and the 2021 NFHS had different numbers of districts, with 640

and 707 respectively. In order to provide a policy-relevant assessment of the progress being made by districts, it was critical to use the 2021 NFHS geometry of districts as the reference, and approximate estimates for 2016 NFHS data based on the 2021 geometry, especially as the identification of the 112 ADs also appears to be based on the 707-district geometry.²⁰

To create a comparable data set of 33 indicators for the 707 districts of India, we linked the clusters from 2016 NFHS to 707 districts in 2021 NFHS. A spatial join was created between the 2016 GPS-enabled clusters and 2021 NFHS district shape file^{31–33} using ArcGIS Pro.³⁴ This approach allowed us to maintain the saliency of the geometry used in the 2021 NFHS data and does not make any alterations to it. Out of the total 707 districts in 2021 NFHS, 577 districts had not experienced any change in geometry. Out of the remaining 130 new districts, 115 were carved out of a single existing district, while 15 districts were created from more than one district. In doing so, the aspect of “district representativeness” could be potentially affected for the 2016 estimates for the 115 districts, although there is no *a priori* reason that this would occur, given the relatively large sample of clusters within each district.

Precision-weighted multilevel modeling strategy

In order to partially account for the fact that survey clusters were *post hoc* assigned to the 2021 NFHS geometry, we used a precision-weighted multilevel modeling strategy to derive estimates for the indicators.^{35,36} We specified a four-level discrete binary random effects logistic model that preserved the original complex multi-stage survey design.

$$\text{logit}(\pi_{ijkl}) = \beta_0 + u_{jkl} + v_{kl} + f_l$$

We modeled the log odds of the probability of a binary outcome variable (*e.g.*, 1 if child is stunted and 0 otherwise) (π_{ijkl}) with the following multilevel structure: individuals at level-1 (*i*) nested within 28,256 clusters (*j*), 640 districts (*k*), and 36 states/Union Territories (*l*) for 2016 NFHS; and 30,170 clusters, 707 districts, and 36 states/Union Territories for 2021 NFHS. The advantage of this modeling approach is that it takes into account the sampling variability attributable to potential imbalance in sample size at each level.³⁷

The parameter β_0 gives the mean log odds for the outcome measure across all the units. The residuals, u_{jkl} , v_{kl} , and f_l , each represents the residuals for cluster *j*, district *k*, and state *l*, respectively. Assuming a normal distribution of the residuals with a mean of 0, the model estimates the variance at different levels: between-cluster (within-district) variance as $u_{jkl} \sim N(0, \sigma_u^2)$; between-district (within-state) variance as $v_{kl} \sim N(0, \sigma_v^2)$; and between-state variance as $f_l \sim N(0, \sigma_f^2)$. The Monte Carlo Markov Chain (MCMC) methods using Gibbs sampler with non-informative priors, a burn-in of 500

cycles and monitoring of 5000 iterations of chains were used for the model estimation. We used STATA and *MLwiN* for estimation and used the *runmlwin*,³⁸ command in Stata.³⁹

From the above model, we derived precision-weighted estimates for each cluster as.

$$\exp(\beta_0 + u_{jkl} + v_{kl} + f_l) / (1 + \exp(\beta_0 + u_{jkl} + v_{kl} + f_l))$$

Which estimates the probability for each outcome (*e.g.*, probability of stunting) for each of the cluster in the 2016 and 2021 NFHS. We then computed the arithmetic mean of the cluster predictions for 2016 and 2021 for each of the 707 districts. The probabilities were expressed as percentages (or per 100 in the case under-5 mortality and neonatal mortality) for presentation and discussion. The preceding modelling procedure was implemented for each of the 33 indicators.

Estimating annual absolute change

After computing precision-weighted estimates for each indicator across 707 districts, we used the mean values for each district in 2016 and 2021 to estimate the observed Annual Absolute Change (AAC) between 2021 and 2016 as.

$$AAC_{actual} = \frac{X_t - X_{t-5}}{5}$$

where, X_t refers to indicator mean in 2021, X_{t-5} represents mean in 2016.

We calculated the required AAC, *i.e.*, the rate required to achieve the defined target by 2030, as.

$$AAC_{required} = \frac{X_t - X_{t-14}}{14};$$

where, X_t refers to the 2030 target and, X_{t-14} represents mean in 2016. For indicators such as stunting, where a lowering of the prevalence denotes improvement, the AAC value for districts that experienced an improvement will have a negative sign. For indicators such as coverage of health insurance, where an increase in prevalence denotes improvement, the AAC value for districts that experienced an improvement will have a positive sign.

Typology of progress

Based on the AAC and the specified SDG targets, we classified India and each of the districts on each of the indicator as one of the following (Table S1).

Achieved: These constitute districts that have already met the SDG target by 2021. The Achieved status can be categorized into two types

- **Achieved-I:** districts that have already met the SDG target by 2021 and have either observed an improvement between 2016 and 2021 or a worsening small

enough in magnitude between 2016 and 2021 such that they will still maintain their Achieved status by 2030.

- **Achieved-II:** districts that have already met the SDG target by 2021 but have observed a worsening magnitude of change between 2016 and 2021. If this trend continues, the status of these districts as Achieved will be undone by 2030.

On-Target: These constitute districts that have not met the SDG target by 2021 and have observed a magnitude of improvement between 2016 and 2021 sufficient to meet the target by 2030.

Off-Target: These constitute districts that have not met the SDG target by 2021 and either observed worsening between 2016 and 2021 or observed an insufficient magnitude of improvement between 2016 and 2021. If these districts continue with either of these trends, they will not meet their targets by 2030.

For all-India and each district indicator not meeting the SDG target by 2030 (Off-Target), we additionally computed the predicted year in which they will achieve their target as.

$$Y = \left[\frac{(X_t - X_{2021})}{AAC_{actual}} \right] - 9$$

where Y is the time to meet the target in years after 2030, X_t is the target of the indicator, X_{2021} is the mean value in 2021, and AAC_{actual} is the Actual AAC between 2016 and 2021. We then classified the time to meet SDG targets (post-2030) for all-India and each district according to following four categories.

- **Meet (2035 or Before):** going to meet the SDG target on or before 2035 (<6 years from 2030).
- **Meet (2035 to 2040):** going to meet the SDG target between 2036 and 2040 (≥ 6 and < 11 years from 2030).
- **Meet (2041 or After):** going to meet the SDG target on or after 2041 (≥ 11 years from 2030); and
- **Will Never Meet:** not going to meet the SDG target (*i.e.*, worsened between 2016 and 2021).

Assessment of the progress by aspirational districts

To assess the progress being made by ADs, we used a binary logistic regression with the outcome as 1 if the district is On-Target and 0 otherwise, and we analyzed whether Aspirational Districts are more likely to be On-Target to meet the SDG goals by 2030 for each indicator compared to the rest of the districts. The results from this regression were expressed as Odds Ratios (OR), with 95% Confidence Intervals (CI) and adjusted for state fixed effects.

Role of funding source

The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Results

Status on meeting SDG targets: All-India

At the all-India level, the one SDG indicator that has already been achieved (Achieved-I) is Adolescent Pregnancy (10–14) (Table 2). India is On-Target to meet 13 out of the 33 indicators, namely, Internet Use, Have Bank Account (Women), Full Vaccination (Card), Improved Sanitation, Multidimensional Poverty, Birth Registration, Skilled Birth Attendants, Electricity Access, Tobacco Use (Women), Child Marriage Girl (<15), Under 5 Mortality, Teenage Sexual Violence and Neonatal Mortality.

India remains Off-Target on 19 indicators (Table 2). Since the prevalence has increased (worsened) for 3 of these, Anaemia among Women, Pregnant, and Non-Pregnant Women between 2016 and 2021, and assuming this trend continues, India would never be able to meet the SDG targets related to Anaemia. For the remaining 16 indicators that are Off-Target, the observed rate of change between 2021 and 2016, though in desirable direction, is insufficient to meet SDG targets by 2030.

Among the Off-Target indicators, assuming the observed 2021–2016 rate of change, India will meet its targets on Improved Water (2031), Hand Washing Facility (2033), Clean Fuel for Cooking (2035), Teenage Pregnancy (15–19) (2039), and Partner Violence (Sexual) (2040) (Table 3). Another 11 Off-Target indicators will be met between 2041 and 2162, including Access to Basic Services in 2047 and Partner Violence (Physical or Sexual) in 2090.

Status of districts on meeting SDG targets: an indicator-level summary

The status of each district differs substantially across the 33 indicators. The Adolescent Pregnancy (10–14) SDG target, which has been realized by India overall, nonetheless remains Off-Target for 12 districts (Fig. 1). In contrast, Anaemia (Women), which is Off-Target and worsening for India, has been met (Achieved-I) in 9 districts and is On-Target in 50 districts. Electricity Access and Improved Water-related SDGs targets have been met by 23 and 30 districts, respectively, but are now worsening (Achieved-II).

The five indicators with the highest number of districts that have met the target (Achieved-I) are Adolescent Pregnancy (10–14) (N = 684), Tobacco Use (Women) (N = 478), Multidimensional Poverty (N = 370), Teenage Sexual Violence (N = 340), and Electricity Access (N = 306) (Fig. 1). The five indicators with the most districts On-Target are Have Bank Account (N = 624), Improved Sanitation (N = 553), Full Vaccination (Card) (N = 538), Internet Use (N = 502), and Skilled Birth Attendants (N = 438).

Indicators with the largest number of Off-Target districts include Anaemia (Women) (N = 644), Anaemia (Non-Pregnant) (N = 643), Access to Basic

Indicator Number	Indicator Name	District Mean (2016)	District Mean (2021)	Absolute Change and (AAC) ^a
Achieved-I				
3.7.2 (Age 10–14)	Adolescent Pregnancy (10–14)	0.19	0.12	-0.07 (-0.01)
On-Target				
17.8.1	Internet Use	11.7	51.95	40.25 (8.05)
8.10.2	Have Bank Account (Women)	52.16	79.98	27.81 (5.56)
3.b.1	Full Vaccination (Card)	52.21	77.65	25.44 (5.09)
6.2.1 (Part A)	Improved Sanitation	57.24	79.35	22.11 (4.42)
1.2.2	Multidimensional Poverty	27.28	15.57	-11.71 (-2.34)
16.9.1	Birth Registration	83.8	92.63	8.83 (1.77)
3.1.2	Skilled Birth Attendants	82.9	91.19	8.29 (1.66)
7.1.1	Electricity Access	89.6	97.19	7.6 (1.52)
3.a.1 (Women)	Tobacco Use (Women)	9.42	5.95	-3.47 (-0.69)
5.3.1 (Before 15)	Child Marriage Girl (<15)	4.17	2.77	-1.4 (-0.28)
3.2.1	Under 5 Mortality	3.73	2.98	-0.75 (-0.15)
16.2.3	Teenage Sexual Violence	1.37	0.75	-0.62 (-0.12)
3.2.2	Neonatal Mortality	2.27	1.83	-0.43 (-0.09)
Off-Target				
7.1.2	Clean Fuel for Cooking	37.52	53.18	15.66 (3.13)
1.3.1 (Men)	Health Insurance (Men)	22.72	35.83	13.1 (2.62)
1.4.1	Access to Basic Services	26.53	38.17	11.65 (2.33)
6.2.1 (Part B)	Hand-washing Facility	60.06	71.46	11.4 (2.28)
1.3.1 (Women)	Health Insurance (Women)	20.62	31.71	11.09 (2.22)
5.b.1	Own Mobile Phone (Women)	45.43	55.75	10.33 (2.07)
3.a.1 (Men)	Tobacco Use (Men)	49	42.66	-6.35 (-1.27)
3.7.1	Modern Contraceptive Use	68.26	73.27	5.01 (1)
2.2.3 (Non-Pregnant)	Anaemia (Non-Pregnant Women)	51.86	56.32	4.46 (0.89)
2.2.3 (All Women)	Anaemia (Women)	51.72	56.07	4.35 (0.87)
5.3.1 (Before 18)	Child Marriage Girl (<18)	22.48	18.73	-3.75 (-0.75)
6.1.1	Improved Water	91.46	93.9	2.44 (0.49)
2.2.1	Stunting	34.99	32.63	-2.37 (-0.47)
2.2.3 (Pregnant)	Anaemia (Pregnant Women)	48.69	50.12	1.43 (0.29)
5.2.1 (Physical or Sexual)	Partner Violence (Physical or Sexual)	21.7	20.27	-1.43 (-0.29)
3.7.2 (Age 15–19)	Teenage Pregnancy (15–19)	6.81	5.49	-1.32 (-0.26)
5.2.1 (Physical)	Partner Violence (Physical)	20.37	19.33	-1.04 (-0.21)
5.2.1 (Sexual)	Partner Violence (Sexual)	4.03	3.31	-0.72 (-0.14)
2.2.2	Wasting and Overweight	22.24	21.66	-0.59 (-0.12)

^aThe change represents 2021 minus 2016.

Table 2: Mean, change, annual absolute change (AAC), and status on the progress related to the Sustainable Development Goal (SDG) indicators for India, 2016 and 2021.

Services (N = 613), Anaemia (Pregnant Women) (N = 606), and Health Insurance (Women) (N = 591) (Fig. 1). Indicators with a smaller number of Off-Target districts include Adolescent Pregnancy (10–14) (N = 12), Multidimensional Poverty (N = 43), Electricity Access (N = 47), Have Bank Account (Women) (N = 80), and Tobacco Use (Women) (N = 97). Among the 16 Off-Target indicators for all-India, the highest number of Off-Target districts were noted for Anaemia (Women) (N = 644), and the lowest for Improved Water (N = 278). In comparison, among the 13 On-Target Indicators for India, Child Marriage Girl (<18) (N = 306) had the highest number of Off-Target districts and Multidimensional Poverty (N = 43) showed the lowest.

For districts that are Off-Target on a given indicator, the time it will take to meet the SDG target post-2030 varies substantially (Fig. 2). Indicators with the highest number of districts that will meet the target by 2035 are Internet Use (N = 126), Own Mobile Phone (N = 112), Child Marriage Girl (<18) (N = 108), Hand Washing Facility (<15) (N = 108), and Tobacco Use (Men) (N = 101). Indicators with the highest number of districts that will meet their targets between 2035 and 2040 are Clean Fuel for Cooking (N = 86), Own Mobile Phone (Women) (N = 74), Access to Basic Services (N = 60), Child Marriage Girl (<18) (N = 56), and Modern Contraceptive Use (N = 55). The indicators with the largest number of districts that will meet their targets after 2040

Indicator Number	Indicator Name	Year Target Will be Met ^a	Will Meet Target 2035 or before	Will Meet Target between 2035 and 2040	Will Meet Target 2041 or after
2.2.3 (Non-Pregnant)	Anaemia (Non-Pregnant Women) ^b	-	No	No	No
2.2.3 (All Women)	Anaemia (Women) ^b	-	No	No	No
2.2.3 (Pregnant)	Anaemia (Pregnant Women) ^b	-	No	No	No
6.1.1	Improved Water	2031	Yes	No	No
6.2.1 (Part B)	Hand-washing Facility	2033	Yes	No	No
7.1.2	Clean Fuel for Cooking	2035	Yes	No	No
3.7.2 (15-19)	Teenage Pregnancy (15-19)	2039	No	Yes	No
5.2.1 (Sexual)	Partner Violence (Sexual)	2040	No	Yes	No
5.b.1	Own Mobile Phone (Women)	2041	No	No	Yes
2.2.1	Stunting	2041	No	No	Yes
5.3.1 (Before 18)	Child Marriage Girl (<18)	2045	No	No	Yes
1.3.1 (Men)	Health Insurance (Men)	2045	No	No	Yes
3.7.1	Modern Contraceptive Use	2046	No	No	Yes
1.4.1	Access to Basic Services	2047	No	No	Yes
3.a.1 (Men)	Tobacco Use (Men)	2050	No	No	Yes
1.3.1 (Women)	Health Insurance (Women)	2051	No	No	Yes
5.2.1 (Physical or Sexual)	Partner Violence (Physical or Sexual)	2090	No	No	Yes
5.2.1 (Physical)	Partner Violence (Physical)	2111	No	No	Yes
2.2.2	Wasting and Overweight	2162	No	No	Yes

^aYear SDG Target Will be Met is rounded down in all cases (i.e. if target will be reached in 2041.8, it is shown as being met in 2041). ^bPrevalence of Anaemia (Non-Pregnant, Women, and Pregnant Women) increased between 2016 and 2021. If this worsening extent continues, then these indicators, given the definition of On-Target/Off-Target, will never be met.

Table 3: Year when Off-Target Sustainable Development Goal (SDG) indicators will be met for India.

are Access to Basic Services (N = 437), Health Insurance (Women) (N = 334), Own Mobile Phone (N = 299), Health Insurance (Men) (N = 296), and Clean Fuel for Cooking (N = 276). Indicators with most districts that

will never meet its targets are Anaemia (Women) (N = 430), Anaemia (Non-Pregnant) (N = 430), Anaemia (Pregnant) (N = 396), Wasting and Overweight (N = 330), and Partner Violence (Sexual) (N = 291).

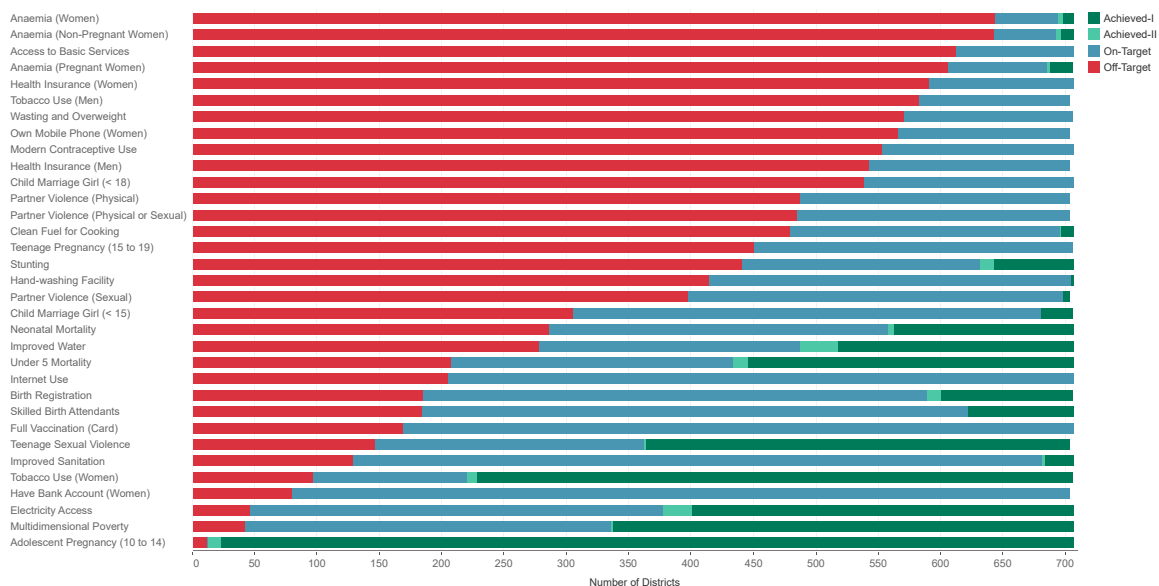


Fig. 1: Distribution of districts (count) for Sustainable Development Goal (SDG) indicators by district status. Total Number of Districts for the following SDG Indicators are not 707: Health Insurance (Men) – 704; Anaemia (Pregnant Women) – 706; Tobacco Use (Men) – 704; Partner Violence (Physical) – 704; Partner Violence (Sexual) – 704; Partner Violence (Physical or Sexual) – 704; Own Mobile Phone (Women) – 704; Have Bank Account (Women) – 704; Teenage Sexual Violence – 704. For underlying data see Table S2.

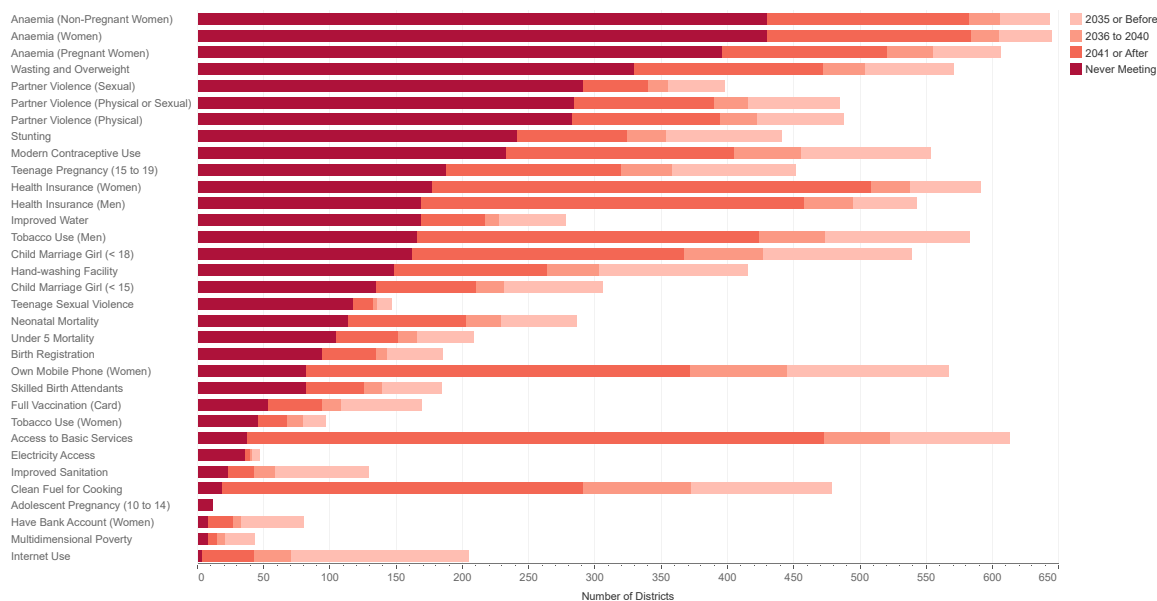


Fig. 2: Distribution (count) of off-target districts when Sustainable Development Goal (SDG) indicators will be met post-2030. For underlying data see [Table S3](#).

Status of SDG indicator performance: a district-specific summary

There is substantial disparity across districts with regards to the categories of Achieved, On-Target and Off-Target (Figs. 3–5). In Figs. 3–5, the Achieved-I and Achieved-II categories were combined, as indicators in both categories met the goal in 2021. The maximum number of SDG indicators that have been achieved by any district is 13 (out of a possible 33) (Fig. 3), met by Lakshadweep and Ernakulam (Kerala). The 61 districts that have achieved 9–13 indicators are largely located in the states of Kerala, Tamil Nadu, Arunachal Pradesh, and Punjab. About 94 districts have achieved 7–8 indicators distributed across the states of Karnataka, Andhra Pradesh, Telangana, Gujarat, Haryana, Punjab, and Uttarakhand. Approximately 171 districts have achieved their target for 2 or less indicators, and are mostly located in central and eastern states such as Madhya Pradesh, Chhattisgarh, Assam, Odisha, and Jharkhand.

The maximum number of indicators On-Target for any district is 23 (Fig. 4), and it is found in the district of Udaipur (Rajasthan). About 54 districts are On-Target to meet 17–23 indicators and are largely in Rajasthan, Madhya Pradesh, and Chhattisgarh. 139 districts are On-Target to meet 14–16 indicators and are clustered in Tamil Nadu, Andhra Pradesh, and Telangana. A total of 159 districts are On-Target to meet 3–8 indicators (lowest quintile), and are mostly located in Maharashtra, West Bengal, and Punjab.

Every district in India is Off-Target on at least 6 indicators (Fig. 5). The districts with the most Off-Target indicators (27 out of 33) are Bijapur (Chhattisgarh), East

Jantia Hills (Meghalaya), West Khasi Hills (Meghalaya), and Sepahijala (Tripura). 96 districts are Off-Target on 22 to 27 indicators, distributed largely in Maharashtra, West Bengal, Bihar, Jharkhand, Meghalaya, and Chhattisgarh. The 103 districts that are Off-Target on 20 to 21 indicators are largely located in the same states as above, while districts that are Off-Target on 6 to 13 indicators ($N = 153$) are largely located in Tamil Nadu, Kerala, Rajasthan, Uttarakhand, and Arunachal Pradesh.

For each of the 33 SDG indicators, an interactive online dashboard displaying whether a district is Achieved-I, Achieved-II, On-Target or Off-Target is included (Fig. S1, <https://geographicinsights.iq.harvard.edu/District-SDG-Progress>).

Are Aspirational Districts (ADs) more likely to be On-Target than other districts on SDG indicators?

ADs are more likely to meet their target on only 11 out of 33 indicators compared to other districts (Table 4), with the statistically significant indicators (more than twice likely to meet the target) including Access to Basic Services (OR 9.4, 95% CI 2.3, 39.2), Multidimensional Poverty (OR 4.2, 95% CI 2.2, 8.1), Clean Fuel for Cooking (OR 2.9, 95% CI 1.7, 5.1), Own Mobile Phone (Women) (OR 3.0, 95% CI 1.5, 6.0), Internet Use (OR 2.1, 95% CI 1.4, 3.3), and Stunting (OR 2.1, 95% CI 1.3, 3.4). ADs are statistically different from other districts with regards to the desirable AAC on only 10 out of 33 indicators (Table S4), and for a vast majority, the difference is considerably less than 1 percentage point per year compared to other districts. Further, a considerable variation in the rate of progress (AAC) among the 112

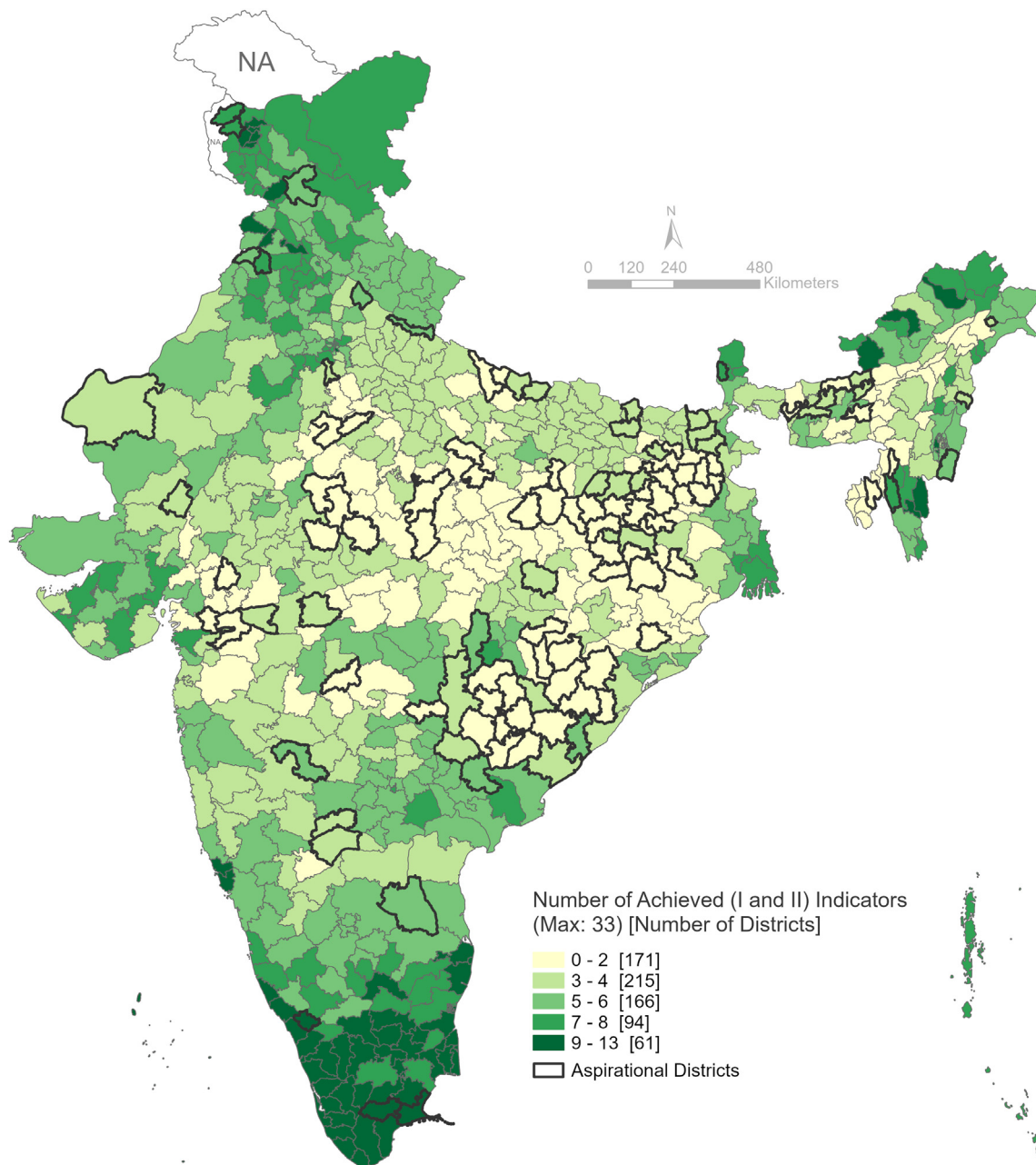


Fig. 3: Percentage of Sustainable Development Goal (SDG) indicators that have met (Achieved-I & Achieved-II) the goal in 2021 for each district of India.

ADs should be factored into any overall assessment of ADs as one group (Fig. S2), as well as geographic heterogeneity (Figs. 3–5).

Discussion

Our study has five salient findings. First, India is Off-Target for nearly three-fifths of the 33 SDGs indicators. These Off-Target indicators are largely related

to the following four SDG goals: No Poverty (SDG 1), Zero Hunger (SDG 2), Good Health and Well-Being (SDG 3) and Gender Equality (SDG 5). The indicators of concern include Access to Basic Services, Wasting and Overweight Children, Anaemia, Child Marriage, Partner Violence, Tobacco Use and Modern Contraceptive Use. Second, on indicators related to these four SDGs, a vast majority of the districts (more than 75%)

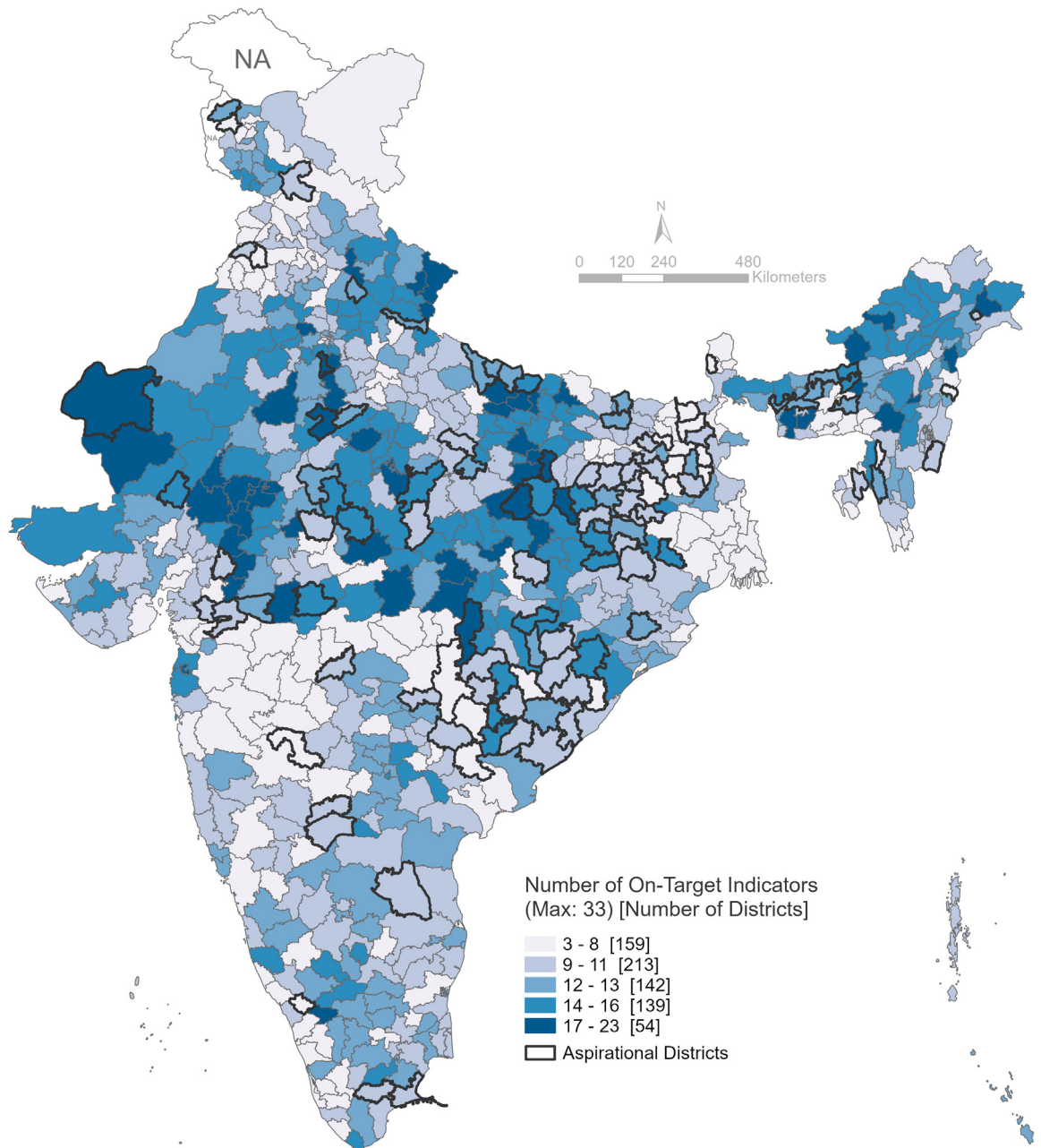


Fig. 4: Percentage of Sustainable Development Goal (SDG) indicators that are "On-Target" in 2021 for each district of India.

are Off-Target. Third, because of a worsening trend observed between 2016 and 2021, and assuming no course correction occurs, many districts will never meet their SDG targets, even well after 2030. Fourth, the districts that risk not meeting the above-mentioned SDGs for a majority of indicators appear to be concentrated in states of Madhya Pradesh, Chhattisgarh, Jharkhand, Bihar, and Odisha. Also of concern are Maharashtra and West Bengal, where most districts are

Off-Target for a large number of indicators. Fifth, ADs do not appear to be more likely to meet SDG targets than other districts on a majority of indicators.

Data-related considerations

The above findings should be interpreted alongside the following data-related considerations. First, in this study we assessed only a selected set of indicators that reflect 9 out of the 17 SDGs, with a vast majority of indicators

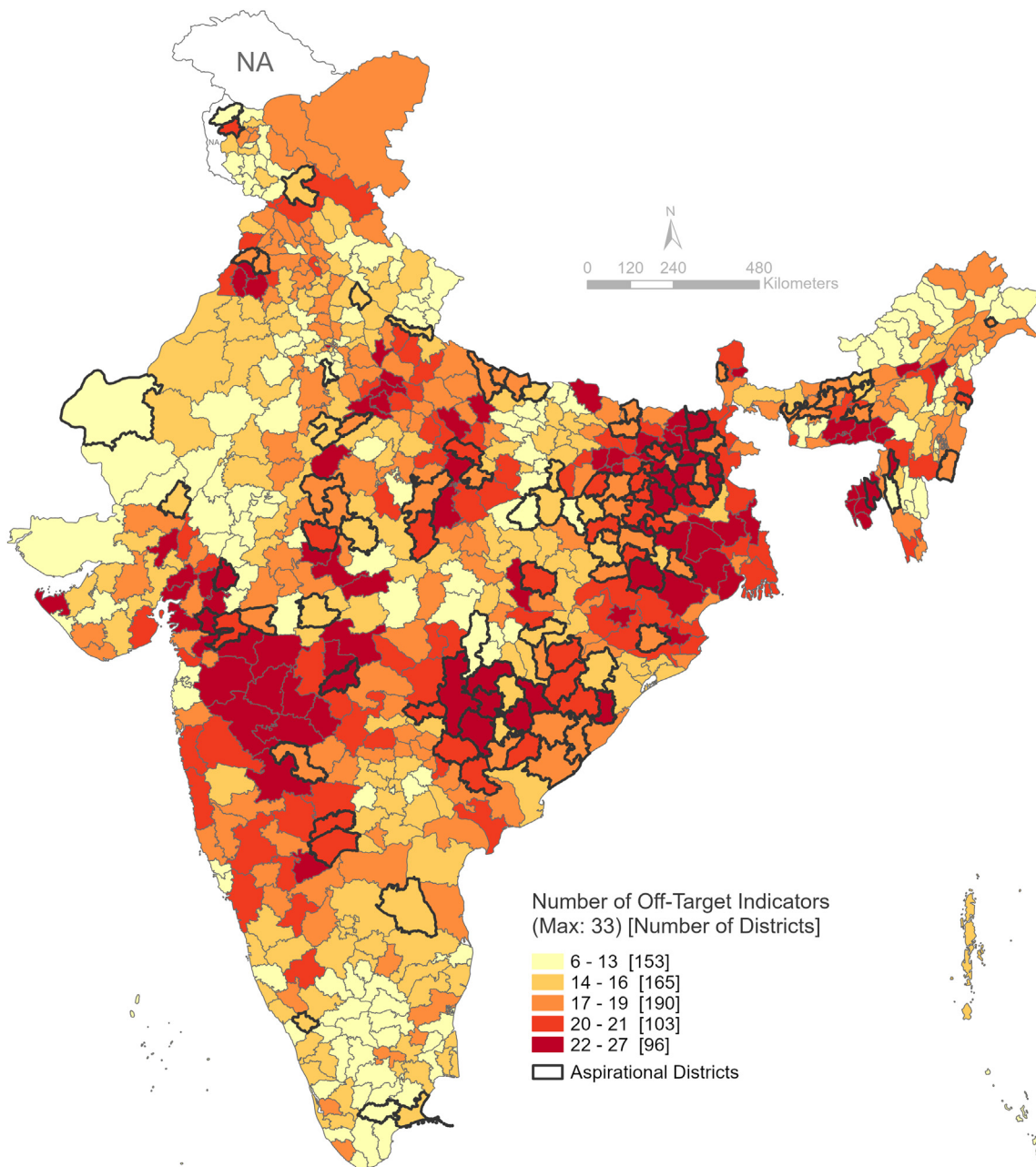


Fig. 5: Percentage of Sustainable Development Goal (SDG) indicators that are “Off-Target” in 2021 for each district of India.

falling within 6 out of the 9 SDGs: No Poverty, Zero Hunger, Good Health and Well-Being, Gender Equality, Clean Water and Sanitation, and Affordable and Clean Energy. For this mid-line assessment, it was critical that we use a data source that was independently collected and had proven credibility across multiple stakeholders, including the GOI. For instance, the NFHS is a Ministry of Health and Family Welfare initiative, but is conducted independently by the autonomous International

Institute for Population Sciences.¹⁴ Thus, the number of indicators across and within an SDG depended on their availability in the NFHS dataset and having been collected in both 2016 and 2021. Second, to facilitate a comparison across 707 districts, we had to assume that the selection of clusters within a district was entirely random in the 2016 NFHS, and thus, its assignment to a new parcel would not systematically bias the estimate. While this assumption applies to 130 of the 707

Indicators	Adjusted (State Fixed Effects)	
	OR	95% CI
Indicators where ADs are more likely to meet targets by 2030		
Access to Basic Services	9.4 ^a	(2.3; 39.2)
Multidimensional Poverty	4.2 ^a	(2.2; 8.1)
Clean Fuel for Cooking	2.9 ^a	(1.7; 5.1)
Own Mobile Phone (Women)	3.0 ^a	(1.5; 6.0)
Internet Use	2.1 ^a	(1.4; 3.3)
Stunting	2.1 ^a	(1.3; 3.4)
Anaemia (Non-Pregnant Women)	1.6	(0.7; 4.0)
Child Marriage Girl (<18)	1.9 ^a	(1.1; 3.4)
Partner Violence (Physical or Sexual)	1.9 ^a	(1.1; 3.1)
Under 5 Mortality	1.9 ^a	(1.2; 2.9)
Anaemia (Women)	1.6	(0.7; 4.0)
Partner Violence (Physical)	1.8 ^a	(1.1; 2.9)
Tobacco Use (Men)	1.6	(0.8; 3.0)
Wasting and Overweight	1.4	(0.8; 2.6)
Child Marriage Girl (<15)	1.5 ^a	(1.0; 2.3)
Neonatal Mortality	1.6 ^a	(1.1; 2.5)
Improved Sanitation	1.3	(0.8; 2.1)
Tobacco Use (Women)	1.4	(0.8; 2.4)
Anaemia (Pregnant Women)	1.2	(0.6; 2.3)
Hand-washing Facility	1.3	(0.8; 2.0)
Teenage Pregnancy (15–19)	1.4	(0.9; 2.2)
Improved Water	1.2	(0.8; 1.8)
Modern Contraceptive Use	1.3	(0.8; 2.3)
Birth Registration	1.1	(0.7; 1.8)
Teenage Sexual Violence	1.0	(0.6; 1.7)
Indicators where other districts are more likely to meet targets by 2030		
Electricity Access	0.2 ^a	(0.08; 0.9)
Health Insurance (Men)	0.4 ^a	(0.3; 0.7)
Adolescent Pregnancy (10–14)	0.9	(0.1; 8.2)
Have Bank Account (Women)	0.5	(0.2; 1.2)
Full Vaccination (Card)	0.5	(0.3; 1.0)
Health Insurance (Women)	0.6	(0.4; 1.1)
Partner Violence (Sexual)	0.9	(0.6; 1.4)
Skilled Birth Attendants	0.9	(0.5; 1.5)

^aRepresents statically significant at $p < 0.05$.

Table 4: Adjusted (for state fixed effects) odds ratio (OR) and 95% confidence interval (CI) for aspirational districts (compared to other districts) on-target status for Sustainable Development Goal (SDG) indicators.

districts, there is potential concern for 15 districts that were created from two or more districts, leading to smaller samples per district in 2016. We partially alleviate this concern by adopting a precision-weighted modelling approach whereby estimates take into account statistical reliability and precision due to varying and small sample size.³⁷ Third, in the absence of annual data being available, we assumed a linear rate of growth between 2016 and 2021, which in turn forms the basis for ascertaining the projected status with regards to meeting SDG targets by 2030 and beyond. Given the relatively short time period between the two surveys, a

linear growth was considered reasonable. However, a note should be made of possible Covid-19 related considerations during the intervening survey periods, which may have influenced some indicators more than others. Notwithstanding these data-related considerations, the larger motivation for this mid-line assessment was to provide a working projection model based on the most recent changes measured in the observed districts.

We discuss the three policy implications of our findings. First, we identify the policy/programs that require a deeper assessment and appraisal. Second, we raise the issue of the appropriate choice of the metric to assess SDGs, especially in the context of Zero Hunger goal. Finally, we discuss how our findings should inform the future of the AD program.

Re-appraisal of existing government of India programs

A majority of Indian districts measured in our analysis are Off-Target for the SDGs related to No Poverty, Zero Hunger, Good Health and Well-Being, Gender Equality. In the current policy landscape, there are existing programs and frameworks in place that can be linked to the indicators that are part of these goals. For example, programs such as *Pradhan Mantri Awaas Yojana* (to deliver affordable *pucca* housing to the poor),⁴⁰ the *Pradhan Mantri Sahaj Bijli Har Ghar* (to provide universal household electrification),⁴¹ the *Ujjawala Yojana 2.0* (to provide clean cooking fuel to all poor households),⁴² and the *Jal Jeevan Mission* (to provide safe and adequate tapped drinking water to all rural households)⁴³ are all relevant for SDG 1 to end poverty in all its forms everywhere.

In this regard, the program *Swachh Bharat Mission* (to provide sanitation facilities for every household)⁴⁴ can offer some lessons, as India is well On-Target to provide universal sanitation to its citizens by 2030, and a majority of its Off-Target districts will achieve their targets by 2035. The political will and administrative focus that has supported the *Swachh Bharat Mission* at the highest levels would benefit other programs aimed at providing basic services for the population of India.

Similarly, with 60% of healthcare in India being borne out of pocket,^{45,46} addressing the lagging indicator of health insurance coverage (related to SDG Good Health and Well-being) through an appraisal of the *Pradhan Mantri Jan Dhan Yojana*⁴⁷ would be necessary. It would be prudent to formulate new policies related to reducing tobacco consumption which is a key concern in a majority of the districts.

Even as India has and continues to make substantial progress on aspects of women empowerment such as education,⁴⁸ health,¹⁴ and financial inclusion,¹⁴ underscoring the value of programs such as *Beti Bachao Beti Padhao* (to curb sex selective abortion and promoting girls education),⁴⁹ the *Mahila Shakti Kendra* (to support

skill development and employment of women),⁵⁰ and *Women Entrepreneurship Program* (to encourage women to launch business ventures),⁵¹ and ensuring woman's security against partner violence continues to be an important concern. According to our projection, India will not meet the SDG on Gender Equality by as late as 2090, and for nearly one-third of districts this goal will never be met in the foreseeable future. The existing legislations⁵² and the judicial process also needs an immediate attention.

Choice of metrics: an exemplification

Under its umbrella programs *Poshan Abhiyan*,⁵³ and *Anaemia Mukht Bharat*,⁵⁴ the GOI has elevated to the forefront the issue of undernutrition among children and women, along with substantial resource allocation. Yet, indicators such as Anaemia have worsened between 2016 and 2021. The persistent challenge of undernutrition also warrants reflection on the appropriate metric to measure this SDG. For instance, the indicator definition for Anaemia currently combines mild, moderate and severe cases. While the prevalence of any anaemia among all women in 2021 NFHS was 57%, severe anaemia in India was only 2%, while moderate and mild were 28% and 25%, respectively.¹⁴ Combining severe, moderate, and mild into the same grouping is less constructive when different groups may require different interventions.⁵⁵ Identifying district prevalence based on the *degree* of anaemia severity would provide clearer insight for more effective policy action.⁵⁶

Another indicator associated with Zero Hunger is Stunting and Wasting of Children. It is well established that measures involving anthropometric height have a significant inter-generational component,^{57,58} which renders them less appropriate for assessing progress on *current* policies.^{59,60} Furthermore, the prevalence of stunting and wasting among children in India is highly sensitive to the standard/reference used⁶¹; changing the reference from the conventionally used WHO Multi-centre Growth Reference Study (MGRS) to one based on an "Indian Urban Middle Class" (IUMC) sample, revises the prevalence of stunting from 33% to 24%, and wasting from 19% to 9%.⁶¹ That India faces a substantial burden of undernutrition is undeniable – but accurately quantifying the extent of undernutrition prevalence is essential. To this end, it would be constructive for the GOI to devise measures that provide robust assessments of food insecurity and hunger, with an emphasis on more direct measures related to food and dietary intake.⁶²

Aspirational Districts (AD) program 2.0: a policy perspective

The AD program that localised SDGs at district levels, launched in 2016, had a two-fold aim: to 'quickly' and 'effectively' transform 112 of the most underdeveloped districts of India.^{20,63} As a catalyst for these districts, the

AD program not only increased their rate of progress on critical indicators, but also reduced the inter-district inequality. However, our findings suggest no clear pattern that AD's are more likely meet the SDG targets compared to other districts. Furthermore, there also appears to be no marked difference in the Annual Absolute Change between ADs and other districts, with variation across ADs and with overlapping distributions with other districts. The lack of clear and consistent pattern for AD change across indicators might suggest that the existing ADs whose progress is measured by a composite score of indicators across five aspects: health and nutrition, education, agriculture, financial inclusion, and basic infrastructure,⁶³ is not necessarily identifying the most under-developed districts for a specific indicator or domain such as undernutrition or gender equality. Indeed, a general drawback of composite index based identification is the risk that a single index measure based on all may not apply to any given measure.

Since the ADP was formulated specifically with an intention to achieve SDGs,²⁰ it may be timely to consider an Aspirational District 2.0 that is goal-specific (*e.g.*, Aspirational Districts (Gender Equality) or Aspirational Districts (No Poverty), and so on). Indeed, the selection of AD based on multiple domains or indicators can benefit from a method that, instead of creating a single index that eschews real variation across indicators, can identify which districts have the most concerning metrics for a given indicator. Such a method can also be helpful in aiding convergence across sectors in selected districts where it may be most needed. Similarly, such a list should be dynamic, to exit successful districts out of the program and include newer ones in need. Another important consideration that will determine district performance is how well it targets its sub-districts or even villages that need the most intervention. To our knowledge, there is no way to systematically identify which of these sub-units should receive additional focus, or any movement to advance a granular version of AD, such as Aspirational Villages or Aspirational Sub-districts. There is now consistent evidence that considerable within-district between-village variations exist in health, nutrition, and social determinants of health^{35,56,64–66}; thus, a greater degree of precision in geographical targeting is required than what can currently be met by using districts as the most decentralized unit for intervention and monitoring. Put simply, a substantial degree of nuance will be required to truly use the AD framework to help India achieve SDGs.

Summary

We provided a systematic mid-line assessment of where districts of India stand with regards to progress on SDGs related to health and social determinants of health. While the districts of India are making progress, there is an urgent need to increase the pace and

momentum on many critical indicators. Our findings suggest an urgent need to develop a strategic roadmap to ensure success with regards to meeting the SDGs, which should include an honest and transparent assessment of existing GOI programs that are directly or indirectly related to SDGs. Such a deliberation could entail identifying robust metrics that are directly measurable and adaptable to India, establishing data systems for timely public release of data sets, identifying what programs need to be created or refocused, and dynamically prioritizing districts (and sub-districts/villages) for intervention consistent with the SDG targets. Given that the various SDGs fall within tightly structured Ministries, there is a case to establish Inter-Ministerial initiatives, with clear governance structures under the Prime Minister's Office. Similar structures could be developed at the state level under the respective Chief Minister's Office. As India rapidly moves forward as a leading economic player in the world economy, its full realization will crucially depend on addressing some of the more basic health and social determinants of these critical health-related SDGs.

Contributors

Conceptualization and Design: SVS; Data Acquisition and Analysis: SR, AK, HC, RK, MA; Data Interpretation: SVS, MA, AK, WJ; Writing of the Manuscript: SVS, MA, AK; Critical Revisions: SVS, MA, WJ, SR, RK; Overall Supervision: SVS.

Data sharing statement

This study is based on publicly available data from India's National Family Health Survey that are available for download through the Demographic and Health Surveys program's data distribution system: www.dhsprogram.com.

Declaration of interests

None of the authors reported any conflict of interest.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.lansea.2023.100155>
Geovisual Dashboard of Progress on SDGs Across Districts in India (<https://geographicinsights.iq.harvard.edu/District-SDG-Progress>).

References

- United Nations. Transitioning from the Millennium development goals to the sustainable development goals [cited 2022 November 30] *Sustain Develop Goals*; 2015. Available from: <https://www.un.org/sustainabledevelopment/blog/2015/09/transitioning-from-the-millennium-development-goals-to-the-sustainable-development-goals/>.
- United Nations. The Millennium development goals report. New York. [https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20\(july%201\).pdf](https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(july%201).pdf); 2015
- United Nations. Historic new sustainable development Agenda unanimously adopted by 193 UN members [cited 2022 November 30] *Sustain Develop Goals*; 2015. Available from: <https://www.un.org/sustainabledevelopment/blog/2015/09/historic-new-sustainable-development-agenda-unanimously-adopted-by-193-un-members/#:~:text=Historic%20New%20Sustainable%20Development%20Agenda%20Unanimously%20Adopted%20by%20193%20UN%20Members>.
- United Nations. Sustainable development goals knowledge platform: voluntary national review 2020, India [cited 2022 November 30]. Available from: <https://sustainabledevelopment.un.org/member-states/india; 2020>.
- Department of Economic and Social Affairs. World population prospects. United Nations New York. <https://population.un.org/wpp; 2022>
- NITI Aayog. *Localising SDGs early lessons from INDIA 2019*. New Delhi.
- Government of India. Report of the working group on USD five trillion Indian economy. New Delhi. https://www.niti.gov.in/sites/default/files/2020-07/LSDGs_July_8_Web.pdf; 2019
- Morgan Stanley. India's impending economic boom [cited November 30 2022]. Available from: <https://www.morganstanley.com/ideas/investment-opportunities-in-india; 2022>.
- NITI Aayog. *The Indian model of SDG localisation*. Government of India; 2022. <https://india.un.org/sites/default/files/remote-resources/2c676b0772666906b8a4650431a8e0e4.pdf>.
- Dreze J, Sen A. *Indian development: selected regional perspectives*. Oxford University Press; 1997.
- Kurian N. Widening regional disparities in India: some indicators. *Econ Polit Wkly*. 2000;35(7):538–550. <https://www.jstor.org/stable/i398912>.
- Government of India Sample Registration System (SRS). *Bulletin*. 2020. <https://censusindia.gov.in/census.website/data/SRSB>.
- World Population Review. Infant mortality rate by country [cited 2022 November 30]. Available from: <https://worldpopulationreview.com/country-rankings/infant-mortality-rate-by-country; 2022>.
- International Institute for Population Sciences. *National family health survey (NFHS 5), 2019-21, India report*. Mumbai: Government of India; 2022. http://rchiips.org/nfhs/NFHS-5Reports/NFHS-5_INDIA_REPORT.pdf.
- Census of India. Administrative atlas [cited 2022 November 30]. Available from: <https://censusindia.gov.in/census.website/data/atlas; 2022>.
- Government of India. Local government directory [cited 2022 November 30]. Available from: <https://lgedirectory.gov.in; 2022>.
- Sarma R. Who is a collector? What are his powers? [cited 2022 November 30]. Available from: <https://lawtimesjournal.in/who-is-a-collector-what-are-his-powers; 2020>.
- Nayak R, Saxena N, Farrington J. *Reaching the poor: the influence of policy and administrative processes on the implementation of government poverty schemes in India*. Overseas Development Institute London; 2002. <https://cdn.odi.org/media/documents/2700.pdf>.
- Sen A. Powers of district magistrate (districte collector) in India. November 30, 2022. Available from: <https://web.archive.org/web/20170816062201/http://www.importantindia.com/1724/powers-of-district-magistrate-in-india; 2013>.
- NITI Aayog. Aspirational districts programme. November 30, 2022. Available from: <https://www.niti.gov.in/aspirational-districts-programme; 2022>.
- International Institute for Population Sciences. *The national family health survey (NFHS-4): India report 2017*. Mumbai. <http://rchiips.org/nfhs/NFHS-4Reports/India.pdf>.
- Demographic and Health Surveys Program. Survey summary, India: standard DHS, 2019-21 [cited 2022 November 30]. Available from: <https://dhsprogram.com/methodology/survey/survey-display-541.cfm; 2021>.
- Corsi DJ, Neuman M, Finlay JE, Subramanian SV. Demographic and health surveys: a profile. *Int J Epidemiol*. 2012;41(6):1602–1613. <https://doi.org/10.1093/ije/dys184>.
- Demographic and Health Surveys Program. SDG indicators that can be estimated in DHS surveys [cited 2022 November 30]. Available from: <https://dhsprogram.com/Topics/upload/SDGs%20in%20DHS%209Dec2020.pdf; 2020>.
- NITI Aayog. SDG India index: baseline report. https://www.niti.gov.in/sites/default/files/2020-07/SDX_Index_India_Baseline_Report_21-12-2018.pdf; 2018.
- United Nations. Global indicator framework for the sustainable development goals and targets of the 2030 Agenda for sustainable development. https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202020%20review_Eng.pdf; 2015.
- United Nations Sustainable Development Group. Universal values principle two: leave no one behind [cited 2022 November 30]. Available from: <https://unsdg.un.org/2030-agenda/universal-values/leave-no-one-behind; 2022>.
- Lozano R, Fullman N, Abate D, et al. Measuring progress from 1990 to 2017 and projecting attainment to 2030 of the health-related Sustainable Development Goals for 195 countries and territories: a

- systematic analysis for the Global Burden of Disease Study 2017. *Lancet*. 2018;392(10159):2091–2138. [https://doi.org/10.1016/S0140-6736\(18\)32281-5](https://doi.org/10.1016/S0140-6736(18)32281-5).
- 29 NITI Aayog. SDG India index 3.0: target justification [cited 2022 November 30]. Available from: https://sdgindiaindex.niti.gov.in/assets/Files/Target_Justification_2020-21.pdf; 2020-21.
 - 30 World Health Organisation. Global nutrition targets 2025 policy brief series. <https://www.who.int/publications/i/item/WHO-NMH-NHD-14.2>; 2014.
 - 31 Demographic and Health Surveys Program. Spatial data repository: India [cited 2022 November 30]. Available from: <https://spatialdata.dhsprogram.com/boundaries/#view=table&countryId=1A>; 2022.
 - 32 Geographic Insights Dataverse. NFHS policy tracker for districts, 2022. [cited 2022 November 30]. Available from: <https://dataverse.harvard.edu/dataset.xhtml?persistentId=doi:10.7910/DVN/NECYOE>.
 - 33 Kim J, Liu Y, Wang W, et al. Estimating the burden of child undernutrition for smaller electoral units in India. *JAMA Netw Open*. 2021;4(10):e2129416. <https://doi.org/10.1001/jamanetworkopen.2021.29416>.
 - 34 ESRI. ArcGIS Pro [cited 2022 November 30]. Available from: <https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview>; 2022.
 - 35 Kim R, Bijral AS, Xu Y, et al. Precision mapping child undernutrition for nearly 600,000 inhabited census villages in India. *Proc Natl Acad Sci U S A*. 2021;118(18):e2025865118. <https://doi.org/10.1073/pnas.2025865118>.
 - 36 Kim R, Liou L, Xu Y, et al. Precision-weighted estimates of neonatal, post-neonatal and child mortality for 640 districts in India, National Family Health Survey 2016. *J Glob Health*. 2020;10(2):20405. <https://doi.org/10.71789/jogh.10.020405>.
 - 37 Goldstein H. *Multilevel statistical models*. John Wiley & Sons; 2011.
 - 38 Center for Multilevel Modeling. Runmlwin: running MLwiN from within Stata [cited 2022 November 30]. Available from: bristol.ac.uk/cmm/software/runmlwin/#:~:text=runmlwin%20is%20a%20Stata%20command,xtmixed%2C%20xtmlogit%20and%20xtmepoisson%20commands; 2022.
 - 39 StataCorp L. *Stata statistical software: release vol. 16* 2019.
 - 40 Ministry of Housing and Urban Affairs. Pradhan Mantri awas Yojana- urban [cited 2022 November 30]. Available from: <https://pmaymis.gov.in/>; 2022.
 - 41 National Portal of India. Pradhan Mantri Sahaj Bijli har ghar Yojana- saubhagya [cited 2022 November 30]. Available from: <https://www.india.gov.in/spotlight/pradhan-mantri-sahaj-bijli-har-ghar-yojana-saubhagya>; 2022.
 - 42 Ministry of Petroleum and Natural Gas. Pradhan Mantri ujwala Yojana 2.0 [cited 2022 November 30]. Available from: <https://www.pmu.gov.in/index.aspx>; 2022.
 - 43 Ministry of Jalshakti. Har ghar jal: jal jeevan mission, 2022. [cited 2022 November 30]. Available from: <https://jaljeevanmission.gov.in/>.
 - 44 Ministry of Jalshakti. Swachh sarvekshan grameen. <https://swachhharatmission.gov.in/SBMCMS/writereaddata/Portal/Images/pdf/SSG-2022-report.pdf>; 2022.
 - 45 Ambade M, Sarwal R, Mor N, Kim R, Subramanian SV. Components of out-of-pocket expenditure and their relative contribution to economic burden of diseases in India. *JAMA Netw Open*. 2022;5(5):e2210040. <https://doi.org/10.1001/jamanetworkopen.2022.10040>.
 - 46 NITI Aayog. Health insurance for India's missing Middle. New Delhi. https://www.niti.gov.in/sites/default/files/2021-11/HealthInsuranceforIndia%2E%80%99sMissingMiddle_01-11-2021_digital%20pub.pdf; 2021.
 - 47 Ministry of Health and Family Welfare. Ayushman Bharat - health and wellness Centre [cited 2022 November 30]. Available from: <http://ab-hwc.nhp.gov.in/>; 2022.
 - 48 Ministry of Statistics and Program Implementation. *Key indicators of household social consumption on education in India* 2018. <http://microdata.gov.in/nada43/index.php/catalog/152>.
 - 49 Government of India. Beti Bachao Beti Padhao [cited 2022 November 30]. Available from: <https://wcd.nic.in/bbbp-schemes>; 2017.
 - 50 Ministry of Women and Child Development, Government of India. Mahila shakti kendra scheme. New Delhi. <https://wcd.nic.in/sites/default/files/Final%20Guidelines%20MSK%28English%29%20Scheme.pdf>; 2017.
 - 51 Ministry of Commerce and Industry. Government of India. The women entrepreneurship platform [cited 2022 November 30]. Available from: <https://www.startupindia.gov.in/content/sih/en/government-schemes/Wep.html>; 2022.
 - 52 National Commission for Women. WOMEN-SPECIFIC legislation [cited 2022 November 30]. Available from: <http://ncw.nic.in/important-links/List-of-Laws-Related-to-Women>; 2022.
 - 53 Ministry of Women and Child Development. Government of India. BUDGETARY allocation on poshan abhiyaan, press bureau of India. India; 2021. <https://pib.gov.in/PressReleasePage.aspx?PRID=1784143>.
 - 54 Ministry of Health and Family Welfare. Anemia mukt bharat budget factsheet. <https://anemiamuktbarat.info/wp-content/uploads/2021/11/AMB-Budget-Factsheet-2021-22-12-11-2021-1-New.pdf>; 2021.
 - 55 National Heart, Lung and Blood Institute. What is anemia?. November 30, 2022. Available from: <https://www.nhlbi.nih.gov/health/anemia>; 2022.
 - 56 Rajpal S, Kumar A, Rana MJ, Kim R, Subramanian SV. Small area variation in severe, moderate, and mild anemia among women and children: a multilevel analysis of 707 districts in India. *Front Public Health*. 2022;10:945970. <https://doi.org/10.3389/fpubh.2022.945970>.
 - 57 Subramanian SV, Ackerson LK, Davey Smith G, John NA. Association of maternal height with child mortality, anthropometric failure, and anemia in India. *JAMA*. 2009;301(16):1691–1701. <https://doi.org/10.1001/jama.2009.548>.
 - 58 Kim R, Mejía-Guevara I, Corsi DJ, Aguayo VM, Subramanian SV. Relative importance of 13 correlates of child stunting in South Asia: insights from nationally representative data from Afghanistan, Bangladesh, India, Nepal, and Pakistan. *Soc Sci Med*. 2017;187:144–154. <https://doi.org/10.1016/j.socscimed.2017.06.017>.
 - 59 Karlsson O, Kim R, Bogin B, Subramanian SV. Maternal height-standardized prevalence of stunting in 67 low- and middle-income countries. *J Epidemiol*. 2022;32(7):337–344. <https://doi.org/10.2188/jea.JE20200537>.
 - 60 Subramanian SV, Karlsson O, Kim R. Revisiting the stunting metric for monitoring and evaluating nutrition policies. *Lancet Glob Health*. 2022;10(2):e179–e180. [https://doi.org/10.1016/S2214-109X\(21\)00504-0](https://doi.org/10.1016/S2214-109X(21)00504-0).
 - 61 Subramanian SV, Khaikar A, Karlsson O. Should India adopt a country-specific growth reference to measure undernutrition among its children? *Lancet Reg Health Southeast Asia*. 2023;9. <https://doi.org/10.1016/j.lansea.2022.100107>.
 - 62 Subramanian SV, Joe W. *Putting food at the centre of India's nutrition agenda, in the Hindu*. 2020. <https://www.thehindu.com/opinion/op-ed/putting-food-at-the-centre-of-indias-nutrition-agenda/article33358244.ece>.
 - 63 Ministry of Health and Family Welfare. National health mission: Aspirational districts program [cited 2022 November 30]. Available from: <https://nhm.gov.in/index1.php?lang=1&level=2&sublinkid=967&lid=587#:~:text=A%20total%20of%2011%20Aspirational,have%20an%20impact%20on%20HDI>; 2022.
 - 64 Jain A, Wang W, James KS, Sarwal R, Kim R, Subramanian SV. Small area variations in dietary diversity among children in India: a multilevel analysis of 6-23-month-old children. *Front Nutr*. 2022;8:791509. <https://doi.org/10.3389/fnut.2021.791509>. Published 2022 Feb 16.
 - 65 Rajpal S, Kim J, Joe W, Kim R, Subramanian SV. Small area variation in child undernutrition across 640 districts and 543 parliamentary constituencies in India. *Sci Rep*. 2021;11(1):4558. <https://doi.org/10.1038/s41598-021-83992-6>. Published 2021 Feb 25.
 - 66 Rana MJ, Kim R, Ko SK, et al. Small area variations in low birth weight and small size of births in India. *Matern Child Nutr*. 2022;18(3):e13369. <https://doi.org/10.1111/mcn.13369>.