nature communications

Article

https://doi.org/10.1038/s41467-025-60195-5

Subnational survey data reveal persistent gaps in living standards across 75 low and middle-income countries

Received: 29 January 2024

Accepted: 19 May 2025

Published online: 11 June 2025

Check for updates

Roman Hoffmann[1] ✉, Omkar Patange[1] ✉, Caroline Zimm[1], Shonali Pachauri[1], Camille Belmin[1,2], Setu Pelz[1], Elina Brutschin[1], Jarmo S. Kikstra[1,3,4], Michael Kuhn[1], Jihoon Min[1], Raya Muttarak[1,5], Keywan Riahi[1], Thomas Schinko[1] & Kian Mintz-Woo[1,6]

Many households worldwide face substantial gaps in decent living standards (DLS), universal and essential material preconditions for achieving well-being and inclusive development. Here, we use subnational Demographic and Health Survey data from 75 low and middle-income countries (1990–2021) to explore the distribution and trends of ten living standards. We estimate that 94.9% of households in our dataset lack the material prerequisites for at least one of the ten standards, and 63.6% for one-third of them. Stark inequalities persist both within and between countries, with regions in sub-Saharan Africa experiencing the most severe deprivations. Despite some improvements, progress remains limited in critical areas such as health care, sanitation, housing, and education. Within countries, rural, agrarian households with low levels of educational attainment are particularly disadvantaged. These granular findings at the subnational level can help direct policy efforts and resources towards those populations most in need.

At the halfway mark of the 2030 Agenda and its Sustainable Development Goals (SDGs), failures in implementation reveal outcomes that are incredibly sobering[1]. Troublingly, improvements in reducing extreme poverty stalled and even regressed after 2020[2–4]. Despite over two decades of global commitment and time-bound targets to reduce multidimensional deprivations, first under the previous Millennium Development Goals (MDGs) and now the SDGs, too many people today still live in abject poverty. Moreover, measures of extreme and acute poverty dominate discussions of poverty alleviation, which continues to be tracked by simple and incomplete income-based indicators such as the share of people living under US$2.15 a day, even when it is evident that many who earn more than that threshold still lack access to or just cannot afford the services necessary to live a decent life[5,6].

Understanding of and interest in tracking the multidimensional nature of poverty has grown over the last decade. The SDGs themselves, despite having been critiqued for being too siloed, mark a significant advancement in the acknowledgment of diverse human needs[7]. They go beyond a focus on the dominant income poverty measure to the tracking of progress in different areas, which reflect well-being more comprehensively[8,9]. In addition to the SDG indicators, several multidimensional indices[10–17] have been developed in recent years to track different facets of deprivations in living standards. However, few, except for the Multidimensional Poverty Index (MPI)[18,19], allow for comparisons not only between but also within countries and across time[20]. Most existing indicators for low- and middle-income countries are only available at a national scale, with consistent and comparable tracking at subnational scales being less common.

[1]International Institute for Applied Systems Analysis (IIASA), Laxenburg, Austria. [2]Potsdam Institute for Climate Impact Research, Potsdam, Germany. [3]The Grantham Institute for Climate Change and the Environment, Imperial College London, London, UK. [4]Centre for Environmental Policy, Imperial College London, London, UK. [5]Department of Statistical Sciences, University of Bologna, Bologna, Italy. [6]Department of Philosophy and Environmental Research Institute, University College Cork, Cork, Ireland. ✉e-mail: hoffmannr@iiasa.ac.at; patange@iiasa.ac.at

In September 2023, under the auspices of the General Assembly, the SDG Summit called for new science-based solutions and increasing support for data as pivotal to unlocking our commitment to "leave no one behind"[21]. Responding to this call, we contribute timely research that develops a novel dataset of decent living standards (DLS)[22] to assess the achievement of ten distinct and non-substitutable living standards subnationally. Our data contains information for over 4.7 million households in 75 countries over the period from 1990 to 2021, covering 66% of the population living in low- and middle-income countries today (Supplementary Figs. S1 and S2). Notably, we built this dataset using regularly conducted multitopic Demographic and Health Surveys (DHS) allowing for replicability, regular updating, and improvements[23]. Our work complements previous efforts to map the distribution of living standards for specific need dimensions across different countries[24–27].

The ten living standards we consider refer to seven dimensions satisfying physical well-being (housing, thermal comfort, nutrition, food preparation/storage, water, sanitation, provision of health care) and three dimensions satisfying social well-being (access to education, social connectedness, and physical connectedness). The DLS dimensions have been previously quantified based on slightly different indicators and thresholds[6,28,29]. The qualitative dimensions we consider closely align with these previous approaches (see Supplementary Tables S1–3 for information on the operationalization of the indicators). Prior research on estimating DLS gaps has focused either on a narrow subset of countries[28], or when covering the globe on a single year[6], country-level data[6,29], or a single DLS dimension[30]. We contribute to the literature on measuring DLS by assessing these subnationally for a wide selection of low- and middle-income countries over a period of three decades.

Our DLS dataset includes some of the same dimensions of deprivation that comprise the MPI[18,19]. However, our measure is distinct from the MPI in five critical ways (See Supplementary Note). First, we do not weigh the dimensions or indicators as we consider these as distinct and non-substitutable. We therefore do not aim to construct a single index of multidimensional deprivation. Second, we go beyond the MPI in including indicators we consider essential to not only individual but also social wellbeing, such as social and physical connectedness, access to education, and health care provisioning. Third, DLS represents a more ambitious approach to poverty eradication compared to MPI, which is described as a measure of 'acute poverty'[19], as it employs stricter thresholds for many of the dimensions considered. Fourth, while the MPI considers access to any of a set of assets —such as a radio, TV, telephone, computer, or refrigerator—as one of the six components of living standards it measures to characterize acute poverty, we consider access to individual assets as distinct indicators that measure separate dimensions of well-being (e.g., access to a refrigerator is essential for food preservation and storage, while it does not satisfy the separate need for communication). Finally, our approach in creating this DLS dataset lends itself to integration with important environmental dimensions of sustainable development. For example, methodologies for assessing the energy and material requirements for providing DLS have been developed in related work[6,28,29,31].

Globally, it is estimated that about 10% of the population in developing countries live in extreme poverty when measured applying the simple income-based metric of less than $2.15 a day (PPP), whereas about 18% are estimated to live in multidimensional poverty as measured using the MPI[5]. We find, however, that about 94.9% of households in our sample (1.99 million households in the last available DHS wave) are deprived of at least one of the ten essential living standards that comprise the DLS basket, and 63.6% are deprived of one-third of the living standards. Over time, access to DLS has improved, but there are still stark and persistent differences in living standards between and within countries, especially between urban and rural areas. We see the biggest deprivations in access to health care, modern means of food preparation (clean cooking and food preservation), housing, clean water, sanitation, and education. The observed progress in improving living standards falls far behind the pace needed to achieve the goals of the 2030 Agenda.

Results

Inequality in decent living standards

The DHS data reveals major gaps in the achievement of DLS across the considered countries. Considering the distribution of DLS across the 1103 subnational regions covered in the last DHS wave in each country, we find that in 920 regions (83.4%) less than 5% of households have achieved each of the ten DLS dimensions considered (Fig. 1A). Across the dimensions, the largest deprivation can be observed for modern means of food preparation (unfulfilled for 72.2% of households in the sample), health care (68.0%), adequate housing (54.8%), and adequate sanitation facilities (47.9%). About 21.3% of households in the last DHS wave reported at least one household member showing nutritional deficits, including signs of undernutrition for adults or wasting and stunting for children. The findings reveal a major shortfall in DLS achievement for large parts of the global population and are at odds with the ambition to eliminate multidimensional poverty as targeted in the SDGs.

The distribution of living standards across the world is highly unequal (Fig. 1B). While some countries are characterized by overall high levels of achievement across several DLS dimensions, others face major gaps. Across world regions, households in sub-Saharan Africa had the least access to DLS, with on average only 12.0% of all households in the latest available DHS wave having attained two-thirds of the DLS dimensions considered. This share was considerably higher in South Asia (37.3%), Latin America and the Caribbean (44.1%), East Asia and the Pacific (52.5%), the Middle East and North Africa (61.0%), and Eastern Europe and Central Asia (73.2%). We caution that these numbers are only characterizing the countries included in the data sample and should not be treated as representative of the world regions. While households in certain world regions were overall more restricted in their living standards, populations across the world experience gaps in decent living standards in at least some of the considered dimensions (Supplementary Fig. S3).

While disparities between countries are evident, inequalities also manifest within countries and within subnational regions (Fig. 1C). Even in countries where progress has been made, some pockets of deep deprivation persist. One key factor contributing to these inequalities within countries is the stark contrast between urban and rural areas. Urban settlements are often hubs of economic activity and infrastructure development, offering better employment opportunities and providing improved access to education, healthcare, and other essential services[26,32]. However, there are also major inequalities in living standards within urban areas. These variations may be masked by the overall perception of urban affluence. Cities are often divided along socioeconomic lines[33,34], leading to significant differences in the quality of life experienced by residents within a small geographical area (Supplementary Fig. S4).

Inadequate progress in the achievement of decent living standards

While improvements in some of the DLS dimensions are observable, temporal trends are characterized by stagnation across numerous domains (Fig. 2A). For example, progress in access to clean water or education has stalled in urban areas, and a slight regression in access to social connectedness is visible in rural areas. Notably, the divide between urban and rural regions persists over time across many of the indicators, although there is a convergence in specific areas, such as

https://doi.org/10.1038/s41467-025-60195-5

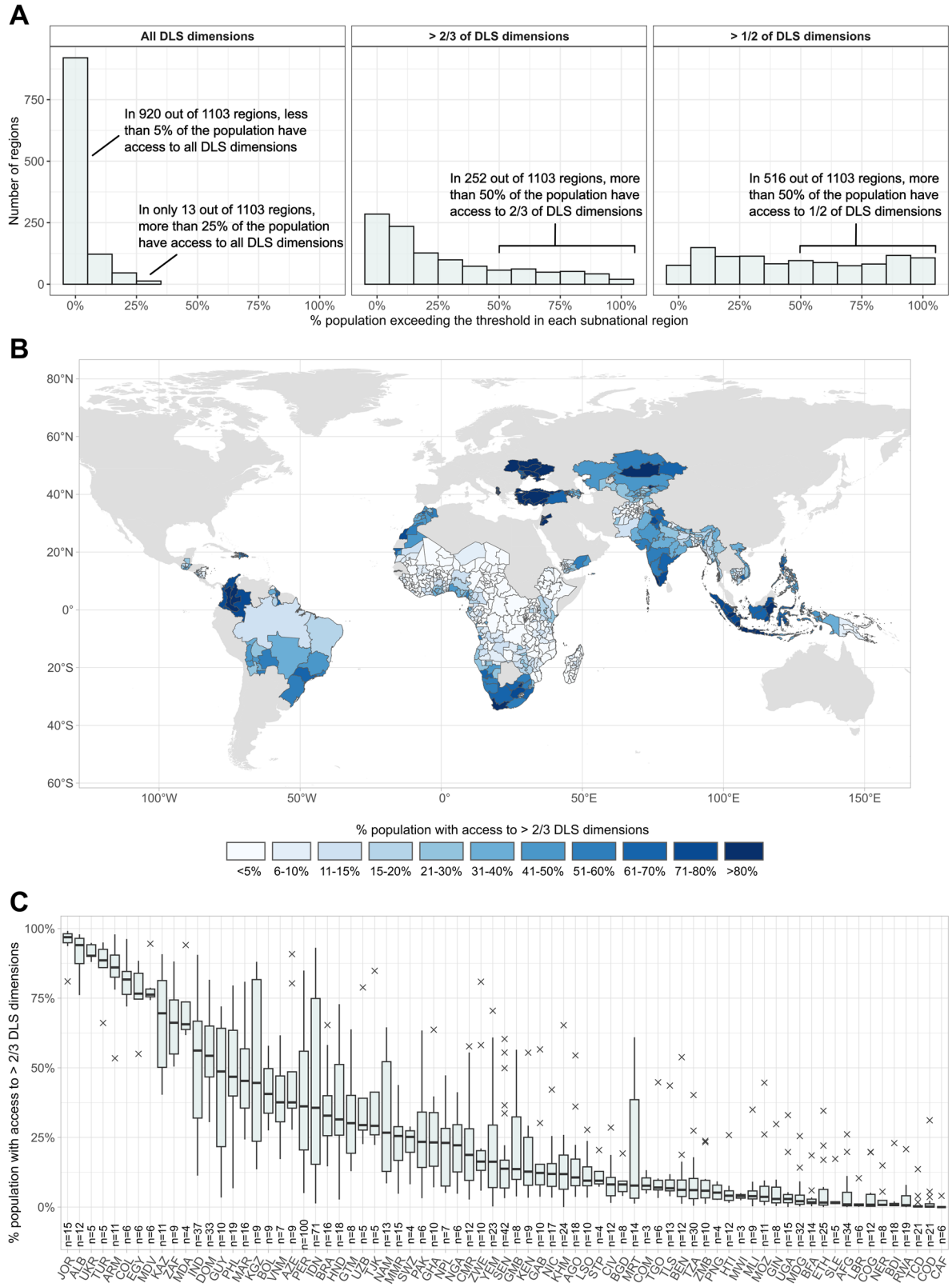

Fig. 1 | Distribution of achievement of decent living standards (DLS) for 75 countries. A shows histograms depicting the distribution of subnational regions according to the share of their populations achieving all, two-thirds, and half of the considered DLS dimensions. The map in **B** shows the share of the population in the subnational regions achieving at least two-thirds of the DLS dimensions. **C** depicts boxplots showing the median, interquartile ranges (IQR), and whiskers (either maximum value or maximum 1.5 × IQR) of the distribution of the share of the population achieving at least two-thirds of the considered DLS dimensions across all subnational regions within the countries. Outliers are marked by crosses. Each subnational region represents one observation in the data, suggesting that a country with a broader boxplot has higher domestic DLS inequality. A number of subnational regions per country are displayed below the box plots. The data depicted are based on the last available DHS wave for each country (Supplementary Fig. S1).

https://doi.org/10.1038/s41467-025-60195-5

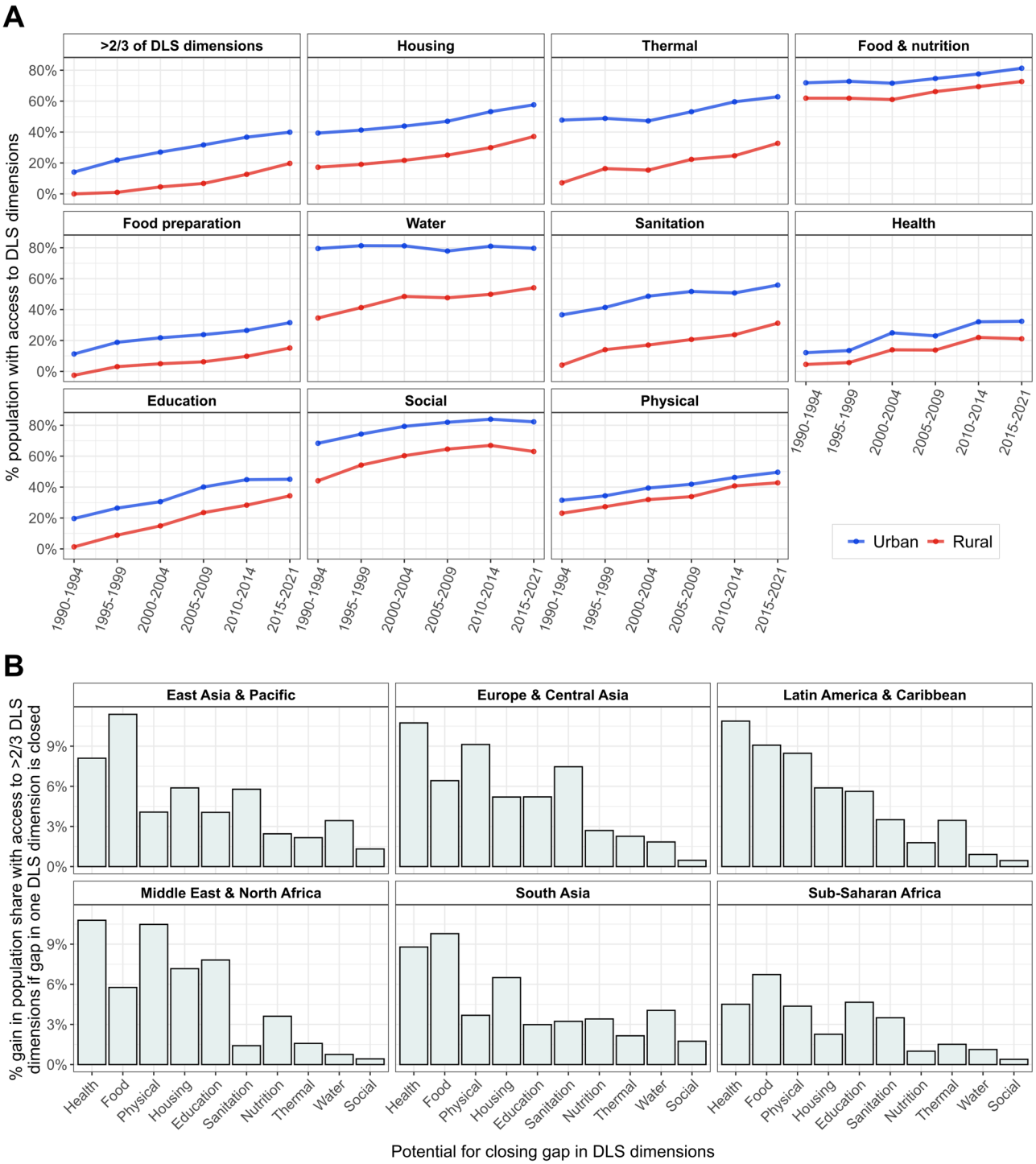

Fig. 2 | Trend and gap analysis showing gaps in the achievement of decent living standards over time and across world regions. A shows the predicted share of households in the DHS data that have achieved a specific DLS dimension over time. The x-axis shows the year of the survey data collection across multiple waves. The figures are based on estimates derived from a model controlling for the presence of different countries in the respective DHS waves via the use of country-level fixed effects (Supplementary Table S4, Models 1–11; $n = 5365$ subnational regions). These models account for the fact that differences over time may be driven by changes in the composition of the DHS sample with specific countries entering and leaving the sample. Missing data for selected dimensions was imputed using predictive mean matching approaches (Supplementary Table S6). **B** shows the potential of closing gaps in specific DLS dimensions by providing access to a specific DLS dimension (x-axis) to everyone in a population. The y-axis in the figure measures the additional share of people who would have access to at least 2/3 of all DLS dimensions, if the gaps in a specific DLS dimension were to be closed, highlighting notable potential for closing gaps in healthcare, food, and transportation infrastructures.

https://doi.org/10.1038/s41467-025-60195-5

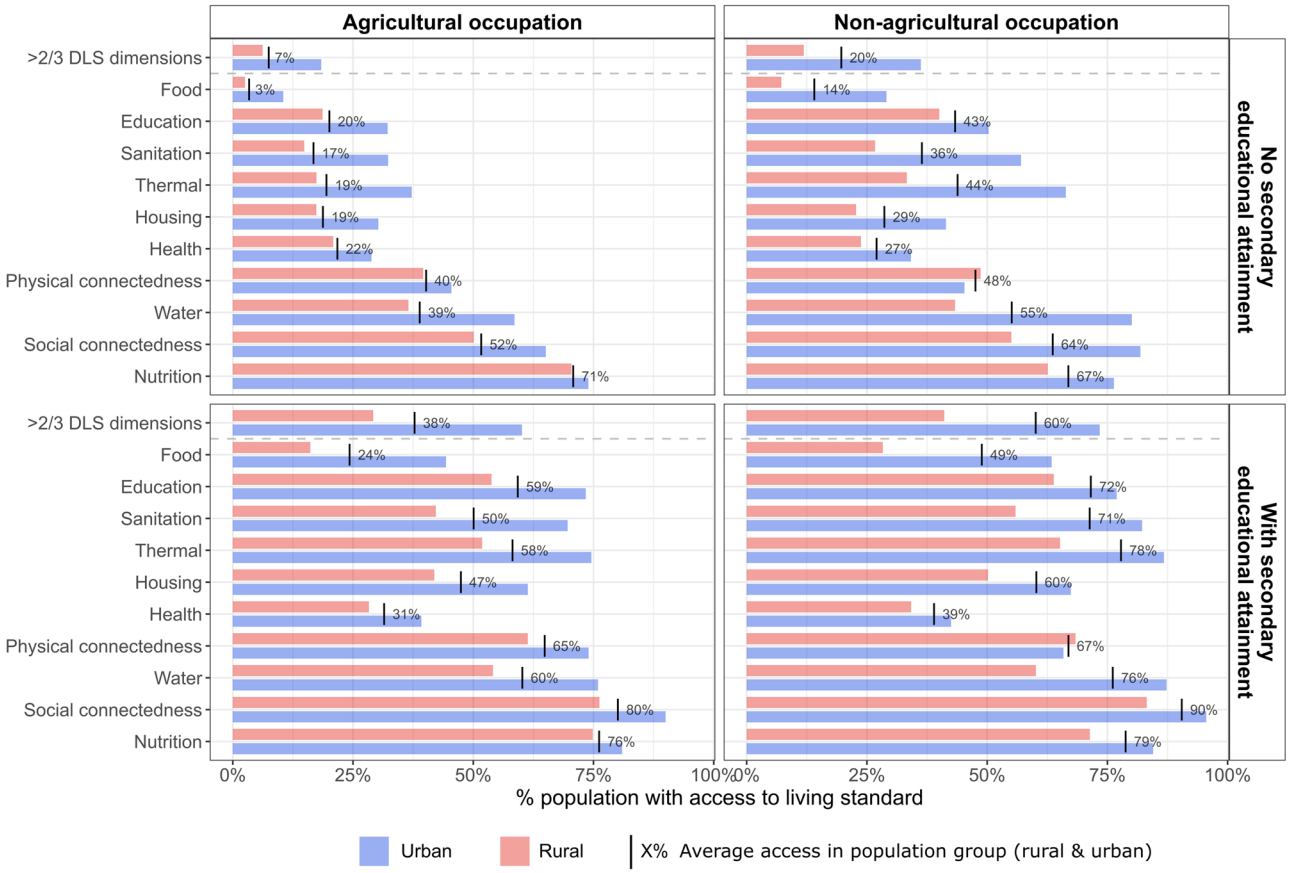

Fig. 3 | Distribution of decent living standards (DLS) for urban and rural households by different educational attainment and occupational categories. The figure distinguishes between households with at least one member with an agricultural occupation and those without members with an agricultural occupation as well as households with and without (at least one member) with secondary educational attainment. The bars show the mean global share of the respective subgroup with a living standard achieved within urban (blue) and rural (red) areas, respectively. The black bar and percentage show the average access levels in a population group, including both rural and urban parts of the local population. Supplementary Fig. S3 shows the distribution of the share of the population with access to the ten DLS dimensions by rural and urban areas across all subnational regions in the data.

access to water, resulting in a narrowing of the gap between urban and rural regions.

Multidimensional poverty, where households are deprived of multiple DLS dimensions, is common in the DHS sample. Supplementary analyses using k-means clustering and bivariate correlations (Supplementary Fig. S5) show that if a household lacks access to services in one DLS dimension, it is likely to also be deprived in other dimensions. The highest correlations at the regional level are between thermal comfort, access to modern means of food preparation, sanitation, and housing. These correlations show the interconnected nature of living conditions and point to the existence of multidimensional poverty and clusters of deprivation where households experience gaps in multiple living standards[11,18,35].

Policies targeting deficits in specific needs and DLS dimensions can help lift households out of multidimensional deprivation (Fig. 2B). The effectiveness of targeting particular dimensions depends on both the world region and which DLS dimension poses the greatest constraint for households. For instance, closing gaps related to food preparation and healthcare would prove highly effective in most world regions. Conversely, addressing gaps in physical connectedness and access to education would be most effective in the Middle East and North Africa. In sub-Saharan Africa, where deprivation spans multiple dimensions, focusing on selected dimensions alone would be less effective. A more comprehensive approach is needed here to simultaneously address gaps across various dimensions[36].

Social inequalities shape the achievement of decent living standards

Social characteristics of households shape the divide in DLS (Fig. 3). The location of households in rural and urban areas as well as their educational attainment level and occupation are influential in determining who has the means to access essential services, adequate housing, and other vital elements that contribute to an improved quality of life. Across all considered DLS dimensions, the lowest levels of DLS are found among rural households with low educational attainment and an agricultural occupation (top left panel). The share of households achieving at least two-thirds of the DLS dimensions is 67.2% lower in this most deprived group compared to the group of urban households with both at least one member with secondary educational attainment and no household member working in agriculture (bottom right panel).

Multivariate models confirm the importance of socioeconomic factors and household characteristics in influencing whether a household has access to DLS services (Supplementary Table S5, Model 10; $n = 3{,}095{,}789$; inference statistics based on t-tests; all standard errors clustered at the regional level). Controlling for the full set of household covariates, we find that the probability of achieving at least two-thirds of all DLS dimensions is significantly reduced by 28.0% for households without secondary educational attainment (CI95: −29.4, −26.5; $p < 0.001$,), by 23.2% for households living in rural areas (CI95: −24.7, −21.8; $p < 0.001$), by 7.8% for households with an agricultural occupation (CI95: −8.8, −6.8; $p < 0.001$), for larger households by 1.3%

per additional household member (CI95: −1.4, −1.1; $p < 0.001$), by 2.6% if the household head has not been present in the household in the previous night as a migration proxy (CI95: −3.2, −2.0; $p < 0.001$), by 1.2% if the household head is female (CI95: −2.0, −0.4; $p = 0.003$), by 4.4% if the household consists only of female adults members (CI95: −4.9, −3.8; $p < 0.001$), and by 5.9% if there are children (<16) living in the household (CI95: −6.5, −5.3; $p < 0.001$). Although these findings are explorative and cannot reflect the influence of local contexts, they highlight the role of household-specific characteristics in influencing access to living standards. Our data and measures provide a basis to further analyze the determinants and relevant mechanisms of multidimensional deprivation and resulting inequality across different settings.

Discussion

The pursuit of providing decent living standards for all has been a central goal of development efforts worldwide. At the midway point of implementing the UN 2030 Agenda, we call for a multidimensional, integrated perspective to alleviating poverty. This must go beyond simple headcount measures derived from income-based thresholds to a focus on eliminating deprivations in access to services that are essential for decent living, both at the household and community levels[4,19,22]. Collecting multidimensional information at the household and subnational regional level is crucial for tracking progress.

To support this call, we present a novel subnational dataset that gives a nuanced picture of (1) where multiple deprivations occur, and (2) how (insufficient) efforts have led to improvements (stagnation) over time in specific dimensions and particular regions. While significant progress has been made in many aspects of expanding services and infrastructures needed for decent living, our data show that major gaps continue to persist, particularly in rural areas and among households that work in agriculture and have low levels of educational attainment. These gaps highlight the ongoing challenges and complexities associated with achieving equitable and inclusive development.

The different DLS dimensions presented in this paper are not mutually substitutable. The range of needs important for human well-being is wider than that captured by indices and measures of multidimensional poverty commonly used today. In our assessment, each of the DLS dimensions is considered separately because deprivation in even one of them constitutes a state of poverty, where households do not have access to goods or services essential for a decent life. Our measurement approach to deprivation makes it easier to distinguish the sources of overall poverty and the relationships between different dimensions of deprivation.

Accordingly, examining the relationship between the DLS attainment gap at national scales and multidimensional poverty reveals that, in nearly all cases, a larger proportion of the population falls short of meeting DLS thresholds compared to direct and indirect poverty thresholds[6]. This is in line with the notion that DLS is not merely about fulfilling absolute survival needs but rather aiming instead to capture a more comprehensive set of requirements for a decent quality of life[22].

Gaps in DLS can have profound implications for subjective well-being, and previous research has consistently shown that material deprivation negatively affects happiness and life satisfaction[37]. However, much of this work has been focused on single indicators of living standards, such as access to specific services and resources. To our knowledge, there has been little examination of how deprivation across a broader set of DLS indicators influences well-being, which is partly due to the lack of appropriate global datasets that link comprehensive DLS measures with subjective well-being outcomes. We consider this an important area for further research, where comprehensive datasets and methodologies like ours can help examine the broader impact of multidimensional deprivation on subjective well-being.

Our data and the constructed indicators face limitations which should be noted when interpreting the results. First, a caveat of the DLS framework is that it cannot fully capture a complete set of universally applicable well-being satisfiers. In many instances, it is hard to reflect access to specific needs, such as mental health, public safety, and economic prosperity, in empirical terms due to data limitations. Empirical definitions of DLS also critically depend on time and may be influenced by available technologies and norms. For example, access to information can be achieved through different technological means, which can change. In our approach, we assess access to basic needs and services based on a set of universal and objective criteria that allow us to quantitatively evaluate disparities and track progress in the achievement of DLS dimensions over time.

Second, any attempt to universally conceptualize standards for a decent life is limited, due to, for instance, cultural and contextual factors of what is regarded as necessary for people to live a good life. Individual aspects of DLS may, therefore, very well be subject to objections, as these concepts have evolved within specific traditions and cultural contexts. For instance, formal education could be an example that might be an avenue to increase equality in access to formally canonized knowledge, but has also been used to suppress Indigenous cultures. While the DLS measure seeks to capture a broad understanding of decent living standards, the definitions and thresholds may not fully encompass the diverse perspectives and lived experiences of different populations.

Third, the DLS dimensions and the index were constructed with a focus on consistency and comparability across time periods as well as regions and countries covered in the data. This presents different challenges when it comes to harmonizing and aggregating the data. For instance, in the case of thermal comfort, data on electricity access is available, but other energy carriers like natural gas (more prevalent for space heating in some countries) are not covered by the DHS. Further, an important aspect of the DLS is the focus on material satisfiers. Due to the data limitations, some of the DLS dimensions, like access to education had to be defined using indirect measures. Future research could expand our data by including a broader range of countries, allowing for more nuanced international comparisons. Improvements in the underlying data and indicators used to capture certain dimensions of DLS could also help with making our datasets more comprehensive in the future.

Fourth, the DHS data are available only for 75 countries with a focus on low- and middle-income settings. This leaves us with data gaps for a large number of countries worldwide, including middle and high-income countries, where large disparities and inequalities in the achievement of DLS persist despite a relatively high wealth level. Several major countries of interest, such as China, are not part of the DHS data collection, and variables used to construct our DLS indicators are not available in country-specific surveys. Despite the limited coverage of our data, they provide a comprehensive and comparable overview of living standards for a very large number of countries and reveal major gaps in the achievement of living standards for large parts of the global population, underscoring our call for action. If novel data sources are published, our openly accessible code and methodology allow other researchers to replicate our work and expand our dataset with further country-specific information.

Past studies have estimated that meeting DLS for the global population would require only a fraction of the current consumption of energy and material resources[6,28,29,31]. Decision-makers need to consider well-being and deprivation across multiple dimensions, recognizing the importance of equitable access to essential services, infrastructure, and resources. Access barriers often stem from structural inequalities and systemic challenges beyond individual control. Governments at all levels bear the responsibility to ensure that everyone, especially marginalized and vulnerable populations, has access to the means to lead a decent life. In this context,

https://doi.org/10.1038/s41467-025-60195-5

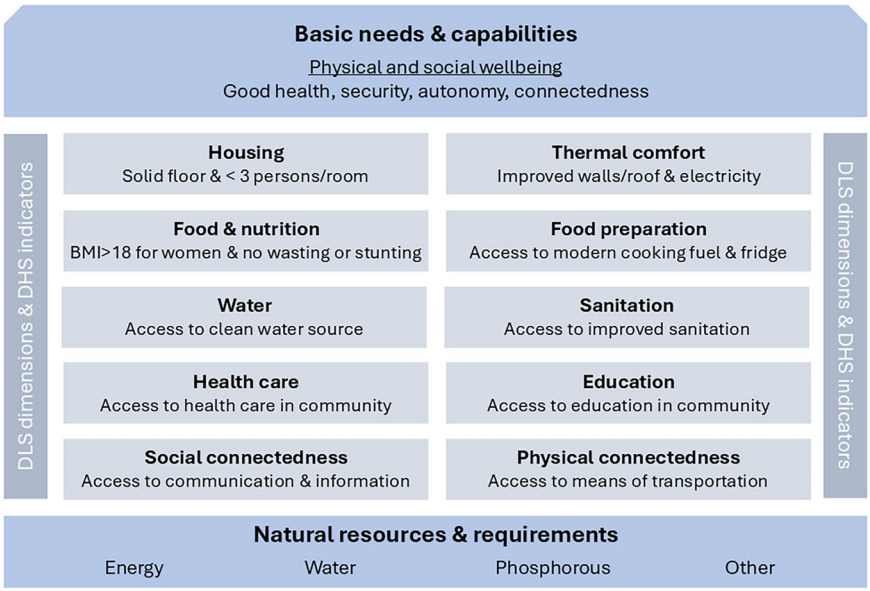

Fig. 4 | Conceptual framework and operationalization of the ten decent living standards (DLS) dimensions in DHS. The dimensions refer to different aspects of physical and social well-being (top part) and build on natural resources and specific material requirements (bottom part). Each dimension was measured using different DHS indicators. Detailed information on the measurement and construction of the DLS dimensions is provided in Supplementary Tables S1 to S3 and Supplementary Fig. S2.

comprehensive data and analytical frameworks, such as the DLS framework, are crucial for providing the evidence necessary to track progress, inform policy decisions, and ensure that resources are directed toward those who need them most.

Methods

Multi-dimensional deprivation measures and the DLS framework

Different concepts have been proposed to measure human well-being[38]. Purely economic indicators, such as GDP, have been criticized for neglecting the diversity and multidimensionality of well-being, including non-material aspects[38–41]. The Human Development Index (HDI) goes beyond a purely economic perspective, taking into account a broader range of factors such as educational attainment and life expectancy. While the HDI is often used as a measure of a country's overall well-being, it captures only a limited number of dimensions and cannot be used to distinguish the well-being of different social groups[10,42,43].

Multidimensional well-being measures, such as the Multidimensional Poverty Index (MPI)[18], the International Wealth Index (IWI)[12], the Multidimensional Poverty Measure[13], and the Individual Deprivation Measure[14], focus on tracking access to basic services, often with a focus on low- and middle-income countries. These measures address some of the gaps of purely income-based measures and provide more detailed information on the level and distribution of well-being within a population[9,12].

The DLS framework complements previous well-being measures by defining a set of universal, non-substitutable, and essential material conditions necessary for achieving human well-being. This standard is based on various accounts of basic justice, such as the capability[8,44] and basic needs[45] approaches, and is designed to comprehensively address living conditions and social participation. The DLS framework distinguishes between physical well-being, encompassing essential aspects like shelter, health, nutrition, and social well-being, involving factors such as socialization, access to education, and mobility (Fig. 4).

The DLS framework includes indicators and quantitative thresholds that can be operationalized and compared across different contexts. Unlike other multidimensional well-being indicators, DLS deliberately focuses on access to basic needs and services, expanding the set of relevant dimensions. It thus provides a more comprehensive picture of multidimensional deprivation, highlighting differences between population subgroups. Furthermore, the framework can be employed to evaluate the energy demands associated with achieving basic living standards for everyone, thus providing a foundation for the development of pathways towards a just transition.

Demographic and Health Surveys

Demographic and Health Survey (DHS) data[23] are used to operationalize the DLS indicators. DHS data include over 350 nationally representative surveys in over 90 low- and medium-income countries worldwide. These data focus on women of reproductive age (15–49), who are subject to comprehensive individual and household surveys. The surveys collect information on dwelling characteristics and contain a roster of all household members along with information on their age, sex, relation to the household head, and educational attainment.

DHS has been collected in eight waves within the period 1986-2023. For some countries, data are not available for each of these waves (Supplementary Fig. S1,) resulting in an unbalanced series of observations over time. In addition, some variables, like the primary cooking fuel used by households, are also missing from the initial survey waves. For our analysis, we use data from 263 surveys covering 4,712,696 household observations from 75 countries within the period 1990–2021 (wave 2 to wave 7). As data for DHS waves 1 and 8 are available only for selected countries, we did not consider these waves in our analysis.

Three types of DHS files were used: Household recode (HR), individual recode (IR), and child recode (KR) files, in which the unit of analysis is the household, women aged 14-49, and children of interviewed women born in the five years prior to the survey, respectively. For each file type and dataset, relevant variables were selected and aggregated to the household level. These variables then form the basis for the construction of the DLS indicators (Supplementary Fig. S2).

For the main analysis, all DHS microdata were combined at the household level and aggregated to the subnational regional level. Suitable household weights were used to weigh the data when deriving

aggregate regional indicators using sampling weights provided by DHS and standard procedures[46]. The weights correct differences in the probability of selection into the DHS sample due to either design or happenstance and ensure the representativeness of the data at the subnational regional admin 1 level (e.g., districts, provinces, or states) for both the rural and urban population residing in an area. By weighting the data, we ensure that the conditions of the most disadvantaged population groups, in terms of living standards, are accurately reflected in our analysis. Our results and the main conclusions derived remain fully robust also when using unweighted data.

Operationalizing the DLS dimensions using DHS data

The DLS has two primary dimensions – physical and social well-being. The physical well-being dimension focuses on aspects like food, nutrition, housing, thermal comfort, and healthcare. The social dimensions contain elements like mobility, communication, and access to education. The binary indicators (either achieved or not achieved) for each of these dimensions are defined at the household level and then aggregated to the subnational regional level to obtain shares of the local (rural and urban) population with a DLS dimension achieved. The detailed indicator definitions, variables, and minimum thresholds used in defining these indicators are described in Supplementary Tables S1–S3 and Supplementary Fig. S2.

Housing living standards are operationalized based on the WHO's Housing and Health Guidelines[47], which define housing standards in terms of crowding, indoor thermal comfort, home safety, and accessibility. The threshold for crowding varies by country, but as a common baseline, we adopt UN Habitat's definition, where 'overcrowding' means that more than three persons share a room. For the operationalization, we rely on two DHS variables: the number of rooms and number of members in a household. Similarly, housing safety is defined using information on the household's type of floor material. The living standard on housing is fulfilled if a household lives in a home (1) built with an improved floor (made of durable material) and (2) with less than three people per room.

To measure a household's thermal comfort, we combine information on the thermal insulation of houses with information on access to energy. For the former, we include information on the wall and roof material of the houses, distinguishing between poor and improved insulation. Furthermore, access to electricity is included, which is crucial for operating cooling and heating appliances. The thermal comfort dimension is achieved if a household lives in a home with (1) well-insulated walls and a roof made of durable materials and (2) access to electricity.

Access to food and nutrition was measured using three DHS indicators approximating the dietary calorie intake and fulfillment of micronutrients requirements in a household. First, based on the IR files, the Body Mass Index of all interviewed women in a household was calculated to identify households with an underweight household member (BMI < 18). In addition, based on the KR files and information on children's height, weight, and age, we calculate binary wasting (weight-to-age ratio) and stunting (height-to-age ratio) indicators. This information is available for all children in a household under five years of age. A household is considered to not have achieved this DLS dimension if any female member in the household is underweight or if any children in the household are wasted or stunted. As information on food and nutrition is missing for many households, we conducted a sensitivity analysis removing this indicator when assessing the overall attainment of DLS (Supplementary Table S8). The removal of this indicator does not strongly affect the share of households characterized by heightened levels of deprivation (<2/3 DLS).

The food preparation and storage dimension complements the food and nutritional intake indicator by considering whether households have access to modern cooking appliances and food storage. To operationalize this dimension with the DHS, we consider the type of cooking fuel used by the households. In terms of food storage, the achievement of the DLS dimension was measured with the ownership of refrigerators as reported in the recent literature on decent living standards[6,22]. A household has achieved this DLS dimension if it (1) uses clean fuel for cooking (following the WHO definition) and (2) if it has a refrigerator for storing its food.

The water and sanitation dimensions are operationalized based on the WHO-UNICEF Joint Monitoring Program (JMP) on drinking water, sanitation, and hygiene (WASH)[48]. The WASH program uses a service ladder approach to measure the progress on drinking water, sanitation, and hygiene. For the DLS dimension, we use the highest ladder ("safely managed") of the WASH guidelines to define the water and sanitation dimensions. This means drinking water available to the household should be from an improved source, accessible in close vicinity and free from contamination. Similarly, decent sanitation means access to improved toilet facilities that are not shared with other neighbors and have safe disposal of excreta.

The measurement of the access to education dimension follows an indirect approach. Since household age structures can widely differ, a direct comparison of educational achievements (e.g., whether a household has secondary educational attainment) is not a feasible approach to determine the accessibility of educational infrastructure and the achievement of this living standard. Instead, we consider (1) the share of children in a community/DHS cluster who are in primary schooling age (6–12) but are currently not enrolled, and (2) the number of older youth (13-18) in a community who have not yet completed primary education. We assume the education living standard not to be achieved if more than 25% of children in a community are either out of school or have not obtained primary education. In additional sensitivity analyses, we changed this indirect measurement approach with a more direct one capturing whether any members of a household have completed secondary school (Supplementary Table S9). All results remain fully robust to this variation, suggesting that the indirect estimation employed in our main analysis does not affect our findings.

Access to health care depends on local health infrastructures and people's ability to access and pay for it. In the DHS, variables on access to healthcare when needed could be found in the individual recode data. To determine household access to healthcare, we consider reasons for not being able to obtain medical treatment despite a need. Access is assumed to be missing if a household member needed medical assistance but could not avail themselves of it due to limitations in transportation, accessibility, or affordability of the services.

Social connectedness is measured considering the ownership of assets of mobile phones (basic or smart), television, radios, and computers. Similarly, for physical connectedness, we consider the ownership of bicycles, motorcycles, and cars. Information on these assets is collected in the household recode data of the DHS, and we use these variables to define the DLS for social and physical connectedness.

The DHS data provide limited information on the quality of services and broader infrastructure required to support all dimensions in the DLS. However, the available data and variables form a common basis for defining DLS dimensions across countries and sub-regions, and to undertake a comparative analysis. Supplementary Tables S1–S3 and Fig. S2 provide complete details on the DLS dimension definitions, DHS variables, data sources, and minimum thresholds used for constructing the DLS dimensions explained here.

Analytical approach and estimation

Different analytical tools were used to explore the DHS-based living standards data. Besides descriptive methods, we use longitudinal fixed effects models to predict temporal trends in the achievement of different DLS dimensions and to explore underlying socio-economic determinants of differences in DLS. To predict temporal trends, we

estimate models of the following form:

$$DLS^{k}_{rct} = \beta T_t + \gamma T_t \times U_r + \alpha_c + \varepsilon_{rct} \quad (1)$$

Where DLS^{k}_{rct} measures the share of the population in a subnational region r in a country c who had achieved a living standard k in a five-year interval t, when the DHS data were collected. Each region r can be further distinguished into an urban and a rural population based on DHS definitions. The outcome is regressed on DHS five-year time interval dummies T_t which allow estimating the temporal trends in the achievement of the DLS dimensions over time (Fig. 2A).

We interact the time dummies with an indicator variable distinguishing between the urban and rural parts of a population in a region, allowing us to estimate separate trends for urban and rural areas. The models control for country fixed effects α_c to account for whether a country was present in a DHS sample in a specific wave. The models, therefore, account for compositional effects that may otherwise confound the estimation of the temporal trends by controlling for constant differences in average DLS achievement levels between countries. For calibration purposes and to derive a baseline estimate of the achievement of a living standard, the achievement level in the time interval 2010–2014 (with the most observations) was used as a reference point. Using this reference as a starting point, the differences between the years estimated in the model (Supplementary Table S4) were used to determine, for each time point, the predicted access of the respective population in a region to each of the ten DLS dimensions.

Complementing the regional models (1), we estimate a series of household models to explore the role of different socio-economic and demographic household characteristics for the achievement of DLS. In particular, we are interested in differences in DLS between households by educational attainment, agricultural occupation, the residency in rural or urban areas, household size, the presence of children in the household, the absence of household members, and the characteristics of the household head (Supplementary Table S5). To explore the relevance of these variables, we estimate models of the following form:

$$DLS_7_{irt} = \beta X_{irt} + \alpha_r + \delta_t + \varepsilon_{irt} \quad (2)$$

Where DLS_7_{irt} is a binary variable measuring whether a household i in a subnational region r in a five-year time interval t has achieved at least two-thirds of all DLS dimensions. The binary outcome was regressed on the vector X_{irt} capturing the different socioeconomic and demographic household characteristics. All of these models control for subnational region α_r and time fixed effects (five-year time periods) to account for any confounding influences. With this, we base our estimation on the variation between households with different characteristics within a region at a specific time point.

The standard errors of all models were clustered at the subnational region level to account for intra-cluster correlations of the observations. Note that all models serve mainly explorative purposes and are not intended to provide a causal estimate of the influence of one factor on the achievement of DLS. Country DHS observations that lacked information on more than three of the considered DLS dimensions were excluded from any of the presented descriptive or multivariate analyses.

To account for missing DLS indicators in the other country cases, we employed multiple imputation through predictive mean matching approaches[49,50]. Imputation is a commonly used strategy to handle missing data by estimating and replacing missing values, ensuring the broadest possible coverage both in terms of the sample and set of indicators underlying the analysis. For the imputation, we used the mice R package[51], which uses an iterative series of predictive models to impute missing variables using information from other available variables in the data. Most commonly, imputation was used for those variables derived from IR and KR data files, which were not collected among all households and hence resulted in a greater share of missing values (i.e., variables "undernutrition", "wasting", "stunting", and "healthcare"). Table S7 in the Supplementary Information provides detailed country and DHS wave-specific information on the share of imputed values for each of the variables underlying the different DLS dimensions. The imputation did not affect the results presented and led to no major changes in the distribution of DLS indicators across the waves (Supplementary Table S6). Also, our results are robust to the exclusion of DLS indicators for which we had to impute many values, such as for the food and nutrition dimension (Supplementary Table S8).

In addition to the statistical models, cluster analysis was used to identify subnational regions in the data with a similar deprivation profile and to explore multidimensional poverty using the DLS indicators. The share of the population in each subnational region achieving a specific DLS dimension is used as the basis for the explorative clustering exercise. For clustering, we use a centroid-based k-means clustering approach. The method's aim is to partition the subnational regions r into a set C of l mutually exclusive and collectively exhaustive clusters such that the within-cluster sum of squares (WCSS), i.e., the difference of each observation from the mean μ_i within each cluster, is minimized. The number of clusters l is defined prior to the clustering, and we employ various tests to identify the optimal number in our application (see Supplementary Figs. S5 to S7). The cluster analysis is performed in R using the *cluster* package[52] and the Hartigan and Wong algorithm[53].

The algorithm initially places data points into randomly generated clusters, determined by how different they are from the cluster centroids. It then computes the WCSS and the changes that would occur if a data point were allocated to an alternative cluster. If this alteration results in a reduced WCSS compared to the original assignment, the data point is reassigned to the new cluster. This process continues iteratively until the assignments stabilize, signifying that further enhancements in the WCSS criterion cannot be achieved by altering data point allocations between clusters. At this point, any modification would either augment internal variability within the clusters or enhance external similarities between them, consequently causing an increase in the WCSS.

Ethics statement

We have complied with all relevant ethical regulations and good scientific practices in the preparation, harmonization, and analysis of the data. No ethical approval was obtained for this study as no primary data collection was undertaken and all data were obtained from secondary sources. All DHS surveys adhere to rigorous standards to protect the privacy of respondents and household members. Standard survey procedures and questionnaires are reviewed and approved by the ICF Institutional Review Board (IRB). In addition, country-specific survey protocols undergo review by both the ICF IRB and, typically, a national IRB in the host country. The ICF IRB ensures compliance with U.S. Department of Health and Human Services regulations for the protection of human subjects, while host country IRBs ensure alignment with local laws and ethical norms. Further information on the DHS ethical procedures can be found on the DHS website (https://dhsprogram.com/methodology/protecting-the-privacy-of-dhs-survey-respondents.cfm).

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

The subnational regional level DLS attainment data used in this study has been deposited in the following repository: Hoffmann, Roman;

Patange, Omkar; Belmin, Camille, 2025, "Replication Data for: Subnational survey data reveal persistent gaps in living standards across 75 low and middle-income countries", https://doi.org/10.7910/DVN/EGFZSD, Harvard Dataverse. The replication data contains all datasets aggregated at the subnational regional level. Access to the underlying microdata is restricted. These are publicly available from DHS: https://dhsprogram.com/.

Code availability

The replication code used to generate and visualize the results reported in this study are available in the following repository: Hoffmann, Roman; Patange, Omkar; Belmin, Camille, 2025, Replication Data for: Subnational survey data reveal persistent gaps in living standards across 75 low and middle-income countries", https://doi.org/10.7910/DVN/EGFZSD, Harvard Dataverse. The data analysis was carried out in R. All used packages are acknowledged and cited in the source code files.

References

1. UN. *Global Sustainable Development Report (GSDR) 2023*. https://sdgs.un.org/gsdr/gsdr2023 (2023).
2. World Bank. *Poverty and Shared Prosperity 2022: Correcting Course*. http://hdl.handle.net/10986/37739 (2022).
3. High-level political forum on sustainable development. *Summary by the President of the Economic and Social Council of the High-Level Political Forum (HLPF) on Sustainable Development Convened under the Auspices of the Council at Its 2023 Session*. https://hlpf.un.org/ (2023).
4. A decades-long decline in extreme poverty has gone into reverse — here's how to fix things. *Nature* **618**, 886 (2023).
5. OPHI. *Global Multidimensional Poverty Index 2023. Unstacking Global Poverty: Data for High Impact Action*. (2023).
6. Kikstra, J. S., Mastrucci, A., Min, J., Riahi, K. & Rao, N. D. Decent living gaps and energy needs around the world. *Environ. Res. Lett.* **16**, 095006 (2021).
7. Biermann, F. et al. Scientific evidence on the political impact of the Sustainable Development Goals. *Nat. Sustain. 2022 5:9* **5**, 795–800 (2022).
8. Sen, A. Well-Being, Agency and Freedom: The Dewey Lectures 1984. *J. Philos.* **82**, 169 (1985).
9. Bérenger, V. & Verdier-Chouchane, A. Multidimensional measures of well-being: standard of living and quality of life across countries. *World Dev.* **35**, 1259–1276 (2007).
10. Ranis, G., Stewart, F. & Samman, E. Human Development: Beyond the Human Development Index. **7**, 323–358 https://doi.org/10.1080/14649880600815917 (2011).
11. Bourguignon, F. & Chakravarty, S. R. The measurement of multidimensional poverty. *J. Econ. Inequal.* **1**, 25–49 (2003).
12. Smits, J. & Steendijk, R. The International Wealth Index (IWI). *Soc. Indic. Res.* **122**, 65–85 (2015).
13. World Bank. *Multidimensional Poverty Measure*. https://www.worldbank.org/en/topic/poverty/brief/multidimensional-poverty-measure (2023).
14. Bessell, S. The Individual Deprivation Measure: measuring poverty as if gender and inequality matter. **23**, 223–240 (2015).
15. World Food Program. *Multidimensional Deprivation Index*. https://resources.vam.wfp.org/data-analysis/quantitative/essential-needs/multidimensional-deprivation-index-mddi (2023).
16. United States Census Bureau. *Multidimensional Deprivation Index (MDI)*. https://www.census.gov/topics/income-poverty/poverty/about/related-sites/rates.html (2023).
17. Asian Development Bank. *Social Protection Indicator*. https://spi.adb.org/spidmz/ (2016).
18. Alkire, S. & Foster, J. Counting and multidimensional poverty measurement. *J. Public Econ.* **95**, 476–487 (2011).
19. Alkire, S., Kanagaratnam, U. & Suppa, N. The global multidimensional poverty index (MPI) 2021. *OPHI MPI Methodological Notes* (2021).
20. The world's goals to save humanity are hugely ambitious — but they are still the best option. *Nature* **621**, 227–229 (2023).
21. UN OHCHR. SDG Summit: 18-19 September 2023, *UN Headquarters, New York*. https://www.ohchr.org/en/sdgs/sdg-summit (2023).
22. Rao, N. D. & Min, J. Decent living standards: material prerequisites for human wellbeing. *Soc. Indic. Res.* **138**, 225–244 (2018).
23. DHS. The DHS Program. Demographic and Health Surveys. https://dhsprogram.com/ (2019).
24. Tellman, B. et al. Satellite imaging reveals increased proportion of population exposed to floods. *Nature* **596**, 80–86 (2021).
25. Burstein, R. et al. Mapping 123 million neonatal, infant and child deaths between 2000 and 2017. *Nature* **574**, 353–358 (2019).
26. Tusting, L. S. et al. Mapping changes in housing in sub-Saharan Africa from 2000 to 2015. *Nature* **568**, 391–394 (2019).
27. Weiss, D. J. et al. A global map of travel time to cities to assess inequalities in accessibility in 2015. *Nature* **553**, 333–336 (2018).
28. Rao, N. D., Min, J. & Mastrucci, A. Energy requirements for decent living in India, Brazil and South Africa. *Nat. Energy* **4**, 1025–1032 (2019).
29. Millward-Hopkins, J., Steinberger, J. K., Rao, N. D. & Oswald, Y. Providing decent living with minimum energy: A global scenario. *Glob. Environ. Change* **65**, 102168 (2020).
30. Mastrucci, A., Byers, E., Pachauri, S. & Rao, N. D. Improving the SDG energy poverty targets: Residential cooling needs in the Global South. *Energy Build* **186**, 405–415 (2019).
31. Rennert, K. et al. Comprehensive evidence implies a higher social cost of CO_2. *Nature* **610**, 687–692 (2022).
32. Bloom, D. E., Canning, D. & Fink, G. Urbanization and the wealth of nations. *Science (1979)* **319**, 772–775 (2008).
33. Schell, C. J. et al. The ecological and evolutionary consequences of systemic racism in urban environments. *Science (1979)* **369**, (2020).
34. Baum-Snow, N., Freedman, M. & Pavan, R. Why Has Urban Inequality Increased?. *Am. Econ. J. Appl. Econ.* **10**, 1–42 (2018).
35. White, R. Multidimensional Poverty and Deprivation: An Introduction. *Measuring Multidimensional Poverty and Deprivation* 1–6 https://doi.org/10.1007/978-3-319-58368-6_1 (2017).
36. KC, S. & Lutz, W. The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. *Glob. Environ. Change* **42**, 181–192 (2017).
37. Christoph, B. The relation between life satisfaction and the material situation: a re-evaluation using alternative measures. *Soc. Indic. Res* **98**, 475–499 (2010).
38. D'Acci, L. Measuring well-being and progress. *Soc. Indic. Res.* **104**, 47–65 (2011).
39. Mikucka, M., Sarracino, F. & Dubrow, J. K. When does economic growth improve life satisfaction? Multilevel analysis of the roles of social trust and income inequality in 46 countries, 1981–2012. *World Dev.* **93**, 447–459 (2017).
40. Easterlin, R. A., McVey, L. A., Switek, M., Sawangfa, O. & Zweig, J. S. The happiness - Income paradox revisited. *Proc. Natl. Acad. Sci. USA* **107**, 22463–22468 (2010).
41. Frey, B. S. & Stutzer, A. What can economists learn from happiness research?. *J. Econ. Lit.* **40**, 402–435 (2002).
42. Sagar, A. D. & Najam, A. The human development index: a critical review. *Ecol. Econ.* **25**, 249–264 (1998).
43. Lutz, W. et al. Years of good life is a well-being indicator designed to serve research on sustainability. *Proc. Natl. Acad. Sci. USA* **118**, e1907351118 (2021).
44. Sen, A. *Development as Freedom*. (Oxford University Press, Oxford, 2001).
45. Streeten, P. Basic needs: Some unsettled questions. *World Dev.* **12**, 973–978 (1984).

46. Belmin, C., Hoffmann, R., Ekabesi, M. & Pichler, P. P. LivWell: a sub-national database on the Living conditions of 1 Women and their Well-being for 52 countries. *Nature Scientific Data*.
47. WHO. *WHO Housing and Health Guidelines. Recommendations to Promote Healthy Housing for a Sustainable and Equitable Future*. https://www.who.int/publications/i/item/9789241550376 (2018).
48. UNICEF. Water, Sanitation and Hygiene (WASH). Safe water, toilets and good hygiene keep children alive and healthy. https://www.unicef.org/wash (2023).
49. Rubin, D. B. Statistical matching using file concatenation with adjusted weights and multiple imputations. *J. Bus. Econ. Stat.* **4**, 87–94 (1986).
50. Little, R. J. A. Missing-data adjustments in large surveys. *J. Bus. Econ. Stat.* **6**, 287–296 (1988).
51. van Buuren, S. & Groothuis-Oudshoorn, K. mice: Multivariate imputation by chained equations in R. *J. Stat. Softw.* **45**, 1–67 (2011).
52. Maechler, M. et al. R Package 'cluster'. *CRAN Repository* (2021).
53. Hartigan, J. A. & Wong, M. A. Algorithm AS 136: A K-Means Clustering Algorithm. *Appl. Stat.* **28**, 100 (1979).

Acknowledgements

The authors gratefully acknowledge funding by the International Institute for Applied Systems Analysis (IIASA) Strategic Initiative Program under the JustTrans4All ("Just Transitions to Net-zero Carbon Emissions for All") Project. R.H. acknowledges funding by the European Union's Horizon Europe Program under Grant Agreement No. 101094551 (SPES) and under Grant Agreement No. 101162653 (2C-RISK) supported by the European Research Council.

Author contributions

All authors (R.H., O.P., C.Z., Shonali Pachauri, C.B., Setu Pelz, E.B., J.K., M.K., J.M., R.M., K.R., T.S., K.M.W.) have contributed to the conceptualization of the paper, as well as the development of its methodology and research design. R.H., O.P. and C.B. were responsible for data preparation and management. R.H. and O.P. conducted the analysis and prepared the display items. All authors participated in the writing, revision and editing process.

Competing interests

The authors declare no competing interests.

Additional information

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41467-025-60195-5.

Correspondence and requests for materials should be addressed to Roman Hoffmann or Omkar Patange.

Peer review information *Nature Communications* thanks the anonymous reviewer(s) for their contribution to the peer review of this work. A peer review file is available.

Reprints and permissions information is available at http://www.nature.com/reprints

Publisher's note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Open Access This article is licensed under a Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License, which permits any non-commercial use, sharing, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons licence, and indicate if you modified the licensed material. You do not have permission under this licence to share adapted material derived from this article or parts of it. The images or other third party material in this article are included in the article's Creative Commons licence, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons licence and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this licence, visit http://creativecommons.org/licenses/by-nc-nd/4.0/.

© The Author(s) 2025