ORIGINAL RESEARCH

Demographic dividends and indices of socio-economic progress of India

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Economic and social transformations of a country depend heavily on population age structure and its growth dynamics along with the impact on policies adopted and the generation of opportunities. The paper describes major socio-economic-demographic consequences of India based on changing demography with emphasis on measurement aspects of demographic dividends (DV) and suggests indices like active participation index (API), comprehensive e-participation index (CEPI), and index of participation rate of females (I_{FLFPR}) combining relevant chosen indicators in ratio or ordinal scales. The proposed indices reflecting the social, economic, and political effectiveness of the country across time and space satisfy desired properties and enable parametric statistical analysis. The linear regression equation of I_{FLFPR} on the gross domestic product (GDP) of a country and the regression of DV on I_{FLFPR} show effect of female labor force participation rate (FLFPR) on socio-economic growth. A country needs to focus on the factors that can foster the progress during the transition from favorable working-age population (WAP) to an increasing share of elderly population. WAP of India with a rising trend of income and educational attainments empowers the citizens to participate in e-participation and active participation in the economic, social, and political effectiveness of the country. Attempts can be made to estimate the required net birth rate, ensuring WAP is around 59%, and initiate policies accordingly.

Keywords: population age-structure, demographic dividend, female labour force participation rate, composite index, normal distribution, participations

Introduction

The human population of the world has registered an increasing trend since World War II. From 2.5 billion in 1950, it has increased to 8.11 billion in 2024. The population of the world is projected to reach 9.8 billion by mid-2050 and 11.2 billion by 2100 despite the decline of fertility in a number of countries. At the global level, the number of persons over 64 years exceeded the number of children less than 5 years in 2018 (1). As per the medium version of World Population Prospects (WPP) 2019, the US and eight developing countries viz., India, Indonesia, Egypt, Pakistan,

Nigeria, Ethiopia, Congo, and Tanzania, are expected to contribute over 50% of the increased population at the global level between 2020 and 2050 (2). India ranks 1st in the world with a population of 1.428 billion (2023), contributing 17.8% to the world population (3).

Life expectancy at birth at the global level increased to over 70 years against 32 years in 1900. It has risen significantly across all ages and regions (1). For India, life expectancy at birth in 2023 was 72.03 (female: 73.65 and male: 70.52). However, life expectancy based on a period life table may not reflect the mortality pattern, which can be calculated in a cohort life table.

Rapid growth of population and industrialization/ urbanization put increasing pressure on the environment and natural resources (4). Economic and social transformation depends heavily on the distribution of population across age groups, and thus, studies on the evolution of population age structure are important (5). Increasing percentages of elderly population, birth rates, mortality rates, and associated social patterns are the major factors contributing to the population structure of a country. While humans consume and destroy natural resources and energy, they also preserve and produce resources and renewable energy.

The population age structure of a country gets changed with time due to influences of economic growth, urbanization, changes in living standards, social preferences, advances in medical and associated facilities, general revaluation of priorities in life, quality of life, etc. (6, 7). Growth dynamics of age-category-wise population have consequences in social and economic aspects of a country in achieving the Sustainable Development Goals (SDGs) and other development goals.

The objective of the paper is to suggest multidimensional indices like the active participation index (API), the comprehensive e-participation index (CEPI), and the index of participation rate of females (I_{FLFPR}), combining relevant chosen indicators in ratio or ordinal scales, after addressing major socio-economic-demographic consequences of India with emphasis on measurement aspects of demographic dividends. The proposed indices reflecting the social, economic, and political effectiveness of the country across time and space satisfy desired properties and enable parametric statistical analysis, including finding empirical relationships with socio-economic benefits along with the challenges and possibilities in the Indian context.

Literature survey

Measures of population age structure

In addition to the median age, the age structure of a country is typically shown as the percentage share of the child population (up to 14 years), the working-age population (WAP) (between 15 and 60 years), and elderly people. Such a presentation helps to compute the "demographic window" (window of opportunity) or demographic dividend of a country and is measured by the Dependency Ratio (DR), defied as
$$\frac{\text{Child population} + \text{Old age population}}{\text{Working age population}} = \text{Child DR} + \text{Old age DR}$$
(8). The desirable window is open when the proportion of the child population is ≤30% and the proportion of people ≥60 years is below 15%, implying WAP ≥ 55%. A lower value of DR indicates more people in the workforce to support the dependent population, which in turn implies a higher per capita gross domestic product (GDP). DR is inversely related

to the active workforce of an economy, measured by

$$\frac{\begin{array}{c}\text{No. of people ages} \\ \geq 16 \text{ who are employed or actively seeking employment}\end{array}}{\text{Total non} - \text{institutionalized working} - \text{age population}}$$

where non-institutionalized population excludes those in prisons, patients (in hospitals/nursing-homes or mental health care), and people in the defense force (9).

While reduction of birth rate, higher mortality of children, and lower maternal mortality and morbidity lower the LFPR, introduction of more young women into the workforce increases LFPR. LFPR in India improved to 57.9 in 2022-23 against 55.2 in 2021-22 with a significant increase in the FLFPR from 27.2 in 2021-22 to 31.6 in 2022-23 (National Sample Survey Office [NSSO] (https://mospi.gov.in). Higher FLFPR and opportunities for decent work are positive signals for an inclusive development.

India's DR is projected to reach its lowest point at 31.2% by 2030 (Earnest & Yong estimate). As per projections of the age structure of India's population, it works favorably against the open window (10). However, DR does not consider variations in age category-wise earnings and consumptions. National Transfer Accounts (NTA), based on the economic life cycle approach, overcomes the limitation (11).

DR is better than other indices that focus primarily on child population and elderly population, like the Index of Demographic Longevity

$$\text{IDL} = \frac{\text{Population}_{60+}}{\text{Population}_{o-14}},$$

and the Index of Demographic Aging

$$\text{IDA} = \left[\text{PP}_{(0-14)t} - \text{PP}_{(0-14)(t+n)}\right] - \left[\text{PP}_{(60+)(t+n)} - \text{PP}_{(60+)t}\right],$$

where PP denotes percentage of population and $(t + n)$ denotes the period than the t-th time period. The Longevity Governance Index (LGI) 2022 (www.dka.global) is a composite index covering six dimensions, viz., demography (changing dynamics of population structure), ecology (exposure to the impacts of a changing climate, sociological or biological hazards), economy (availability of resources to alleviate the impact of aging), government care (government activities and spending on healthcare, laws, policies, and plans for longevity initiatives), health status (population health with reference to life expectancy, well-being, and mental health indicators), and society (development of human capital within the society) obtained from a large number of countries. Here, each feature is normalized by the max–min function

$$Z = \frac{X - \min(X)}{\max(X) - \min(X)}$$

and dimension score is obtained as

$$\left(\sum \text{weighted indicator subgroups}\right) \times 100$$

followed by

$$\text{LGI} = (\text{Demography})\,1/6 + (\text{Ecology})\,1/6$$
$$+ (\text{Economy})\,1/6 + (\text{Government Care})\,1/6$$
$$+ (\text{Health})\,1/6 + (\text{Society})\,1/6,$$

where $0 \leq \text{LGI} \leq 100$.

Longevity Governance Index requires huge reliable data. Max–min normalization depending heavily on $X_{\max}$ and $X_{\min}$ (could be outliers and unreliable) reflects relative performance of a country. A decline or increase in value of $X_{\min}$ can change the Z-value of a country even if the X-value of the country remains unchanged and also change the ranks of the countries in terms of Z-values (12). The increase in Z per unit increase in X is different for different values of X. The method of selection of weights is not beyond criticism.

Considering the extent of production and consumption, i.e., per capita labor income and per capita consumption, Navaneetham and Dharmalingam (13) computed Support Ratio (SR) as:

$$\text{SR} = \frac{\text{Working age population}}{0.9*\text{Child population} + \text{Old Age population}}$$

Economic support ratio (ESR), as the ratio of economically active population (producers) to the economically inactive population (consumers), could be a better measure. Age-wise, the effective number of workers or consumers is computed as the population at each age weighted by the labor income or consumption profile (11).

Demographic dividends

The percentage of WAP in India increased from 64.76% in 2012 to 68% in 2023 and resulted in a decreasing trend of DR (54.42% in 2012 and 47.06% in 2023). The favorable trend may continue till 2055 for India (3), implying higher growth of per capita income, known as the first demographic dividend (FDD) (14). People in WAP are aware of increasing life expectancy and increasing cost to support consumption and security at old ages. Thus, they tend to save and accumulate wealth during the working years. This in turn accelerates real output, higher economic growth, and further generation of employment (15). This is known as the second demographic dividend (SDD).

Magnitude and duration of FDD and SDD varied for different countries (16). Ladusingh and Narayana (10) estimated demographic dividends considering per capita income, labor productivity, and SR taken as

$$\frac{\text{Effective number of producers (L)}}{\text{Effective number of consumers (N)}}.$$

Here, FDD is expressed as the ESR, i.e.,

$$\frac{L}{N} = \frac{\sum_{a=0}^{w} \gamma(a)\,P(a,\ t)}{\sum_{a=0}^{w} \phi(a)\,P(a,\ t)} \qquad (1)$$

where, $P(a,\ t)$ is the size of the population with age a at t-th time period, $\gamma(a)$ is the age pattern of labor income and $\phi(a)$ is the same for consumption. Denoting income, total population and total number of workers by Y, N, and L, respectively, per capita income can be taken as $\frac{Y}{N} = \frac{L}{N} \times \frac{Y}{L} \implies$ growth rate of $\frac{Y}{N} =$ growth rate of $\frac{L}{N} \times$ growth rate of $\frac{Y}{L}$ (11). In other words, per capita output may continue to grow when the growth rate of workers > growth rate of the total population irrespective of output per worker (17).

Differentiation of $\frac{Y}{N} = \frac{L}{N} \times \frac{Y}{L}$ gives the relationship of growth rate of per capita income (g_y) with the growth rate of income per worker (g_z), growth rate of the labour force (g_l), and growth rate of total population (g_n) as

$$g_y = g_z + (g_l - g_n) \qquad (2)$$

Capital accumulation by people in the WAP-category is taken as wealth held by the population who are aged over 50 years and may be used for estimation of life cycle wealth and SDD (11). Thus, wealth accumulation in the t-th year by the people born on or before the b-th year can be expressed by

$$W_{\leq b,t} = \left[\frac{C_{\text{Effective consumer}_t}}{Y_{\text{Effective labour}_t}} \right] \left[\frac{PVN_{\leq b,t}}{N_t} \right] - \frac{PVL_{\leq b,\ t}}{L_t} \qquad (3)$$

where $PVN_{\leq b,t}$ denotes the present value of future lifetime years of consumption for all persons born in the b-th year or earlier ($\mathcal{P}_{\leq b}$) per effective producer in the t-th year and the $PVL_{\leq b,\ t}$ denotes the present value of future lifetime years of production of $\mathcal{P}_{\leq b}$ per effective producer in the t-th year.

Equation (3) is difficult to estimate due to complex changes in reality. For example, $\frac{\text{Wealth}}{\text{Income}}$ for a country changes with time; life cycle wealth may not register a continuous increasing trend; there may be a mismatch of employment generation and the number of job seekers, etc. To realize the economic gains from FDD, growth of employment opportunities needs to match with the numbers seeking new jobs. The SDD may be undermined by generous pension plans and also by poorly developed financial markets.

The favorable demographic dividend of India arising out of the increasing share of WAP in the population age structure, services orientations (highest GDP share by the service sector), etc., is likely to reach its maximum around 2041, when the share of the WAP reaches 59% and helps India to unlock sustainable long-term economic growth. However, the following illustrative measures need to be accelerated:

1. Upskilling of workers (number of programs already initiated)

2. High priority on innovations and technology,

3. Encouraging and supporting FLFPR along with initiatives for girls' education, skill development, entrepreneurship facilitation, workplace safety, advancing the agenda of "women-led development," etc. to (i) enhance women's empowerment to promote

equal economic rights, access to employment, and economic activities; (ii) reduce gender inequality to achieve the targets of SDG-5, which also emphasizes equal rights, ownership of all forms of property across genders, education, and employment (18).

4. Strong wave of financial inclusion and investments to build digital payments infrastructure, etc.

5. Bringing the untapped labor to labor market.

Female labor participation rate (FLFPR)

A large proportion of Indian women in WAP are not involved in paid work, which reduces human capital, which in turn slows down socio-economic progress of the country (19). FLFPR increases income but lowers fertility (20). The demographic dividend effort index (DDEI) to reflect national efforts to derive benefits of demographic dividend was approached by Rusatira et al. (21) through a sector-specific questionnaire where ordinal scores of 10-point items were averaged to get sectoral and dimension scores, and country scores were obtained as a weighted sum, where the sectoral weights were defined as

$$(S_w) = \frac{\text{No. of participants in the Sector}}{\text{Total no. of participants for each country}}.$$

Major limitations of DDEI are the non-admissibility of arithmetic aggregation of scores of ordinal multi-point items (22) and the controversial weighting scheme. In addition, computation of reliability of a multi-dimensional questionnaire by Cronbach's alpha, violating its assumptions like tau-equivalence, does not appear to be justified (23).

To see how FLFPR is influenced by GDP, Tam (24) considered equation of the form

$$FLFPR_{it} = \alpha + \beta_1 log(GDP_{it}) + \beta_2 log(GDP_{it})^2 + error_{it}$$

where positive values of β_1 and negative values of β_2 result in an inverted U-shaped curve.

Major problem areas are:

1. Interpretation of negative value of α is difficult

2. $log(GDP)$ impact FLFPR more strongly for extreme values.

3. Value of $r_{GDP^2, GDP}$ is high, which implies multicollinearity.

4. The form of equation considered by Tam (24) indicates $log(GDP) = -\frac{\beta_1}{2\beta_2}$ at the point of inflection, which has no theoretical justification.

5. Logarithmic transformation changes value of r_{XY}. For example, Kovacevic (25) found $r_{\text{Life expectancy, HDI}} > r_{\text{Life expectancy, GDP}}$ but $r_{\ln(\text{Life expectancy), HDI}} < r_{\ln(\text{Life expectancy), GDP}}$. Chakravarty (26) showed that desired properties of aggregation, like translation invariance and aggregation consistency, are not ensured by logarithmic transformation. FLFPR was poorly correlated with $\log(GDP_{per\ capita})$) (27).

Major factors of FLFPR are education level (28), urbanization, unemployment rate, liberal socio-cultural attitudes (29), wage differential, social/cultural norms (30, 31), etc. However, a declining fertility rate is an output of higher FLFPR (32).

Suggested method

Chakrabartty (33) proposed an index of FLFPR by multiplicative aggregation of relevant causal indicators, excluding the outputs of FLFPR. For a country, let $X_{1t}, X_{2t}, \ldots, X_{nt}$ be the values of the chosen indicators at t-th year with corresponding values $X_{10}, X_{20}, \ldots, X_{n0}$ at the base period, where pre-adjustment of data ensures that $X_{ij} > 0$ and each indicator is positively related with FLFPR for $i = 1, 2, \ldots, n$ and $j = 0$ or t.

The country specific and year specific index of FLFPR (I_{FLFPR_t}) may be taken as Geometric Mean:

$$I_{FLFPR_t} = \sqrt[n]{\frac{X_{1t}.X_{2t}\ldots X_{nt}}{X_{10}.X_{20}\ldots X_{n0}}}$$

or equivalently by

$$I_{FLFPR_t} = \prod_{i=1}^{n} \frac{X_{it}}{X_{i0}}$$

Properties

The index I_{FLFPR_t} facilitates:

1. Assessment of changes by $\frac{I_{FLFPR_t}}{I_{FLFPR_{(t-1)}}}$ or by $[I_{FLFPR_t} - I_{FLFPR_{(t-1)}}]$.

2. Indicator-wise changes by $\frac{X_{it}}{X_{i(t-1)}}$

3. i-th indicator becomes critical if $\frac{X_{it}}{X_{i(t-1)}} < 1$ and requires managerial attention for necessary corrective action.

4. Relative importance of j-th indicator can be computed by $\frac{\nabla(I_{FLFPR_t})}{\nabla X_j}$

5. By taking log on both sides of $I_{FLFPR_t} = \prod_{i=1}^{n} \frac{X_{it}}{X_{i0}}$, mean and variance of $\ln I_{FLFPR_t}$ are $e^{\mu_X + \frac{\sigma_X^2}{2}}$ and $e^{2\mu_X + \sigma_X^2}(e^{\sigma_X^2} - 1)$ respectively for a group of countries (34).

6. The index I_{FLFPR_t} satisfies time-reversal test and helps in the formation of chain indices. An empirical relationship may be found between GDP_t or per capita GDP as the dependent variable and I_{FLFPR_t} as the independent variable for a country. Similarly, $(FDD + SDD) = \alpha + \beta(FLFPR)$ can show influence of FLFPR on demographic dividend of a country.

Results

Maternal mortality

Maternal mortality and death rate in WAP reduce the size of WAP. For a developing country like India, the death of a mother is beyond an emotional crisis and may give rise to long-term social and economic problems for the immediate family and wider community. Male children of the family may drop schools for earning and the burden of female children may be solved by early marriage, which results in early motherhood; both indicate renewal of the poverty cycle for the next generation. Developing countries like India may go beyond the target of a maternal mortality rate of 70 per 1,00,000 live births as given in SDG 3.1 to derive demographic benefits.

Social benefits

Gross domestic product (GDP) measures the quantitative value of goods and services and does not cover the non-monetary segment of society, like free medical services, the value of qualitative changes made in the consumption baskets, etc. Thus, GDP fails to measure social progress and well-being of a nation. Different frameworks have been developed to assess social progress in terms of quality of life, human development, sustainable development, etc. by conceptual approach (what progress means) or consultative approach (measuring chosen components/dimensions of progress through consultation), and different initiatives to measure progress require different frameworks. Such approaches are not mutually exclusive and can be combined. Illustrative emerging activities with implications for social progress are detailed below:

Active participation

The effectiveness of a country in economic, social, and political areas depends on how its citizens aged ≥ 18 years participate in the following four dimensions:

1. *Political dimension*—rights and responsibilities
2. *Social dimension*—behavior of individuals with a measure of loyalty and solidarity, including enhancement of social skills and knowledge of social relations
3. *Cultural dimension*—consciousness of a common cultural heritage and
4. *Economic dimension*—relationship between individuals with labor and the consumer market, including the right to work and to a minimum subsistence level (primarily by WAP)

Active citizenship is related to the participation of adults in civil society, community, and political life in accordance with human rights and democracy and is an important development objective (35). However, the multidimensional API lacks a sound operational definition. OECD (36) identified factors of API both at individual and national levels and found that countries with high income and materialistic values, homogeneous distribution of income, and heterogeneous religious climate enjoy higher active citizenship. Participation of disadvantaged people in the society becomes poor with an increase of socio-economic inequalities (37, 38). Educated youths with enhanced civic knowledge show higher levels of political engagement and electoral participation (39).

Chakrabartty (40) proposed the API by aggregating chosen indicators distributed over a finite number of dimensions by arithmetic aggregation (Method 1) and geometric aggregation (Method 2). While Method 1 ensures normally distributed scores facilitating parametric statistical analysis, Method 2 offers a generalized approach and can take an additive model with logarithm transformation. GDP of a country may be regressed on API or dimensions of API to find the effect of API on economic growth. Similarly, the effect of demographic structure, good governance, and stability on the growth of API may be investigated.

E-participation

E-participation deals with participation of adult citizens in the governance process through Information and Communications Technologies (ICTs). It is a growing phenomenon for strengthening collaboration between governments and citizens. In line with target 7 of SDG-16, e-participation involves adult citizens in policy decisions and governance in an inclusive fashion (41).

Four levels of participation are

1. Information: One-way communication to people through newsletters, websites, brochures, etc. about services and decisions.
2. Consultation: Two-way communication encouraging the public to express their feedback for possible adjustments and decisions through surveys, message boards, interviews, suggestion boxes, etc.
3. Collaboration: Dialogue-based communication with citizens for making decisions collaboratively through forums, mapping, idea collection, education events, volunteer activities, etc.
4. Empowerment: Dialogue-based communication giving managerial power of decision-making to the public through citizen proposals, community-run committees, etc.

Numbers of internet users are increasing in India. However, there exists a gender gap in internet accessibility

due to several factors, including economic and socio-cultural barriers. The increasing trend of the median age of India's population and efforts towards digitalizing India would induce a higher number of older adults to adopt new technologies in their daily activities and participate in e-participation.

The e-participation index (EPI) of a country indicates the extent of use of online tools for interactions among government-to-citizens (G2C), government-to-business (G2B), government-to-government (G2G), and people. Measures of e-participation using questionnaires of different formats and different scoring methods have methodological shortcomings. Chakrabartty (42) proposed a normally distributed CEPI where each sub-index and component indicator was transformed to normally distributed scores with different parameters. Normality of CEPI enables testing of equality of means of CEPI for two countries, significance of improvement of CEPI by a country from the previous year, etc. The index helps in the assessment of e-participation in expanded areas to cover broader political, administrative, and other socio-economic contexts, with emphasis on inclusive design, including e-inclusion. CEPI helps the policymakers to find empirical relationships for a sustained social service delivery system, strengthening human capital and social values and social equality through democratic fashion.

Discussion

Measurement issues of FDD, SDD, and relationship between age structure and socio-economic growth are described. Ways to augment the size of WAP could be encouraging more females to participate in the labor force, matching job creation with people seeking jobs by up-skilling and training, improving the quality of life of the elderly population, and implementing a robust support system in terms of better social security for old-aged people, including widows, with emphasis on the unorganized sector.

WAP of India with a good educational background and rising trend of income, reduced DR is the main group taking part in e-participation and active participation in the economic, social, and political effectiveness of the country. A country may run the risk of transition from a favorable size of WAP to an aging population due to the declining trend of birth rate, the increasing trend of life expectancy, and the progression of large cohorts to older ages. Better understanding of the evolutionary path of the age structure ranging from the child population to WAP to the aging population, is felt to be needed. Demographic window period and FDD and SDD depend on policies based on demographic changes, current and anticipated phases of employment scenarios, participation of citizens in policy formulations, etc.

The proposed indices, like index of FLFPR (I_{FLFPR_t}), API, and CEPI, can consider all relevant chosen indicators, including those in percentages or ratios, and facilitate better comparisons, plotting of progress paths across time, and parametric statistical inferences. A suitably designed index of governance can be developed in this line.

As India marches towards the *Amrit Kaal* (an auspicious period most conducive to achieving the country's potential), it will be critical for India to capture the emerging opportunities and enhance the factors fostering the progress. Major areas of challenge are:

1. Simplifying and maintaining a business-friendly environment for a fast growth path

2. Improving ease-of-doing-business by leveraging digital tools and lowering the regulatory burden, etc.

3. Determining drivers of labor force participation by gender in rural and urban areas and improving LFPR

4. Increasing uptake of the consumer credit ecosystem and increased financial inclusion

5. Arrest jobless growth. Reorient the growth strategy to make the growth process more employment-intensive. Ensure growth of employment opportunities matches the numbers seeking jobs.

6. Ensure continuation of rising productivity by appropriate institutional reforms and meet the challenges posed by older adults.

Conclusion

For evaluation of measurement of demographic dividend, India needs to:

1. Update NTA data to capture the progress made. State-specific NTAs need to be calculated, and states need to be ranked for investing in the youth per annum.

2. Ensure health spending keeps pace with India's economic growth.

3. Improve health and education parameters for a better rank of the country in United Nations Development Programmes's Human Development Index,

4. Coordination between states on emerging population issues like migration, aging, skilling, FLFPR, urbanization, etc., and necessary corrective measures in areas showing poor performances.

Appropriate health policy and strong public health surveillance systems focusing on demographic changes, epidemiological transition, disease burden across the age and gender categories, vulnerable groups, causes of death, etc. Attempts can be made to estimate the required net birth rate, which ensures that the WAP is around 59%, and initiate policies accordingly. Future studies may be undertaken with real-life data pertaining to India for better estimation of

changes in demographic dividend across time periods and empirical relationships among FLFPR_t, year-wise per capita GDP, FDD_t, and SDD_t, API_t, and CEPI_t, showing impact of policies on various sections of society through National and State level programmes.

Data availability

Nil (the paper used hypothetical data).

Ethics statement

Not applicable. No data collected from human subjects or animals.

Author contributions

SNC: Conceptualization, Methodology, Data analysis, Writing and editing.

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Code availability

No application of software package or custom code.

Conflicts of interest

The author has no conflicts of interest to declare.

References

1. UN, World Population Prospects. *Processed by Our World in Data. "Ages 25-64" [dataset]*. UN, World Population Prospects (2022).

2. Oeppen J, Vaupel JW. Demography. Broken limits to life expectancy. *Science*. (2002) 296(5570):1029–31. doi: 10.1126/science.1069675

3. United Nations. *The World Population Prospects 2019*: Highlights. New York: United Nations (2019). Available on: https://population.un.org/wpp/Publications/Files/WPP2019_Highlights.pdf

4. Khan I, Hou F, Zakari A, Irfan M, Munir Ahmad M. Links among energy intensity, non-linear financial development, and environmental sustainability: new evidence from Asia pacific economic cooperation countries. *J Clean Prod*. (2022) 330:129747. doi: 10.1016/j.jclepro.2021.129747

5. Bai C, Lei X. New trends in population aging and challenges for China's sustainable development. *China Econ J*. (2020) 13(1):3–23.

6. Alders P, Broer DP. Aging, fertility and growth. *J Pub Econ*. (2005) 89(5–6):1075–95.

7. Zbigniew D, Piotr R. Risk of population aging in Asia. *Proc Soc Behav Sci*. (2014) 120:36–45. doi: 10.1016/j.sbspro.2014.02.079

8. United Nations. *World* Urbanization Prospects: The 2003 Revision. . United Nations (2004).

9. U.S. Bureau of Labor Statistics. *Labor Force Statistics from the Current Population Survey: Concepts and Definitions*. U.S. Bureau of Labor Statistics (2023). Available on: htpps://www.bls.gov/cps/definitions.htm

10. Ladusingh L, Narayana MR. Demographic dividends for India: evidence and implications based on national transfer accounts. In: Park D, Lee S-H, Mason A editors. *Aging, Economic Growth, and Old-Age Security in Asia*. Cheltenham, UK: Edward Elgar Publishing (2012). p. 203–30. doi: 10.4337/9781781953600.00013

11. Mason A, Lee R, Abrigo M, Lee SH. *Support Ratios and Demographic Dividends: Estimates for the World* (2017/1; Technical Paper). (2017). Available on: https://www.un.org/en/development/desa/population/publications/pdf/technical/TP2017-1.pdf

12. Seth S, Villar A. Measuring human development and human deprivations. *OPHI Working Paper 110*. University of Oxford (2017).

13. Navaneetham K, Dharmalingam A. Age structural transitions, demographic dividends and millennium development goals in South Asia: opportunities and challenges. *XXVI IUSSP, International Population Conference, 2009, Morocco*. (2009).

14. Lee R, Mason A. What is the demographic dividend? *Fin Dev*. (2006) 43(3):16–7.

15. Ribaj A, Mexhuani F. The impact of savings on economic growth in a developing country (the case of Kosovo). *J Innov Entrep*. (2021) 10:1. doi: 10.1186/s13731-020-00140-6

16. Mason A. Demographic transition and demographic dividends in developed and developing countries. *Paper prepared for the United Nations Expert Group Meeting on Social and Economic Implications of Changing Population Age Structures, Mexico City*. (2005).

17. Bhat PNM. A demographic bonus for India? On the first consequence of population ageing. *A Key note Address Presented on the Occasion of the 10th Anniversary Celebration of the Population Research Centre, University of Groningen, The Netherlands*. (2001).

18. Dugarova E. *Gender Equality as an Accelerator for Achieving the Sustainable Development Goals*. Discussion Paper. New York, USA: United Nations Entity for Gender Equality and the Empowerment of Women (2018).

19. Sanghi S, Srija A, Vijay SS. Decline in rural female labour force participation in India: a relook into the causes. *Vikalpa*. (2015) 40(3):255–68.

20. Bloom DE, Canning D, Fink G, Finlay JE. Fertility, female labor force participation, and the demographic dividend. *National Bureau of Economic Research, Working Paper 13583, Cambridge, MA 02138*. (2007).

21. Rusatira JC, Cardona C, Martinez-Baack M, et al. Development of the demographic dividend effort index, a novel tool to measure existing efforts to create a favourable environment to harness a demographic dividend: results from an experts' survey from six sub-Saharan African countries. *BMJ Open*. (2023) 13:e059937. doi: 10.1136/bmjopen-2021-059937

22. Bastien CH, Vallieres A, Morin CM. Validation of the insomnia severity index as an outcome measure for insomnia research. *Sleep Med*. (2001) 2(4):297–307.

23. Teo T, Fan X. Coefficient alpha and beyond: issues and alternatives for educational research. *Asia Pac Educ Res.* (2013) 22:209–13. doi: 10.1007/s40299-013-0075-z

24. Tam H. U-shaped female labour participation with economic development: some panel data evidence. *Econ Lett.* (2011) 110(2):140–2.

25. Kovacevic M. Review of HDI critiques and potential improvements. *The Human Development Research Paper (HDRP) Series, Research Paper 2010/33.* (2011).

26. Chakravarty SR. A generalized human development index. *Rev Dev Econ.* (2003) 7(1):99–114.

27. Chaudhary R, Verick S. *Female* Labour Force Participation in India and Beyond. New Delhi: ILO (2014). p. 1–32.

28. Vlasblom JD, Schippers JJ. Increases in female labour force participation in Europe: similarities and differences. *Eur J Popul.* (2004) 20: 375–92.

29. Tsani S, Paroussos L, Fragiadakis C, Charalambidis I, Capros P. Female labour force participation and economic growth in the South Mediterranean countries. *Econ Lett.* (2013) 120:323–8.

30. Dildar Y. Patriarchal norms, religion, and female labor supply: evidence from Turkey. *World Dev.* (2015) 76:40–61.

31. Mehrotra S, Parida JK. Why is the labour force participation of women declining in India? *World Dev.* (2017) 98:360–80.

32. Fatima A, Sultana H. Tracing out the U-shape relationship between female labor force participation rate and economic development for Pakistan. *Int J Soc Econ.* (2009) 36:182–98.

33. Chakrabartty SN. Index of female labour force participation and its association with demographic dividends of India.

34. Alf EF, Grossberg JM. The geometric mean: confidence limits and significance tests. *Percept Psychophys.* (1979) 26(5):419–21.

35. Hoskins B, Mascherini M. Measuring active citizenship through the development of a composite indicator. *Soc Ind Res.* (2009) 90(3):459–88. doi: 10.1007/s11205-008-9271-2

36. Publishing OECD. *JRC47008.* (2008). Available on: http://213.253.134.43/oecd/pdfs/browseit/3008251E.PDF

37. Donbavand S, Hoskins B. Citizenship education for political engagement: a systematic review of controlled trials. *Soc Sci.* (2021) 10:151.

38. Hoskins B, Huang L, Arensmeier C. Socioeconomic inequalities in civic learning in Nordic Schools: identifying the potential of in-school civic participation for disadvantaged students. In: Biseth H, Hoskins B, Huang L editors. *Northern Lights on Civic and Citizenship Education. IEA Research for Education.* (Vol. 11), Cham: Springer (2021). doi: 10.1007/978-3-030-66788-7_5

39. Chryssochoou X, Barrett M. Civic and political engagement in youth: findings and prospects. *Z Psychol.* (2017) 225(4):291–301. doi: 10.1027/2151-2604/a000315

40. Chakrabartty S. Index of active participation in society. *Discov Glob Soc.* (2023) 1:13. doi: 10.1007/s44282-023-00014-8

41. UN. *E-Government for the Future We Want, E-Government Survey 2014.* New York: Department of Economic and Social Affairs (2014).

42. Chakrabartty SN. Methodology of comprehensive e-participation index. *[RMd] Multidiscip J.* (2024) 6(2):doi: 10.23882/emss.24212