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Multi-dimensional Composite Health Indices in India: A Review of literature

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Abstract

Composite indices are widely used in different fields to measure and quantify a variety of multi-dimensional concepts into a single construct. While many multi-dimensional composite health indices are produced and applied in developed countries, there are relatively few studies for developing countries, and even considerably less in Asia. However, the indicators of health relevant in high-income countries will not be suitable for use in developing countries such as India due to differences in health system characteristics, differences in disease patterns, and data availability and quality. Therefore, it is important to consider the specific context and characteristics of a country when developing a composite health index to ensure its relevance and usefulness for policy and decision-making. In this paper, we review published studies on the multi-dimensional composite health indices in India, specifically focussing on the purpose of the index, the indicators chosen to represent population health, methods used in the calculation of the indices, geographical level of aggregation, sources of data, the application and validation of index. While doing so, we also assessed the policy or practical relevance of such indices.

Introduction

Health is a complex, multidimensional construct, and any attempt to create a health index needs to capture the multidimensional nature of health. Various indicators have been used globally to measure health and they vary from single indicators to multiple indicators. Traditionally, health has been measured using single indicators such as mortality rates, life expectancy, and health-adjusted life expectancy. The main advantage of using these indicators is the availability of data. However, these measures have analytical limitations (McDowell, et al. 2004). Additionally, due to changing health problems (such as increase in the prevalence of chronic diseases), their usefulness is also limited in measuring a concept as complex as health. The recent developments in measuring population health status and disease burden include multi-dimensional composite health indices which use several mortality and morbidity/disease indicators into a single index. Such multi-dimensional composite health indices (CHIs) are useful to make comparisons of health risks

within and across populations in different geographical regions (Ashraf et al, 2019; Costa et al, 2019), to track progress over time, to monitor effectiveness of health interventions (Costa et al, 2019; Yap et al, 2020) and serve as tool to assist in allocating resources (Ashraf et al, 2019).

While many CHIs are produced and applied in the developed countries, there are relatively few such attempts for developing countries, and even considerably less in Asia (Kaltenthaler et al, 2004; WHO, 2018; Ashraf et al, 2019). However, health indicators that are relevant to the developed countries are not be suitable for use in developing countries, like India, because of differences in health system characteristics, differences in disease patterns, and data availability and quality. Applying CHIs designed for the developed countries to the developing countries may run the 'risk of exporting failure' because of different social and cultural context of health and health care between developed and developing countries (Miranda and Zaman 2010). It has been argued that for such an index to be useful to health makers, it is essential that it should be suitable for needs assessment at the community or the national level and for monitoring and evaluating changes in health (Kaltenthaler et al, 2004). Therefore, it is important to consider the specific context and characteristics of a country or sub-national geographical region when developing a composite health index to ensure its relevance and usefulness for policy and decision-making.

In India, there have been some efforts to develop composite health indexes using different perspectives. In this paper, we present a review of these indexes with the aim of describing the context, development, use and validation of the multi-dimensional composite health indices that have been developed in India. India has made a significant progress in improving the health of the population over the last four decades as reflected through the reduction in infant mortality rate (IMR), crude death rate (CDR), crude birth rate (CBR), maternal mortality ratio (MMR) and through improvement in the life expectancy at birth (Government of India, 2022). However, there are significant regional, geographical, and socioeconomic inequalities in health across multiple axes of caste, class, and gender that are quite pervasive and persistent (Bango and Ghosh, 2022). Given the large and diverse population of the country, with marked variation in the levels of health outcomes across regions and population groups, greater focus on composite health indices which are sensitive to the diversity in India is needed to identify and address health inequalities. As suggested in the literature (Ashraf et al, 2019; Kaltenthaler et al, 2004) the paper focusses on the purpose of the index, conceptual basis of constructing the index, indicators chosen to reflect the state of health, methods used in the construction of the index, sources of data and their geographical level aggregation, application of the index and the validation of the index. We have also attempted to discuss the policy or practical relevance as and where possible.

Methodology

We had searched four databases (PubMed, EMBASE and Web of Science, and Google Scholar), and government sites up to January 2023, to isolate composite health indexes developed and used in the Indian context. The following search terms and

truncations were used as the search criteria - India and health index or indices or indicator, or child health, or maternal health, or health coverage, or health service, or Sustainable Development Goals (SDGs). Only those studies were retained for the review which were related to health outcomes, hence indexes such as development index, deprivation index or nutrition indicators were excluded. We also searched the references of the selected articles to find additional studies that could not be retrieved in the initial search. We did not place any restriction on the time of the publication of the study. We, however, did put restrictions regarding the language of publication. The search was restricted to only these studies which were published in English only.

Findings

Table 1 presents summary statistics of different composite health indices developed by different authors and agencies to measure and monitor health of the people in India. One of the early attempts of constructing a composite health index for India was undertaken in 1991 (Sekhar et al, 1991). The authors proposed an index that, they argued, reflected the need for health resources. The index was not meant to measure and monitor the health status of the Indian people. The rationale put forward by the authors for creating the composite index was that there was huge inequality in the allocation of health resources within the country, across states and Union Territories. It was, therefore, deemed important to create and use a composite index of health resources so as to monitor the allocation of resources to meet the health needs of the people. The indicators that they used in the construction of the index were restricted by their availability, and even the selected set of seven indicators used by the authors was available for 17 of the 22 states of the country. The data for the construction of the index for the country and for its selected states were taken from different resources including police records, Sample Registration System (SRS), State Medical Council data on registered doctors, 1981 Census of India, and other government records. The selection of the indicators for the construction of the index, however, lacked a solid conceptual framework. Factor analysis technique was used to derive standardized indices which helped to compare quantitatively the health needs of the people of different States. The factor analysis revealed that the seven indicators could be grouped into two factors. The first factor, comprising of four indicators, explained 67 per cent of the total variation in the dataset and was termed the 'proximate determinants' factor, The second factor comprised of three indicators described 16 per cent of the total variation and was termed as the 'socio-medical background' factor. The authors acknowledged the need of creating a composite index for health resources at the district level but constructed the index at the state level only because of the paucity of data at the district level. The authors acknowledged and discussed the need for including other indicators such as morbidity measures, life expectancy at birth, neonatal and post-neonatal mortality in the construction of the index. The authors also planned for collecting longitudinal data to allow for a better assessment of the need of health resources and to assess the validity of the index, but this was not pursued. The authors, however, emphasised that their index could trigger the examination of the causes behind the poor ranking of states and to help to determine the corrective steps in resource allocation, health services, and awareness about States lagging in health status.

Table 1: Summary of different composite health indexes.

Reference	Index	Indicators Used	Method of Aggregation	Data Source
Sekhar et al, 1991	Composite Health Index	No conceptual framework is specified. Homicides per 100 000 population, Crude death rate, Infant mortality rate, Crude birth rate, Doctors per 1000 population, Percentage of literates based 1981 census, Hospital beds per 1000 population.	Factor analysis was carried out to group seven indicators into two factors. The factor scores of the two factors were combined using the proportion of variation explained by each factor.	Secondary data sources included police records for the number of homicides, the Sample Registration System (SRS), the State Medical Councils, the 1981 national census, the hospitals, health centres and nursing homes registered with the government.
Satyanarayana et al, 1995	Index of Child Mortality	No conceptual framework is specified. UFMR, IMR, NMR, perinatal mortality rate and still birth rate.	Factor analysis of data on five indicators of child mortality was used, two factors that together explained most variation were combined.	Secondary data sources included SRS reports of the Registrar General of India; State.
Antony and Rao, 2007	Composite Index to explain variations in Poverty, Health, Nutritional Status	No conceptual framework is specified. Demographic: Male and Female life expectancy at birth; birth rate, death rate, MMR, IMR, UFMR, Socio-economic status (per capita GDP, percentage below poverty line, male and female school enrolment ratio, male and female literacy, government	Factor Analysis was applied on five sets of indicators.	Secondary data sources included Indian Government publications on economic and health surveys, The Health Monitor and Economic Survey of 1998.

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		expenditure on education, Health status: Availability of proper sanitation facilities, drinking water, underweight in under five year children, contraceptive use), Food intake (per consumption unit/day in grams): cereals, pulses, roots, fruits, milk, etc. Nutrient intake: Total fat, calories, and proteins, along with indices to measure poverty, human development, and standard of living.		
Government of India, 2014	Composite Index (CI)	No conceptual framework is specified. 16 indicators covering four stages of lifecycle, pre-pregnancy/reproductive age: Post-partum sterilization, Male sterilization, all family planning methods, pregnancy care: total ANC registration, 3 ANC check-ups to total ANC registration, Pregnant women given 100 IFA, Obstetric Complications, Pregnant women receiving TT2 or Booster, childbirth/delivery:	Arithmetic mean of standardized indicators. States have been classified into four levels based on quartile of CI score, and coded as Red – depict very low performance, Pink – Low performing, Yellow - promising and Green – good performance.	Secondary data from HMIS.

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		Skilled Birth Attendant attended home deliveries, Institutional deliveries, C-Section, post-natal and maternal and new-born care: Newborns breast fed within 1 hour, Women discharged under 48 h, Newborns weighing less than 2.5 kg, Newborns visited within 24h of home delivery , Infants who received Measles.		
Anand, 2014	Composite Indices of Health Status and Health Services	No conceptual framework is specified. Health status indicator: Crude birth rate, Total fertility rate, Institutional deliveries, Crude death rate, IMR, UFMR, Health infrastructure indicator: Number of hospitals per lakh population, Number of Primary Health Care facilities per lakh population, Number of doctors per lakh populations, Number of beds per lakh populations, Number of	Maher's normalization technique and principal component analysis. Based on these indices, districts have been classified into five levels of development, very high, high, average, very low and low.	Secondary data from Annual Health Survey (2011) and Statistical Diary (2011), *Shankhikya Patrika* (2010-2011), Uttar Pradesh Planning Commission and Bihar Statistical Handbook (2010-2011).

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		nurses/paramedical staff per lakh populations.		
Meher et al, 2014	Composite Health Development Index (CHDI)	No conceptual framework is specified. IMR, birth rate, death rate, MMR, total fertility rate of female in the reproductive age group and life expectancy at birth of both males and females.	Arithmetic mean of standardized indicators, deprivation method was followed to compute the index. The Index values of the 17 states were compared for three time periods 1998–99, 2004–05 and 2009–10.	Secondary data published by the Government of India, National family health survey (NFHS-II, 1998–99 & NFHS-III, 2005–06), and Office of Registrar General, India, Special bulletin on maternal mortality in India 2007–09, Abridged life tables 2002–06, Sample registration system (SRS reports different years), Statistical report 2005 & 2008.
Chauhan et al, 2017	Composite Index	No conceptual framework has been specified. In all twenty six health-related indicators related to demographics: share of slum population to urban population, population density, population growth rate, total literacy rate, female literacy rate, population sex ratio, child sex ratio, dependency ratio, total fertility rate , crude birth rate , crude	Standardized indicators were aggregated into an index by statistical method proposed by (Prem et al., 2007).	Secondary data published by the Ministry of Health and Family Welfare, Government of India, and other official sources.

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		death rate and infant mortality rate, family planning: contraceptive method, maternal health care % Tetanus expectant mothers, IFA full course, % of institutional delivery, immunization of children: including TT 10 year, prophylaxis against blindness (below 1 year and under 5 years), and health and other infrastructure facilities: Share of primary health care (PHC) working 24 × 7, share of latrine facility within premises of houses.		
Prinja et al, 2017	Composite Universal Health care Coverage Index (CUHCI)	Used Universal Health Care framework. Maternal and Child Health Iron and folic Acid, TT (2 injection), ≥ 3 Antenatal check-up, Institutional delivery, Postnatal care, Full immunization, ORS use rate, Family Planning Contraceptive prevalence rate,	The index was generated by standardized values of the ten indicators. Three approaches were used for aggregation of indicators by geometric mean, principal component analysis, and regression models.	Primary data collection, cross section survey of 51656 households across all districts of the state.

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		Curative Care Overall met need for any illness, Met need for non-communicable diseases, financial risk protection Pre-payment poverty headcount, post-payment poverty headcount, Catastrophic Hospitalization Expenditure. Quality of care Full effective ANC, Care from qualified provider		
Doke, 2018	Comprehensive Health Index	No specific framework has been specified. Health outcome: IMR, Birth rate, Sickle cell carrier rate, Annual parasite incidence of malaria. Health System: Doctor population ratio, Nurse population ratio, Bed population ratio, other health determinants), use of latrine (by subtracting the proportion of open-air defecation), use of clean fuel for cooking. Health-care utilization: Institutional deliveries.	Each block was scored relative to the highest value of each indicator. The ten indicators were integrated into one score using Principal Component Analysis.	Secondary data sources included Census, Survey of Cause of Death scheme, Health Management Information System, Directorate of Economics and Statistics, and Maharashtra Medical Council largely from 2013-14 or prior years. Management Information System of Women and Child Development Department (malnutrition in children). Special survey was conducted (preferred health-care provider, drug addiction). Interactions with key

Reference	Index	Indicators Used	Method of Aggregation	Data Source
				informants (morbidity and mortality experiences, functioning of public and private health sectors, and traditions and cultural factors in seeking health care).
Sharma et al, 2019	Health system performance index (HSPI).	Conceptual framework has been specified, it included health system outputs and outcomes. Health system outputs: Primary care coverage; Curative care utilization; Equity in health financing; Efficiency and equity in service delivery. Health system outcomes: Morbidity rates; Mortality rates; Financial risk protection.	Value of indicators was normalized and aggregated using geometric mean approach, to generate domain-specific and overall index. The index was generated by three different statistical approaches.	Primary data was collected through a community-based survey and Secondary data from HMIS.
Government of India, 2022	State Health Index	No conceptual framework has been specified. Up to 24 indicators grouped in the domains of health outcomes: NMR, UFMR, Sex Ratio at Birth, MMR, Modern Contraceptive Prevalence Rate, Full immunization coverage,	Weighted average of standardized indicators was used to compute the index. Weights were determined by technical experts.	Secondary data sources included State Department of Health, Health Management Information System (HMIS), National Tuberculosis Control Programme (RNTCP), National Family Health Survey (NFHS), Centre NHM Finance Data, Reserve Bank of

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		Proportion of ANCs registered, Proportion of pregnant women who received 4 or more ANCs, Proportion of institutional deliveries, Total case notification of tuberculosis and Treatment Success Rate, Proportion of people living with HIV on antiretroviral therapy ; Governance and information: Institutional deliveries, ANC registered within first trimester, Average occupancy of an officer at State level for last three years , Average occupancy of a full-time officer (in months) for all the districts in last three years , Number of days taken for transfer of Central NHM fund from State Treasury to implementation agency, Proportion of State Government Health Expenditure to Total State Expenditure), and key inputs and processes: Proportion of shortfall of health		India (RBI) Reports, reports of Ministry of Health & Family Welfare (MoHFW)-Government of India, Civil Registration System, Integrated Disease Surveillance Project (IDSP).

Reference	Index	Indicators Used	Method of Aggregation	Data Source
		care providers, Proportion of total staff covered under a functional IT enabled integrated Human Resources Management Information System, Proportion of specified type of facilities functioning b. Proportion of public health facilities with Kayakalp score >70%, Proportion of functional Health and Wellness Centres, Proportion of district hospitals with functional Critical Care Units , Completeness of Integrated Disease Surveillance Programme (IDSP), Proportion of public health facilities with accreditation certificates, Proportion of labour rooms and proportion of Maternity OTs certified under LaQshya.		

With the objective of measuring and monitoring the health status of children over time, another composite index was proposed in 1994 which was termed as the index of child mortality (Satyanarayana et al, 1995) has developed a comprehensive index, the Index of Child Mortality. The index was based on five indicators - under-five mortality rate (U5MR), infant mortality rate (IMR), neonatal mortality rate (NMR), perinatal mortality rate (PEMR), and stillbirth rate (SBR). No conceptual framework was, however, underpinned in the selection of indicators. The index was constructed using the data from the Sample Registration System of the country. The study also used the factor analysis technique to construct the composite index. The study found that the five indicators can be grouped into two factors, first factors include three indicators – NMR, IMR, and U5MR – while the second factor comprised of SBR and PEMR. The study also examined the relationship between the trend in the composite index and the trend in U5MR. It was a good initiative for across state comparison across states and for longitudinal monitoring of child health status. However, tedious statistical computations prohibited widespread use of this index.

In 2006, an attempt was made to construct a composite index to explain variation in poverty, health, nutritional status, and standard of living across states (Antony and Rao, 2007). This composite index used five sets of indicators namely demographic situation, (male and female life expectancy at birth and at 5 years); socio-economic status (per capita gross domestic product; proportion of population below the poverty line); health status (prevalence of contraception, availability of sanitation, health services and safe drinking water, proportion of severe and moderate underweight children below 4 years of age); food intake (per consumption unit/day in grams); and nutrient intake (per consumption unit/day and total fat, total calories, total protein). The authors have also used indices to measure poverty, human development, and standard of living. However, indicator selection by the authors was not guided by any conceptual framework. The index was calculated for 14 large states of the country. Discriminant function analysis and factor analysis were used to assess state ranking based on health inequality and standard of living. The first component which included the intake of cereals, male educational status, infant mortality rate, total fat intake, income, life expectancy at birth, and availability of sanitation facilities accounted for 60 per cent of the total variation. The second component included intake of fruits and explained 15 per cent of the total variation. Human Development Index (HDI) was used for the purpose of validation. Cohen's Kappa statistics were calculated for validation and Bland and Altman plot was used to find agreement between the two methods. Primary data from an urban and rural site was used to validate the index. This composite index gives better indication of development and standard of living rather that health. The construction of the index uses only four health related indicators, but these indicators do not represent different stages of life, difference in morbidity, accessibility, and quality of health services, that are associated with health status.

Health Management Information System (HMIS) score card is one of the first attempts made by the Government of India to capture the disparity in the state of reproductive, maternal, newborn, child and adolescent health across states, districts, sub-districts or blocks in in the country (Government of India, 2014). The main purpose was to strengthen the health care delivery system to achieve the goals of RMNCHA strategy. The score card is based on 16 reproductive, maternal, newborn, child, and adolescent health indicators covering four stages of the lifecycle: pre-pregnancy/reproductive age, pregnancy

care, childbirth/delivery, post-natal, maternal, and newborn care. However, the conceptual framework was notably absent in the choice of indicators. The normalized index values of each of the 16 indicators are combined by using the arithmetic mean as the aggregation function to arrive at the overall composite index. One of the advantages of this index is the availability of data from the health management information system. However, evidence suggests that data from HMIS suffer from poor quality, incompleteness of records and a tendency to over report outputs and outcomes (Verma and Prinja, 2007; Pandey et al, 2010, Sharma; et al, 2016).

Anand (2014) has constructed composite indices to measure the extent of inequality in health status and health care services in the two most populous states of India, Uttar Pradesh, and Bihar in an attempt to define inter-regional and inter-district variation for appropriate policy prescription. The data from the Annual Health Survey, 2011 (Government of India, 2011) and Statistical Diary (2011) pertaining to 6 health status indicators and 5 health infrastructure indicators were used to compute the index. Health status indicators included crude birth rate, total fertility rate, institutional deliveries, infant mortality rate, and under five-mortality rate. The health infrastructure indicators included number of hospitals per one hundred thousand population, number of doctors per one hundred thousand population, number of beds per one hundred thousand population, number of nurses/paramedical staff per hundred thousand population. Selection of the indicators was not guided by any conceptual framework. The author has used Maher's normalisation technique and principal component analysis to develop weights for the indicators. The author also used inequality measures such as co-efficient of variation to measure disparities between states for overall performance in health attainment. The main advantage of this health index was the use of routinely available data at the district level. Many important indicators in terms of achieving better health status and health infrastructure such as maternal mortality rate and life expectancy at birth were not used in the construction of the index. There is also data comparability issue as data from different sources have been used in the study.

Meher and Patro (2014) have created composite health development index to highlight the trend and level of disparities in health status of the population at state level. Using data from different sources, the authors analysed health status of people, health development programmes and public health services in 17 major states of India for three different time periods 1998–99, 2005-06, 2009-10. The indicators used in the construction of the index included infant mortality rate, crude birth rate, crude death rate, maternal mortality ratio, total fertility rate, and life expectancy at birth for both males and females. There was no conceptual framework to serve as the base for the construction of the index. The index was constructed using the deprivation method as followed in the Human Development Report (United Nations, 1990). The states were classified into five groups ranging from highly developed to backward to highlight differences in health status. Since, the index was computed for three time periods, a trend assessment has also been undertaken. One major strength of this index is to reflect the persistence of disparity across states. However, no validation of the index has been carried out.

Another attempt to construct a composite health index first analyses inter-state variation in health-related indicators (Chauhan et al, 2017). The aim of the index was to

improve the performance of the health sector to have a 'uniform efficiency level' throughout the country, thereby to accelerate the progress towards "health for all." The index is based on 26 health-related push and pull indicators covering demographic situation (12 indicators), family planning (1 indicator), maternal health care (3 indicators), immunisation of children (8 indicators), and health and other infrastructure facilities (2 indicators). The selection of indicators lacked a conceptual framework. The statistical procedure used to construct the index is similar to that used by Sharma and colleagues (Sharma et al, 2007). The index is designed to range between 0 and 1, the lower the index the better the performance. The index covered many indicators related to health, but no rationale is given for including the indicators. The statistical methodology used for the construction of the index has also not been described.

Another composite index attempts to measure progress towards universal health coverage at the district level (Prinja et al, 2017). The index aims at ranking districts by the availability of affordable health care services to all. Unlike other indexes, this index is based on primary data collected from all districts of Haryana, India during 2012-2013. The index is based on the universal health care framework of the World Health Organisation (Prinja et al, 2017). The focus of the index is to develop methodology to measure and compare preventive and curative services which could be delivered at all levels of the health system. Methods used for constructing the index include geometric mean aggregation, standardising the values of indicators, principal component analysis and regression methods. The index is validated using a variety of sensitivity and scenario analyses. The index has many strengths including coverage of indicators based on the list outlined by Government of India and using the conceptual framework proposed by the World Health Organization. However, it falls short of measuring the health status of the population. Universal health coverage is an important determinant of health, but there are many other indicators which are not included in the construction of the index. For example, many social determinants of health are not included. The authors have also acknowledged the limitations of their measures of quality of care and financial risk protection measurements.

Doke (2018) has attempted to assess community health status at the block level in Gadchiroli district of Maharashtra in terms of a comprehensive health index. The primary purpose of the index is to compare health status and financial allocation at the block level. The index is based on a variety of indicators related to different dimensions of health including infant mortality rate, crude birth rate, sickle cell carrier rate, annual parasite incidence of malaria (API), doctor population ratio, nurse population ratio, bed population ratio, use of latrine, use of clean fuel for cooking, and institutional deliveries. However, construction of the index lacks a conceptual framework. The principal component analysis is used to combine different indicators into the composite index and the index has been correlated with degree of urbanization for validating the index-based ranking. The assessment of the health status based on the index is, however, restricted due to limited coverage of indicators representing community health. Moreover, the authors gave different weightings to different groups and subgroups.

There has also been an attempt to construct a health system performance index following the conceptual framework of the World Health Organization (Sharma et al, 2019). The World Health Organization (WHO) identifies six core components or "building blocks"

of the health systems: (i) service delivery; (ii) health workforce; (iii) health information systems; (iv) access to essential medicines; (v) financing; and (vi) leadership/governance. The index is based on 70 input and process indicators grouped into 20 sub-domains. The indicators were normalised and aggregated to generate domain-specific and overall health system performance index by using a preference-weighted approach which gives equal weight to each indicator, each subdomain, and each domain of the health system. The aggregation was done using geometric mean. The validation of the index was done using different methods of aggregation and through sensitivity analyses to assess the robustness. Data pertaining to many indicators used in the construction of the index requires primary survey which makes it challenging to repeat and replicate the index.

The NITI Aayog, the think tank of the Government of India has also constructed a state health index based on 24 indicators grouped into domains of health outcomes, governance and information, and key inputs and processes for the large states, 19 indicators for small states, and 16 indicators for Union Territories (Government of India, 2022). Each domain has been assigned weight based on its importance. The weights used for aggregation are, however, based on expert opinion so that weighting can introduce self-selection bias in the construction of the index (Chowdhury and Squire, 2006). Within a domain or sub- domain, the weight is equally distributed among the indicators in the domain or sub- domain. The index is not comparable across large states, small states, and Union Territories because the number of indicators used in the construction of the index is different. The ranking of the states based on the index has also not been validated.

Discussion

This paper has attempted to provide an overview of the attempts made to develop a composite health index to reflect the state of health in India. The paper reveals that different composite health indexes developed and used in India are directed towards different purposes from measuring and monitoring health resources (Sekhar et al, 1991) to measuring and monitoring child health (Satyanarayana et al, 1995); to explain variation in poverty, health, nutritional status and standard of living (Antony and Rao, 2007); to make block-level comparison in financial allocation (Doke 2018) or to measure and monitor the inequity in the coverage of health services (Prinja et al, 2017). There has also been attempt to develop a composite index that reflects the overall health of the population (Sekhar et al, 1991). The Government of India has also constructed composite indexes for specific domains (Government of India, 2014; 2022), Attempts have also been made to develop composite indexes for health system outputs and health system outcomes (Sharma et al, 2019) and for health status and health services (Anand, 2014). However, none of the composite indexes reviewed in this paper gives a complete picture of the health of the population.

In general, the composite indexes have used secondary data from different sources barring a few exceptions (Prinja et al, 2017; Doke, 2018; Sharma et al, 2019). Most of the indexes have been calculated at the state level and, therefore, have scale limitations. There are only a few attempts to apply the composite index at district level (Anand, 2014;

Government of India, 2014; Sharma et al, 2019) while there is only one study that used composite index to measure health at the block level (Doke 2018).

Availability of the data has been found to be a major obstacle in the construction of composite health index that fully reflects the state of health of the people (Sekhar et al, 1991; Satyanarayana et al, 1995; Prinja et al, 2017). Different approaches have been adopted to address the data constraints. Some researchers have modified the geographical area (Antony and Rao, 2007); others limited the scope of the Index (Sekhar et al, 1991) or carried out special surveys to fill data gaps (Doke 2018; Prinja et al, 2017). There is a need of measuring health at lower administrative units such as district or block as studies have acknowledged the importance of local geography for public policy (Kim et al, 2019). This is also consistent with the evidence that magnitude and persistence of health inequalities is large when smaller geographical areas are considered as compared to when the larger areas are considered (Krieger et al, 2002). Data constraints, however, inhibit any attempt to measure the health of the people at the local level in India.

There has also been variation in the way health has been conceptualised in the construction of different composite indexes. Mortality indicators such as infant mortality have commonly been used to reflect the state of health. If a composite index is to serve as an effective tool to monitor the progress in health and to give an overall reflection of the health of the people, other indicators, which address the complex notion of health, need to be incorporated in the composite index. The central idea underpinning the construction of multi-dimensional composite health index is based on measuring and monitoring population health which is reflected in terms of health outcomes which are shaped by the determinants of health. Health determinants also serve as predictors for future health outcomes. The composite health indexes developed in the Indian context have primarily focused on indicators related to health outcomes, health inputs, health processes, health outputs, and health impact. It may, however, be emphasised that health outcomes and health impact do not depend upon the health care delivery system alone. They are also influenced by a host of social, cultural, economic and environment factors that are exogenous to the health system. As such, a composite health index that considers only the health outcome and health impact has limited relevance in measuring the performance of the health system. The importance of the social determinants of health on the health of the people has been repeatedly and extensively emphasised (WHO, 2018). However, only one study (Antony and Rao, 2007) has included indicators related to the social determinants of health in the construction of the composite index.

There has also been little discussion about the choice of indicators in the construction of the composite index in all the studies reviewed. Indicators used in the construction of the composite index appears to have been arbitrarily chosen, mainly depending upon the availability of the data and without any justification or rationale about the selection of the indicator for the construction of the composite index. In addition, some of the indicators have not been used in the construction of the composite index because either these indicators were available for only some of the administrative areas or were not required at the national level. The lack of publicly available data has been a major hindrance in the selection of indicators for the construction of the composite index in most of the studies.

A crucial consideration in the construction of the composite index involves examining the multicollinearity among the indicators for the construction of the composite index as strongly correlated indicators reflect similar characteristics. The present review suggests that many studies have used statistical tools like factor analysis, discriminant analysis or principal component analysis to address the multicollinearity among the indicators used in the construction of the composite index. The review also suggests that some studies have explicitly examined the correlation among the indicators used for the construction of the composite index (Sekhar et al, 1991; Satyanarayana et al, 1995; Antony et al, 2007).

All composite indices use an aggregation function to combine indicators reflecting different dimensions of health. These aggregation functions range from simple one-dimensional aggregation function such as arithmetic mean of standardized indicators or geometric mean (e.g., composite index (CI) by Government of India (2014), composite health development index (CHDI) by Meher and others (Meher et al, 2014), health system performance index (HSPI) by Sharma and colleagues (Sharma et al, 2019), state health index (Government of India, 2022) to multi-dimensional aggregation function such as factor analysis or principal component analysis (e.g., composite health index by Sekhar and others (Sekhar et al, 1991), index of child mortality by Satyanarayana and others (Satyanarayana et al, 1995), and comprehensive health index by Doke (2018). It is important to underscore that all indices we have reviewed are relative in nature, meaning they are dependent on the underlying data. If the data undergo changes, the ranking based on these indices will also change. This naturally prompts concerns about the comparability of the indices, and it constrains their utility for their intended purpose and the indicators they encompass.

There is also wide variation in the way weights were assigned to different indicators while combining them into an overall index. Some studies did not give information on weighting, few indexes had weights assigned through expert judgement (Government of India, 2022), other studies have used a variety of methods to assign weights to the health indicators. For example, index of child health (Satyanarayana et al, 1995), and composite health index for states of India (Antony and Rao, 2007) have used factor analysis, others have used principal component analysis (Prinja et al, 2017).

Only few studies have validated the indices. In one of the recent studies, multiple approaches have been adopted for computing the index and the internal validity of ranks has been based on different indices produced by different approaches (Prinja et al, 2017). While NITI Aayog has validated the indicators used in the index through independent validation agencies but has not validated the index (Government of India, 2022). Another study has validated the index with the Human Development Index (Antony and Rao, 2007). Additionally, except Prinja and others (Prinja et al, 2017) and Sharma and others (Sharma et al, 2019), there has been a lack of use of theory or conceptual framework in the selection of health indicators which shows that the studies have mainly used the health indices as a statistical tool rather than test out theories of disease or how to promote wellbeing. However, a theoretical or conceptual framework provides a structure to select the independent indicators representing health, defines the analytical approach, and serves as the guide to discuss the findings (Nilsen, 2015). In fact, a theoretical or conceptual framework should precede the selection of indicators (McDowell et al, 2004). Despite the

significance of a conceptual framework in creating a health index, only 7 out of 27 studies in a scoping review of population health indices had a conceptual foundation guiding the choice of indicators (Ashraf et al, 2019). Given lack of consensus on the common criteria used to measure health, the usage of conceptual framework in the selection of indicators gains added significance. However, in most of the cases, the composite index is developed mainly as a statistical tool to combine different indicators, rather than testing out the theories of disease or how to promote well-being.

The paper has some limitations. First, we might have omitted some papers because of our specific focus on health. Secondly, we did not include in our review indexes using only one dimension such as India Hunger Index. However, our review of the composite health indexes in the Indian context highlights areas of improvement. We recommend selecting theory-based indicators to measure health, using data from small areas such as district to acknowledge local geography for public policy and using routinely collected data at uniform intervals to track progress over time to monitor effectiveness of health interventions. We also recommend examining the validity of composite indices by examining their association with health outcomes or with health inequality measures.

The present review highlights the unavailability of quality data at lower administrative levels such as district. As data are the main determinant of the accuracy, and for the validation of the composite health index, we recommend to policy makers to fund health data collection on both processes (data related to health systems) and determinants of health (including both protective and risk factors affecting health) representing different life stages (childhood, adult, and elderly), and health outcomes (morbidity and mortality measures). Future research should focus not only on constructing composite indexes based on data of high quality but should also examine the use of composite health indexes in developing better understanding of the progress towards health.

Conclusions

The complexity of measuring and monitoring public health arises from the multidimensional nature of the health construct. Measuring and monitoring the health of the people, therefore, is quite complex. There is no single indicator that can measure and monitor the health of the people in its totality. As such, composite indexes that capture different dimensions of the health of the people are proposed. The review of different composite health indexes proposed to measure and monitor health of the people in India suggests that none of the proposed composite indexes captures different dimensions of the health of the people in their entirety and a more nuanced approach is needed to develop a composite index to measure and monitor the health of the people. We suggest selecting indicators grounded in theory including both determinants of health (e.g., factors representing health care deliver and different social, economic, cultural, and environmental dimensions of health) and health outcome measures encompassing diverse domains. Additionally, we propose using data from small areas, such as district, to account for local geography. Each domain may then be represented by a set of indicators which may then be combined first into sub-domain-specific composite indexes and then into overall composite

index that reflects the state of health of the people. There are different approaches available for combining different indicators into one composite index and these methods have their own advantages and disadvantages. Statistical methods and tools are commonly preferred over other methods. Lastly, we recommend that future research should explore the role of health indices in monitoring progress towards health.

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