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Classification of health indicators affecting human development index: a cross-country study

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Abstract

The health dimension of Human Development Index (HDI) is currently assessed by life expectancy at Birth. In this regard, the question is whether or not the life expectancy indicator merely can explain the health status of countries. Accordingly, the aim of this study was to determine and classify health indicators affecting human development index. For this purpose, 70 countries were selected as cases, and 27 health indicators were determined as variables. The data were gathered from 2000 to 2012 and analyzed using R-type factor analysis technique within the principal components in software. Based on the obtained results from factor analysis, the examined variables were classified into six main factors including "manageable diseases", "serious diseases", "environmental factors", "quality of health care", "disease preventive services", and "public health expenditure" that explained 73% of the total variance. This finding indicates the deep effect of these six main factors on health status of a community. So, it can be argued that health development description is not limited to the life expectancy Index. Instead, it is affected by many factors including diseases, health services, health care costs, and environmental factors. Therefore, life expectancy cannot be a comprehensive indicator of health sector in HDI and the current understanding in this regard should be revised.

Keywords: Health, Human Development, Life Expectancy

Introduction

In the contemporary world, Human Development Index (HDI) is a proper alternative for Gross National Product per capita to indicate the level of regional welfare and development [1]. The application of HDI is getting expanded day by day in order to supervise the level of development in nations. Countries use the United Nations Development Program (UNDP) annual reports, which estimate HDI for all countries, as well as human development national reports to provide strategies for decision makers and politicians in governmental levels for improving development status in their communities and eradication of inequalities. Nevertheless, the indices applied by the UN practically fail to include various dimensions of human development and have frequently been criticized [2].

Because of the significance and frequent use of HDI in development studies, many of these

drawbacks have been evaluated and revised to provide an ideal index. However, health dimension of HDI has been totally neglected in the amendments [3]. Therefore, the numerical value of HDI might be unrealistic and even misleading. For a long and healthy life not only physical health is necessary, but also the quality of life is very important; while this cannot be addressed by life expectancy alone. The trivial contribution of health dimension in HDI in countries that have exportable natural resources and consequently higher revenues (Oil Country) is highlighted and apparently reveals the necessity of revising health dimension in HDI.

On the other hand, in evaluating the fundamental dimensions and indices in human development and social development in any community, the quality and quantity of providing health services as well as individuals' access to these services in rural and urban areas should be taken into account [4]. In fact, a suitable access to health services and facilities is counted as one of the basic prerequisites for the sustainable human development [5]. In case of disease incidence and prevalence, a sustainable development would not be achieved; moreover, without building a healthy environment and without providing health services and facilities, individual health in society would not persist [6]. Therefore, sustainable development emphasizes improving health and treatment systems and providing sustainable health for people [7].

Accordingly, the purpose of the present study was to investigate the influential factors in individual health in a society. In the meantime, identifying and introducing these factors to their classification based on their level of significance would be dealt with.

The investigations demonstrate that among the surveys carried out in terms of regional development and regional and cross-country inequalities, a few studies have dealt with the regional development level based on health indices. In majority of the surveys, a limited number of health development indices besides a group of other economic, social, and cultural indices have been investigated whose outcomes have presented an overall portray of development in different regions. Nevertheless, there are abundant indices present in heath sector, and each shows one of the health-related dimensions in individuals. Accordingly, the current paper aimed to present a suitable prioritizing among the indices by concentrating on indices in health sector.

For instance, by applying two techniques of factor analysis and cluster analysis as well as using 22 health indices in a survey, Zangi Abadi et al in 2013 demonstrated that health and treatment indices in East Azerbaijan province were not distributed equally and there was a gross difference among counties in the province in terms of health services development [8]. Mohammadi et al in 2012 showed that there was a general deprivation dominant in West Azerbaijan province respecting health and treatment indices; in addition, distribution of the present facilities was not really corresponded to population needs and potency in counties [9].

Also, Zarabi and Sheikh Beiglou in 2011 investigated Iran provinces in terms of 32 health development indices by applying factor analysis method. The obtained results of factor analysis led to a reduction of the indices under the subject of study to five factors including "expert human force", "rural health services", "pharmaceutical services", "state health services", and "private health services". Also, multi-variable regression analysis indicated that the mentioned factors accounted for 61% of health development in the provinces [10]. Bahadori et al in 2013 addressed the classification of health structural indices in Golestan province. The outcomes revealed that with respect to development, there was not existed a huge gap among the province counties [11].

Houshyar et al. considered the improvement of human development indicators in the provinces of Iran. The results obtained showed that despite relatively good progress, the overall level of human development still needed to be worked on. The research methods

used were descriptive–analytical; theoretical concepts of human development were applied to human development indicators and trends in Iran [12].

Boutayeb et al. dealt with the relationship between health indicators and human development in the Arab region beyond descriptive. Without including the Gross Domestic Product (GDP) indicator, the analysis showed that the 19 Arab countries may be classified independently of their geographic proximity, in three different groups according to their global human development level (Low, Medium, and High). Consequently, while identifying health deficiencies in each group, the focus was made on the countries presenting a high potential of improvement in health indicators. In particular, maternal mortality and infant mortality which are really challenging the health authorities of the first and third groups were critically discussed [13].

Method

The current study was an applied quantitative-analytical research. The data were collected by referring to reports and international statistical sites, then analyzes them via statistical methods. In the current study, 70 countries around the globe were investigated by their health development indices. With respect to the selection of statistical sample, it should be mentioned that although high-income countries are expected to have a higher HDI, it is not necessarily true. Cross-country comparisons show that many high-income countries fall in HDI low levels and vice versa, in some countries HDI is higher than their per capita-income standing.

The comparison of HDI ranking in different years, especially in case of petro states, has revealed that increasing spot in this ranking cannot be indicative of an improvement in citizens' quality of life. Considering HDI is obtained by the average of three indicators of life expectancy, educational improvement, and per capita income based on equality of purchase power and per capita income is per se one of the elements of HDI, rising petroleum price per capita income elevates and leads to a rise in HDI without necessarily changing life expectancy and educational development in a significant manner.

It should be mentioned that stressing HDI improvement in a single period can be definitely misleading particularly in petro states. In fact, the gap between per capita income ranking and HDI ranking is what should be taken into account and needs to be applied in policy making. A negative gap between per capita income and HDI standing means that received revenues are not adequately used for improving citizens' quality of life and human development variables (health, education, standards of living) or put it in other words, citizens do not feel the impact of revenue rise (petro states in particular) in their everyday life. The study of HDI and per capita income rankings, especially in petro states, makes it necessary to pay more attention to the components of quality of life and social welfare inevitably.

Correspondingly, taking the advantage of HDI reports which are annually published by the UN, 70 countries suffering a negative gap between per capita income ranking and HDI ranking were selected among which, 23 were oil countries and 47 non-oil countries. The separation of oil and non-oil countries is based on net exports (Net exports refer to the value of a country's total exports minus the value of its total imports) of oil and other petroleum products (Information on export and import of oil and other petroleum products is taken from the Energy Information Administration). The list of the selected countries for statistical sample divided in terms of petro states and non-petro states are provided in Table 1.

The selected time period in this article, regarding the availability of data, includes the time interval between 2000 and 2012.

The variables in this study comprised 27 variables in health section which cover different aspects of health in a society (mortality, birth, diseases, medical costs, health-treatment services, environmental factors, etc). The list of the variables used in this paper is given in Table 2.

Table 1 *The list of the selected countries for statistical sample*

Oil Country				Non-Oil Country			
OPEC		Non OPEC					
1	Algeria	11	Azerbaijan	24	Afghanistan	48	Lesotho
2	Iran (Islamic Republic of)	12	Bahrain	25	Andorra	49	Liechtenstein
3	Iraq	13	Colombia	26	Angola	50	Luxembourg
4	Kuwait	14	Congo	27	Antigua and Barbuda	51	Malaysia
5	Libya	15	Côte d'Ivoire	28	Austria	52	Maldives
6	Nigeria	16	Gabon	29	Benin	53	Mali
7	Qatar	17	India	30	Bhutan	54	Mauritania
8	Saudi Arabia	18	Kazakhstan	31	Botswana	55	Mexico
9	United Arab Emirates	19	Oman	32	Brazil	56	Morocco
10	Venezuela (Bolivarian Republic)	20	Russian Federation	33	Brunei Darussalam	57	Namibia
		21	Thailand	34	Burkina Faso	58	Niger
		22	Trinidad and Tobago	35	Cape Verde	59	Pakistan
		23	Turkmenistan	36	Chad	60	Papua New Guinea
				37	China	61	Saint Kitts and Nevis
				38	Djibouti	62	Seychelles
				39	Dominican Republic	63	Singapore
				40	Egypt	64	South Africa
				41	El Salvador	65	Sudan
				42	Equatorial Guinea	66	Suriname
				43	Gambia	67	Swaziland
				44	Guatemala	68	Timor-Leste
				45	Guinea	69	Turkey
				46	Hong Kong, China (SAR)	70	Yemen
				47	Indonesia		

On selecting these variables, it is worth mentioning that at first, all the variables in health section were listed and then, they were sorted in order of priority and impression on people's health in society. Afterwards, the availability of variables for the selected sample was checked out and 27 variables, whose data were available during the research period for the selected sample, were chosen as the research variables. Finally, 27 selective parameters were reduced to some extent of meaningful factors by factor analysis.

Factor analysis has various applications. If the purpose is to summarize the number of indices into meaningful factors, R-type factor analysis should be employed; if the purpose is to combine and abridge few places or geographical regions into homogenized groups inside a territory, Q-type analysis should be used [14]. Considering that the purpose of this research was to study and summarize 27 health development indices into fewer components, R-type factor analysis was utilized within the principal components.

On the other hand, factor analysis is performed in two forms of exploratory factor analysis and confirmatory factor analysis. Considering the purpose of this study, and with regard to the matter that the authors had no authentically predetermined hypothesis on this subject, exploratory factor analysis was applied.

Table 2 *The list of the research variables*

Row	Code	Indicator name
1	NUMW	Nurses and midwives (per 1,000 people)
2	PHYS	Physicians (per 1,000 people)
3	BEDS	Hospital beds (per 1,000 people)
4	TBS.DTEC	Tuberculosis case detection rate (%, all forms)
5	IMM.IDPT	Immunization, DPT (% of children aged 12-23 months)
6	IMM.MEAS	Immunization, measles (% of children aged 12-23 months)
7	VAC.TTNS	Newborns protected against tetanus (%)
8	VITA	Vitamin A supplementation coverage rate (% of children aged 6-59 months)
9	STA.ACSN	Improved sanitation facilities (% of population with access)
10	H2O.SAFE	Improved water sources (% of population with access)
11	XPD.PUBL	Health expenditure, public sector (% of GDP)
12	XPD.PRIV	Health expenditure, private sector (% of GDP)
13	XPD.OOPC	Out-of-pocket health expenditure (% of total expenditure on health)
14	AIDS	Prevalence of HIV, total (% of population aged 15-49)
15	AIDS.FE	Women's share of population aged 15+ living with HIV (%)
16	TBS.INCD	Incidence of tuberculosis (per 100,000 people)
17	ANM.CHLD	Prevalence of anemia among children (% of children under 5)
18	ANM.NPRG	Prevalence of anemia among non-pregnant women (% of women aged 15-49)
19	PRG.ANEM	Prevalence of anemia among pregnant women (%)
20	ITK.DEFC	Prevalence of undernourishment (% of population)
21	CBRT	Birth rate, crude (per 1,000 people)
22	IMRT	Mortality rate, infant (per 1,000 live births)
23	NMRT	Mortality rate, neonatal (per 1,000 live births)
24	U5.MORT	Mortality rate, under 5 (per 1,000 live births)
25	AMRT	Mortality rate, adult (per 1,000 male and female adults)
26	BOD	Organic water pollutant (BOD) emissions (kg per day)
27	CO2E	CO_2 emissions (kt)

Results

Prior to factor analysis, the validity of factor analysis should be investigated. In fact, every set which owns lesser number of variables can be introduced into one factor analysis although the output might be invalid or useless [15]. In order for a factor analysis to be useful and meaningful, the variables need to be correlated; otherwise, there is no reason for factor analysis. To do so, Bartlett's Test of sphericity was employed. The purpose of the test was to reject the null hypothesis implying the correctness of identity matrix (Identity matrix is a matrix with ones on main diagonal and zeros elsewhere) in society. Bartlett's Test examined this hypothesis that the observed correlation matrices belonged to a society with uncorrelated variables.

Bartlett's Test is considered proper only when it is significant for factor analysis ($p<0.05$). In this test, KMO statistic (Kaiser-Mayer-Olkin) is calculated and yields a value between zero and one. The value of 0.60 is suggested as the minimum for a proper factor analysis. If this statistic exceeds 0.70, the present correlations will be suitable for factor analysis in general. If its level is between 0.50 and .69, the data will be suitable for factor analysis, although it largely demands precision and the levels less than 0.50 imply that analysis is not suitable for the certain set of variables.

Table 3 lists the results of KMO and Barlett's tests as well as appropriateness of indices' significance level.

Table 3 *KMO and Bartlett's test results*

KMO and Bartlett's test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy		0.865
Bartlett's Test of Sphericity	Approx. Chi-Square	457.941
	df	351
	Sig.	0.000

Having considered the research outcomes, it is observed that a significant KMO coefficient (p=0.000) above 0.70 (equal to 0.86) was obtained. Hence, it is verified to use factor analysis appropriately in the present study.

Having confirmed factor analysis a right method for the present data in research, principal factors or components were extracted. On this way, 27 selected variables in health section were reduced to six principal factors which explained totally 73 percent of the variance on its own. This indicates that factor analysis and variables under the subject of study were satisfactorily selected. The eigenvalue of the mentioned factors along with variances as well as cumulative variances are summarized in Table 4.

Table 4 *Initial eigenvalues, variance, and cumulative variances*

Component	Component	Variance (%)	Cumulative variance (%)
1	10.45	38.690	38.690
2	3.09	11.452	50.142
3	1.84	6.822	56.964
4	1.75	6.493	63.458
5	1.31	4.877	68.335
6	1.26	4.668	73.003

In addition, the Cattell Scree test displayed in Figure 1 was performed to determine principal factors.

As observable in Figure 1, a shift in steepness in the spots three and four and also spots five and six is observed and after the sixth spot, the diagram becomes steady in steepness. Therefore, six principal components can be suggested.

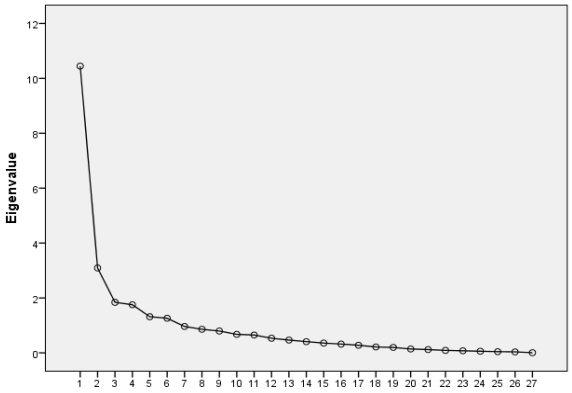

Figure 1 *Cattell Scree test result*

Having determined the number of factors, in order to easily interpret the factors, the outlined factors at the initial stage should be rotated. In order to rotate the factors, Oblimin rotation, which is the best method for this purpose, was utilized.

At this stage based on the significant correlations between factors and indices, these factors are named as following (Table 5):

1) *Manageable diseases:* The eigenvalue of this factor was 10.45 implying it can explain 38.96 percent of the variance on its own. This factor has the highest impact among the six factors and composed of three indices including anemia percentage among non-pregnant women aged 15-49, anemia percentage among pregnant women, and anemia percentage among children under 5. Appropriately, this very factor can be named "manageable diseases".

2) *Serious diseases:* Eigenvalue of this factor is 3.09 implying it can explain 11.452 percent of the variance. This factor is loaded with 2 indices including prevalence of AIDS among people aged 15-49 and the rate of people diagnosed with tuberculosis per 100,000 of the population. Accordingly, this very factor can be called "serious diseases" factor.

3) *Environmental factors:* Eigenvalue of this factor is 1.84 indicating it explains 11.452 percent of the variance. This factor is loaded with 2 indices including discharge of water pollutants (kilograms BOD per day) and CO_2 emissions. Accordingly, this very factor can be called "environmental factors".

4) *Quality of health services:* Eigenvalue of this factor is 1.75 which can explain 11.452 percent of the variance. This factor is loaded with 3 indices\including the number of physicians (per 1000 of the population), the number of nurses and midwives (per 1000 of the population), and the number of hospital beds (per 1,000 people). Respectively, this very factor can be called the factor of "quality of health services".

5) *Disease preventive services:* Eigenvalue of this factor is 1.31 which can explain 4.87 percent of the variance. In this factor 3 indices are loaded including percentage of vaccinated infants against tetanus, percentage of infants vaccinated against diphtheria and pertussis, percentage of infants vaccinated against measles, and potable water system (percentage of the population who has access to). On this basis, this factor can be named the factor of "disease preventive services".

6) *Public health expenditure:* Eigenvalue of this factor is 1.26 which can explain 4.668 percent of the variance. One index is loaded in this factor named public sector health costs (as a percentage of GDP). Subsequently, this factor can be called the factor of "public sector costs in health section".

Table 5 *Main factors and related variables*

Factor order	Factor name	Index	Factor loading
First factor	Manageable diseases	Prevalence of anemia among non-pregnant women (% of women aged 15-49)	0.860
		Prevalence of anemia among pregnant women (%)	0.859
		Prevalence of anemia among children (% of children under 5)	0.784
Second factor	Serious diseases	Prevalence of HIV, total (% of population aged 15-49)	0.937
		Incidence of tuberculosis (per 100,000 people)	0.887
Third factor	Environmental factors	Organic water pollutant (BOD) emissions (kg per day)	0.899
		CO_2 emissions	0.882
Fourth factor	Quality of health services	Physicians (per 1,000 people)	0.875
		Nurses and midwives (per 1,000 people)	0.755
		Hospital beds (per 1,000 people)	0.741
Fifth factor	Disease prevention services	Percentage of vaccinated infants against tetanus	0.929
		Percentage of infants vaccinated against diphtheria and pertussis	0.705
		Ppercentage of infants vaccinated against measles	0.641
		Treated water resources (percentage of the population who have access to)	0.598
Sixth factor	Public health expenditure	Health expenditure, public sector (% of GDP)	0.460

Discussion

Considering HDI as one of the most crucial and widely-used indicators in demonstrating country's level of development and welfare, and also since this index is a foundation for many strategies and decisions in viewpoint of state decision makers and politicians; it should be comprehensive to cover all the aspects in its working area. Therefore, the focus has always been on the eradication of index imperfections and deficiencies.

Although HDI has occasionally undergone some changes, it still seems failed to display all the dimensions of development. Despite paying too much attention to income and education dimensions, health dimension has been totally ignored and life expectancy has been used for a long time as the health dimension indicator.

The basic issue developed here is that the life expectancy index is only influenced by birth and mortality rate, while health has several dimensions and therefore, different indicators are needed to show the status of community health.

In most previous studies, a few number of

health development indicators along with a group of other economic, social, and cultural indicators were examined, which have been providing overall picture of development in different regions. For example, with the aim of classifying health indicators, Zangiabad et al. [8] conducted a study in East Azerbaijan, Mohammadi et al. [9] in West Azerbaijan, Taghdisi et al. [15] in Gilan, Bahadori et al. [11] in Golestan, and Zarabi and Sheikh Beiglu [10] in Isfahan and showed that health indicators are not distributed in balance.

In this research, we have tried to focus on health indicators and prioritize these indicators. Accordingly, the aim of this paper was to analyze, review, and critique health indicators. In this analysis, the focus was on the health dimension of human development index. Despite numerous modifications undergone, this index still has deficiencies with respect to the health dimension. This study tried to modify this dimension by identifying the most influential factors. For this purpose, 70 countries including 23 oil countries and 47 non-oil countries were selected as cases, and 27 health indicators were determined as variables. The research period for data collection was set between 2000 and 2013. In this comparative study, factor analysis using principal component analysis in SPSS 11 software constituted the research method. The results identified six main factors in health indicators including “manageable diseases”, “serious diseases”, “environmental factors”, “quality of health services”, “disease preventive services”, and “public sector costs in health section”. Similar to the present study, Zarabi and Sheikh Beiglou (2011) examined 32 provinces of Iran in terms of health development indicators. The results indicated five indices classified as "experts", "rural health services", "medical services", "public health services", and "private health care" that totally explained 61 percent of the province's development variance.

Conclusion

The obtained results revealed that health development indicators are not merely confined to the life expectancy index (birth and mortality rate); instead, numerous indicators including diseases, health services, health expenditure, and environmental factors are influential parameters. Hence, life expectancy cannot be a full indicator for health aspect in HDI and this increases the need for revision of the Human Development Index. Therefore, it is suggested that HDI be revised in terms of health sector indicator. By constructing a new combined index as health indicator, HDI is estimated once more and thus, all the aspects of health involved in assessing countries’ level of development are scrutinized.

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Contribution

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Data collection and analysis: NH, VM, BS
Manuscript preparation: NH, BS, VM, AA

Conflict of Interest

"The authors declare that they have no competing interests."

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