



Is Human Comprehensive Development Coordinated with the Development of National Public Health and Medical Security?

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Abstract. Human development index (HDI) is a comprehensive indicator to measure the human development level in each region, which consists of three indicators as life expectancy, education standard and life satisfactory representing health, education and economic level respectively. However, relevant data shows that the emergency capability and control effect in response to infectious epidemic diseases as the COVID-19 recently is not completely consistent with the HDI level in some countries. This may due to the constraint that the selected representative factors of index HDI may not fully reflect the development in their aspects, especially, the national public health standard. Therefore, in this article, we are interested to explore the relationship between human development level and the national public health development level. Choose the current health expenditure (percentage of GDP) (CHE) as the representative factor concerning the public and medical security of national people's livelihood. For the sake of more accurate evaluation about the difference between levels of two indicators, coordinated development degree (CDD) is utilized to reflect the development relationship between two aspects qualitatively. Further analysis based on the latest updated data by regions around the world indicates that the overall global trend has been stable over the years, while different relationships including coordinated developed type and maladjusted recession type with varying extents exist between human comprehensive development and national public health development among countries rather than a single highly positive or negative dependency. Combined with the specific actual situations in different regions, objective factors like external environmental challenges and development pressure of each country, as well as the internal development conditions including national capabilities and related government policies, may explain for the various observed correlations between the human comprehensive development and the development of national public health and medical security. Interesting phenomena of the development coordination are also demonstrated through the analysis of case fatality rate of COVID-19.

Keywords: human comprehensive development, human development index, public health level, current health expenditure, coordinated development degree, national public health and medical security

1 Introduction

The United Nations Development Programme has established the human development index (HDI)[1] in 1990, which is a comprehensive index to measure the human development level of each country all over the world. Since then, it has played an extremely important role in guiding countries especially developing countries to formulate corresponding national development strategies and policies. This summary measurement is based on the average achievement in key dimensions of human development, as life expectancy, education standard and quality of life representing a healthy and long life, being knowledgeable and a decent standard of living, respectively. Many related researches have been conducted to investigate the relations between HDI and these three aspects, such as the relevance of education in [2], life satisfactory in [3], [4], income standard in [5],[6],[7], and physical diseases and activities in [8],[9],[10].

Although HDI is constructed as a comprehensive indicator to reflect the overall development level, it only captures part of what human development entails, with just three representative factors. An objective fact is that since the outbreak of infectious epidemic COVID-19 on a global scale, the emergency capability and control effect in each country has varied to certain extents. This may be greatly attributed to the governmental policies and relevant epidemic prevention measures as well, but most important is the capacity of national public health and medical system. However, compared with the HDI level, the epidemic situation in some countries is not completely in line with the development level, which may serve as a strong evidence of the conjecture about the incomprehensibility of the HDI index, especially concerning the national public health and medical development level.

In terms of public health part of HDI, life expectancy is considered as an indicator to measure the health level of residents in a country or region, reflecting the quality of society life to some extent. However, in addition to objective aspects as social and economic conditions or physical care level, other subjective problems like genetic factors may also influence the personal life length. Therefore, for a more intuitive and specific reflection of the public health standard and medical security development, compared with analyzing the relationship between HDI and public health level based on the life expectancy index alone, it is natural to find a more representative and comprehensive indicator.

Medical safeguard question is a significant issue of the people's livelihood which the government department cares highly, and the medical security benefits is also the important realistic benefit that people sincerely pay attention to. To better present the public health standard and development level, we choose current health expenditure as the representative indicator. Current health expenditure (percentage of GDP) (CHE) is defined as the spending on healthcare goods and services, expressed as a percentage of GDP, excluding capital health expenditures as buildings, machinery, information technology and stocks of vaccines for emergency or outbreaks. In most developing

countries, especially in least developed countries, increasing attention has been paid to the health financing and development of the health workforce, including recruitment, training and retention. From the definition, the CHE is a comprehensive reflection of achievements in health science and medical technology, national health and medical conditions, emergency response capability of public health and medical care system, economic benefits of health services and other aspects concerning public health of livelihood in a country. Based on the more comprehensive meaning about public health and medical service, it is of great significance to analyze the correlation between HDI and CHE for further formulation of national public health development strategies.

2 Materials and Method

To further explore how the CHE is associated with HDI, we use the data including the human development index (HDI) and the current health expenditure (CHE) in 179 countries covering a time span from 2010 to 2017, which is publicly available on the official website of the United Nations Development Programme (UNDP) (<http://hdr.undp.org/>). For the purpose of better convenience of analysis, we construct the current health expenditure index (CHEI) with the calculation equation as $CHEI = [CHE - \min(CHE)] / [\max(CHE) - \min(CHE)]$, where the min CHE is set as 1 and the max CHE is set as 21, according to the range of CHE in these countries. To conduct a more accurate evaluation of the development relation between HDI and CHEI, the coordination degree commonly used to reflect the degree of dispersion in the data is applied to measure the coordination level of HDI and CHEI. The coupling coordination degree (CCD) between these two indicators is first defined as

$$CCD = \left[\frac{HDI \times CHEI}{\left(\frac{HDI + CHEI}{2} \right)^2} \right]^k, \quad (1)$$

where k is the tuning parameter. In this article, we take k as 1. Due to the fact that when the values of two indicators are both small and close, the index CCD will presents large value under the situation of low development level but with high coordination. This may due to the fact that the CCD only reflect the coordination degree of the indicators, instead of taking the development level into account. Therefore, to display a more intuitive presentation of divergence and obtain a more scientific assessment of the coordinated development relation between HDI and CHEI, the comprehensive development index (CDI) of the indicators is first defined as

$$CDI = w_1 \cdot HDI + w_2 \cdot CHEI, \quad (2)$$

where w_1 and w_2 are the weight of indicators. Take $w_1 = w_2 = \frac{1}{2}$, $CDI = \frac{HDI + CHEI}{2}$. Then, the coordinated development degree (CDD) of two indicators is defined as

$$CDD = \sqrt{CCD \times CDI}. \quad (3)$$

Generally, the coordinated development degree can be divided into ten levels from 0~0.1 to 0.9~1, which is presented in Table 1. Specifically, the values lower than 0.5 indicate that the development coordination correlation of two indicators belongs to maladjustment recession type, otherwise mean coordinated development type, and the degree of coordination or maladjustment is judged by the grade of values.

Table 1. Grade division of coordinated development degree

CDD	0~0.1	0.1~0.2	0.2~0.3	0.3~0.4	0.4~0.5
Grade	extreme maladjustment recession	severe maladjustment recession	moderate maladjustment recession	mild maladjustment recession	on the verge of maladjustment recession
CDD	0.5~0.6	0.6~0.7	0.7~0.8	0.8~0.9	0.9~1
Grade	reluctant coordinated development	primary coordinated development	intermediate coordinated development	good coordinated development	superior coordinated development

3 Results and Analysis

Generally speaking, since health level is one of the key factors of human development level, it is natural to think that CHEI, as the representative indicator of public health level, is highly correlated with HDI. However, this cognition seems not to always hold from the following result. Before numerical calculation and analysis, Figure 1 first intuitively presents countries with HDI and CHEI in 2017.

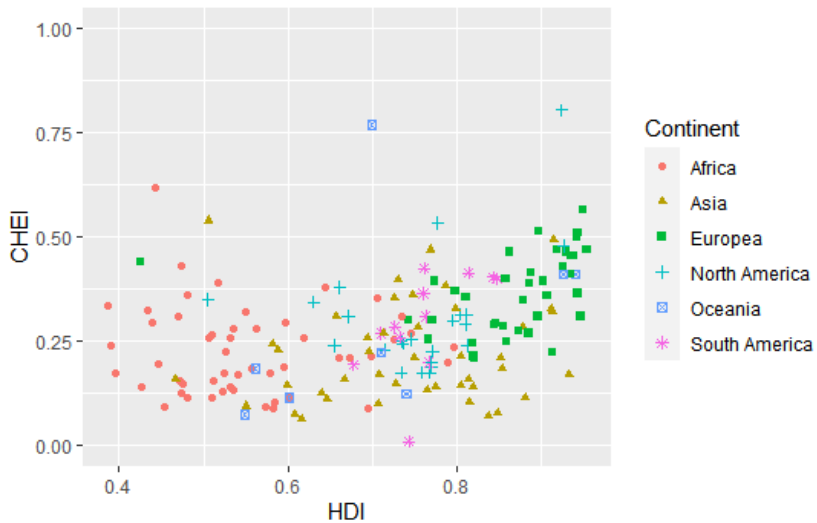


Fig. 1. Countries with HDI and CHEI around the world

First of all, from Figure 1, it is obvious that countries with the close development level of HDI and CHEI (upper right or lower left part) or with slight deviation (middle part) account for majority, indicating that in most countries, the human development level and the public health expenditure are mutually dependent with a positive relation. In addition to the above situations, another unexpected situation is that there are still some countries own these two indicators with completely opposite levels (upper left and lower right part). The absolutely negative correlation also verifies the previous conjecture that HDI can not fully reflect the human comprehensive development, especially the public health development level.

For better analysis of the qualitative relation between these two indicators, the coordinated development degree (CDD) is calculated utilizing the HDI and CHEI in each country. Meanwhile, since previous discussion is based on the data of year 2017 only, to get a more general and comprehensive pattern of coordinated development relations, we choose the data from 2010 to 2017, and get the calculation results of annual data. Table 2 serves as a strong numerical evidence of the relatively stable distribution of global overall coordinated development level over the time period.

Table 2. Distribution of coordinated development degree (CDD) all over the world during the period from 2010 to 2017

Year CDD	2010	2011	2012	2013	2014	2015	2016	2017
0.9-1	0.56%	0.56%	0.56%	0.56%	0.56%	0.56%	0.56%	0.56%
0.8-0.9	1.68%	1.12%	2.23%	2.79%	3.35%	3.35%	3.35%	3.35%
0.7-0.8	18.99%	18.99%	18.44%	18.44%	18.44%	18.44%	19.55%	18.99%
0.6-0.7	30.17%	27.93%	31.28%	31.28%	27.93%	32.96%	31.84%	31.84%
0.5-0.6	25.14%	26.26%	25.70%	25.70%	29.05%	27.93%	24.58%	24.58%
0.4-0.5	16.76%	16.20%	12.85%	13.97%	13.41%	12.29%	16.76%	15.64%
0.3-0.4	4.47%	5.03%	6.70%	5.59%	6.70%	3.91%	3.35%	4.47%
0.2-0.3	1.68%	3.35%	1.12%	1.68%	0.56%	0.56%	0	0
0.1-0.2	0.56%	0.56%	1.12%	0	0	0	0	0.56%
0-0.1	0	0	0	0	0	0	0	0

For another hand, from Figure 1, which marks the continents to which each country belongs as well, it seems that some common characteristics exist in the locations of countries all over the world. Therefore, the geographical region is considered for explanation when analyzing the coordinated development degree in each country. Table 3 presents the detailed distribution of coordinated development degrees in each continent during the last five years of period. Since the coordinated development degrees are mainly concentrated in 0.4 to 0.8, therefore, for better understanding and explanation about the situation of each continent, we first classify those with the coordination development grade less than 0.5 into one group as general maladjustment recession type, and those greater than 0.7 into great coordinated group, leading to a rough division of grades with four groups.

Table 3. Detailed distribution of coordinated development degree (CDD) in each continent during the period from 2010 to 2017

Asia					
Year CDD	2013	2014	2015	2016	2017
0.7-1	1.59%	1.59%	1.59%	3.35%	2.79%
0.6-0.7	7.26%	6.15%	7.82%	6.70%	6.15%
0.5-0.6	5.03%	6.70%	6.70%	6.15%	6.70%
0-0.5	10.61%	10.06%	8.38%	8.38%	8.94%

Europe					
Year CDD	2013	2014	2015	2016	2017
0.7-1	13.41%	13.41%	12.85%	12.29%	12.29%
0.6-0.7	6.15%	5.59%	7.26%	7.82%	7.82%
0.5-0.6	1.59%	2.23%	1.12%	1.12%	1.12%
0-0.5	0	0	0	0	0

Oceania					
Year CDD	2013	2014	2015	2016	2017
0.7-1	2.79%	2.79%	2.23%	2.79%	2.79%
0.6-0.7	0.56%	0.56%	0.56%	0	0
0.5-0.6	1.59%	1.12%	2.23%	1.59%	1.59%
0-0.5	1.12%	1.59%	1.12%	1.59%	1.59%

Africa					
Year CDD	2013	2014	2015	2016	2017
0.7-1	0.56%	0.56%	1.12%	1.12%	0.56%
0.6-0.7	8.94%	7.82%	7.82%	7.82%	8.94%
0.5-0.6	9.50%	11.17%	12.29%	10.06%	9.50%
0-0.5	9.50%	8.94%	7.26%	9.50%	9.50%

North America					
Year CDD	2013	2014	2015	2016	2017
0.7-1	1.59%	1.59%	1.59%	1.59%	1.59%
0.6-0.7	6.15%	5.03%	7.26%	6.70%	6.70%

0.5-0.6	5.03%	6.15%	3.91%	4.47%	4.47%
0-0.5	0	0	0	0	0

South America

Year CDD	2013	2014	2015	2016	2017
0.7-1	1.59%	2.23%	2.79%	2.23%	2.79%
0.6-0.7	2.23%	2.79%	2.23%	2.79%	2.23%
0.5-0.6	2.79%	1.59%	1.59%	1.12%	1.12%
0-0.5	0	0	0	0.56%	0.56%

From the table, we can find that the relations of HDI and CHEI in most European countries belong to primary or great coordinated development type, while most American countries have slight difference with reluctant or primary grade, both representing better national human comprehensive development level, greater livelihood safeguard benefits, and more advanced public health and medical system. Meanwhile, majority of Asian and African countries are basically distributed in the coordinated development type with reluctant, primary grade and on the verge of maladjustment recession type on the average, along with few countries with general maladjustment recession. This fact indicates a certain gap between governmental attention and fiscal expenditure paid on the national public health security improvement and the development of the economic and cultural aspects in these countries. Furthermore, combined with Figure 1, essential differences also exists between these two regions. Specifically, most Asian countries with maladjustment recession type have HDI above medium level, yielding that the uncoordinated relation is mainly caused by the relatively backward development of the national public health and medical security. On the contrary, looking back on the African countries, the lower level may attribute to the underdevelopment of both human comprehensive development and public health safeguard benefits level.

This result may be not surprising. Firstly, since most of the developed countries are located in the Europe, the improvement of human comprehensive development and public health system are both influenced by the whole national developed capabilities in each country, leading to high coordination of two aspects. Next, due to the fact that majority of developing countries are in the Asia and America, most countries focus on the development of economy, industry and commerce, thus subjectively reducing the governmental emphasis on the relevant policies related to the development of national public health and medical care. In addition, in many capitalist countries, the increasing establishment of private medical institutions make public health welfare gradually lower. Lastly, owing to the fact that the vast majority of least developed countries are in the Africa, the low coordinated development degree signifies the severe medical environment and the backward development level of the whole society, which may be attributed to the objective challenges such as warfare, famine, drought and infectious disease, as well as the subjective factors like government decision making in response to external environment and national capacity development.

As mentioned earlier, the human development level may not consistent with the situation of infectious disease as COVID-19 in each country completely, which can be seen from Figure 2. The figure displays relations between HDI and case fatality rate in countries around the world, where the case fatality rate is defined as the ratio of cumulative deaths to the cumulative confirmed cases based on the cumulative data from January 22,2020 to December 15,2020, which is available on the official website of the World Health Organization (WHO) (<http://www.who.int/>). Obviously, it is not countries with high HDI that have relatively low case fatality rate, or vice versa, just like countries in the lower left and upper right corner, which also fully shows that HDI, as a comprehensive indicator including health level can not completely reflect a country's epidemic situation. Therefore, more works related to the coordination development and case fatality rate of the COVID-19 could be conducted for further analysis about the epidemic situation in various countries.

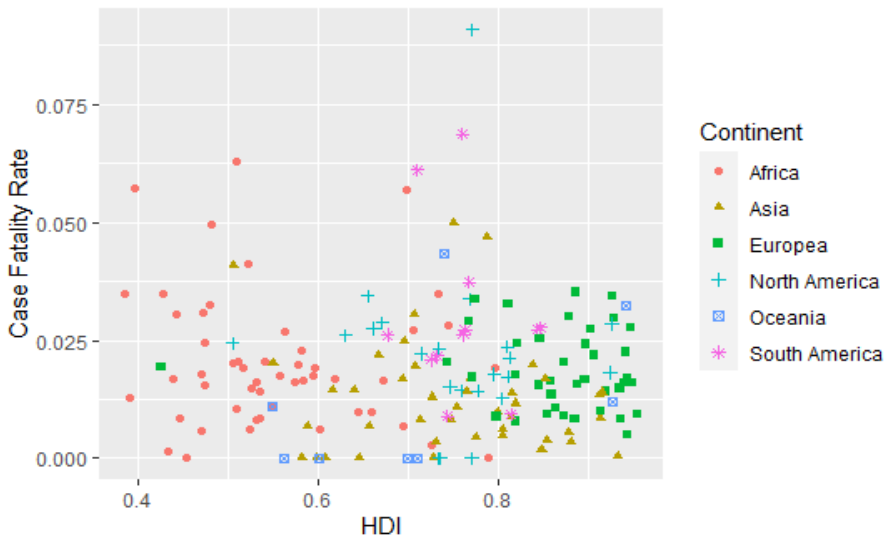


Fig. 2. Countries with HDI and case fatality rate of COVID-19 around the world

In the process of studying the effect of coordinated development relationship on the case fatality rate of COVID-19, some interesting phenomena were also revealed. Figure 3 displays the relation between CDD and case fatality rate in countries of different continents. Obviously, except for majority of African countries with relatively higher case fatality rates, the ones in European and American countries are higher than that in most Asian countries. This result seems to have some differences with CDD in various regions, but it makes sense considering the actual situation of various countries since the outbreak of the epidemic.

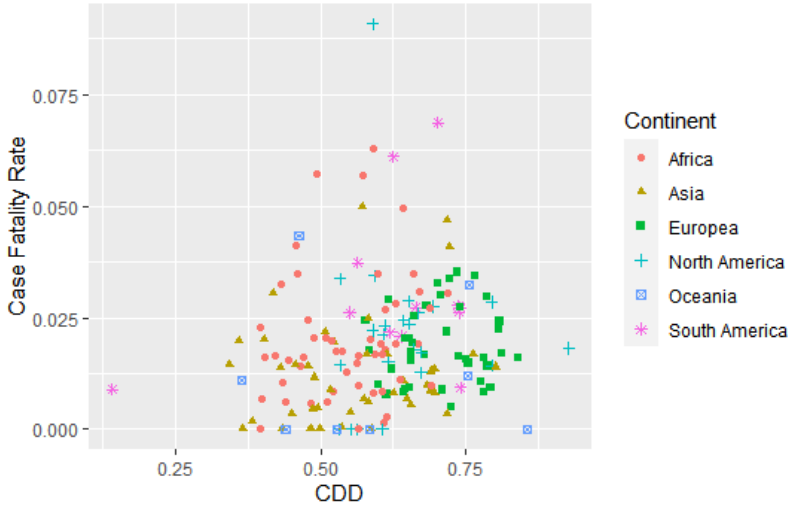


Fig. 3. Countries with CDD and case fatality rate of COVID-19 around the world

Specifically speaking, for most African countries, the maladjustment recession of national comprehensive development, including public health system, yielding the insufficiency of medical materials, backwardness of medical treatment technology, and shortage of medical staff, thus, more deteriorated epidemic situations. In comparison, relatively lower case fatality rate of most Asian countries may be attributed to the better countermeasures and greater governmental efforts for the active response to the disease because of the concerns about relatively less developed national public health system. However, for most European and American countries with greater development coordination, due to their overconfidence of the emergency response ability of own national medical system and national development strength for heavy infectious disease, combined with their neglect of the rapid transmission speed and strong infection intensity of disease, these countries have paid less attention to the control and improvement of their national epidemic situations, and lack of effective epidemic prevention measures and related policies, as well as the efficient medical treatment methods, leading to a worsen epidemic situation with higher case fatality rates.

4 Conclusion and Discussion

On the whole, we are interested to investigate the development relation between human comprehensive development and the national public health and medical security standard in countries around the world. Due to the fact that human development index (HDI) can not fully reflect the level of national people's livelihood medical security, we choose the current health expenditure (CHE) and generate the corresponding index as the representative indicator. To incorporate the development level in the analysis of coordination, the coordinated development degree (CDD) is calculated to reflect the diverse in the development level of two aspects.

The analysis based on the numerical results includes various situations with different grades and causes. Specifically, the human development level in most European countries are consistent with the improvement of public health and medical security. Similar result holds for some Asian and American countries as well but with lower coordination degree. In addition, though many Asian countries own high value of HDI, but the low coordination indicates that it is necessary to actively improve the social welfare of public health system and the equality of medical service. On the other hand, for most least developed countries with low coordinated development levels in Africa, in addition to the subjective conditions that great efforts and constant improvement should be made to develop the country capabilities, global appeal and assistance may also need to ease the heavy burden owing to the external environment, especially on their public health and medical care system as well. The analysis about the case fatality rate of COVID-19 also reveals the significant impacts of development coordination relationship. Briefly speaking, Asian countries need to keep the epidemic situations under great control and pursue better improvement, while more attention and active response is needed for most European countries, and international medical aid is in urgent need for African countries. The above discussion may explain the relationship between human comprehensive development and the national public health and medical security development, and make certain guidance for the future development of countries.

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