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Correlates of Healthy Life Expectancy in Low- and Lower-Middle-Income Countries --Manuscript Draft--

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Abstract:	<p>Background: Healthy life expectancy (HALE) at birth is an important indicator of health status and quality of life of a country's population. However, little is known about the determinants of HALE as yet globally or even country-specific level. Thus, we examined the factors that are associated with HALE at birth in low- and lower-middle-income countries.</p> <p>Methods: In accordance with the World Bank (WB) classification seventy-nine low- and lower-middle-income countries were selected for the study. Data on HALE, demographic, socioeconomic, social structural, health, and environmental factors from several reliable sources, such as the World Health Organization, the United Nations Development Program, Population Reference Bureau, WB, Heritage Foundation, Transparency International, Freedom House, and International Center for Prison Studies were obtained as selected countries. Descriptive statistics, correlation analysis, and regression analysis were performed to reach the research objectives.</p> <p>Results: The lowest and highest HALE were observed in Sierra Leone (44.40 years) and in Sri Lanka (67.00 years), respectively. The mean years of schooling, total fertility rate (TFR), physician density, gross national income per capita, health expenditure, economic freedom, carbon dioxide emission rate, freedom of the press, corruption perceptions index, prison population rate, and achieving a level of health-related millennium development goals (MDGs) were revealed as the correlates of HALE. Among all the correlates, the mean years of schooling, TFR, freedom of the press, and achieving a level of health-related MDGs were found to be the most influential factors.</p> <p>Conclusion: To increase the HALE in low- and lower-middle-income countries, we suggest that TFR is to be reduced as well as to increase the mean years of schooling, freedom of the press, and the achievement of a level of health-related MDGs.</p>
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Response to Reviewers:

Dear Editor,

Thank you so much for your fine assessment to improve the manuscript. We, the authors are very grateful to you and the reviewers for their scholastic suggestions. The manuscript has been revised considering all your suggestions which are as follows:

1. Data section has been slightly revised.
2. The final paragraph of discussion section has been modified.
3. In the Ethical approval section, it has been written as "Not applicable".
4. In the Availability of data and materials section, needful references are given.
5. Authors contribution section has been rewritten
6. In the methods section it has been clearly stated that the Fig. 1 is presented with the help of the geographical software ArcGIS 9.3.
7. Figures file is sent in a separate file.

I do hope the necessary revisions would able to cover the quarries. However, I am ready to revise or modify any section of this manuscript. Thank you once again for your extreme cooperation.

With kind regards,
Professor Dr. Md. Nazrul Islam Mondal

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Correlates of Healthy Life Expectancy in Low- and Lower-Middle-Income Countries

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Field of study: Correlates of healthy life expectancy

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Correlates of Healthy Life Expectancy in Low- and Lower-Middle-Income Countries

Abstract

Background: Healthy life expectancy (HALE) at birth is an important indicator of health status and quality of life of a country's population. However, little is known about the determinants of HALE as yet globally or even country-specific level. Thus, we examined the factors that are associated with HALE at birth in low- and lower-middle-income countries.

Methods: In accordance with the World Bank (WB) classification seventy-nine low- and lower-middle-income countries were selected for the study. Data on HALE, demographic, socioeconomic, social structural, health, and environmental factors from several reliable sources, such as the World Health Organization, the United Nations Development Program, Population Reference Bureau, WB, Heritage Foundation, Transparency International, Freedom House, and International Center for Prison Studies were obtained as selected countries. Descriptive statistics, correlation analysis, and regression analysis were performed to reach the research objectives.

Results: The lowest and highest HALE were observed in Sierra Leone (44.40 years) and in Sri Lanka (67.00 years), respectively. The mean years of schooling, total fertility rate (TFR), physician density, gross national income per capita, health expenditure, economic freedom, carbon dioxide emission rate, freedom of the press, corruption perceptions index, prison population rate, and achieving a level of health-related millennium development goals (MDGs) were revealed as the correlates of HALE. Among all the correlates, the mean years of schooling, TFR, freedom of the press, and achieving a level of health-related MDGs were found to be the most influential factors.

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Conclusion: To increase the HALE in low- and lower-middle-income countries, we suggest that TFR is to be reduced as well as to increase the mean years of schooling, freedom of the press, and the achievement of a level of health-related MDGs.

Keywords: Healthy life expectancy; Low- and lower-middle-income countries; Quality of life; Correlates of healthy life expectancy

Background

Healthy life expectancy (HALE) at birth is the summary measure of a population's health, developed by the World Health Organization (WHO), which attempts to capture a complete estimate of health than life expectancy (LE). HALE is an estimate of how many years that a person might live in a healthy state. It is an indicator of health conditions of the country's population, including the impacts of mortality and morbidity. It is related to the declined rate of mortality and morbidity and an improvement of health measures since the 1960's [1]. In 1964, Sanders published important results focusing on measuring community health levels [2]. In 1969, an improved measure of the health, health-adjusted life expectancy or HALE, was published by the United States (US) Department of Health, Education, and Welfare for the first time [1]. But, the methods for calculating HALE were publicized by Sullivan in 1971 [2].

Different demographic, socioeconomic, social structural, health-related and environmental factors, as well as the regional variation, found to be the influential factors of HALE [3]. The lowest HALE has been reported in African region (52.30 years) while it is around 68.00 years in America and Europe and 60.50 years in South Asia [3]. Overall, the global HALE is estimated to be 63.10 years in 2015 [3]. Beside these geographical variations, variation is also observed by the economic status of the different countries. Lower HALE is observed in

1 the low-income countries (53.00 years) which are around 17.00 years higher in the high-
2 income countries (70.00 years). This difference is around 4 years between low- and lower-
3 middle-income countries [3]. There are many factors that often created to increase HALE.
4 Increasing mean years of schooling [4], health expenditure, physician density, entrance to
5 improved drinking-water sources and hygienic sanitation system, economic freedom [5],
6 freedom of the press, corruption perceptions index (CPI), achieving a level of health-related
7 millennium development goals (MDGs), and gross national income (GNI) per capita; and
8 decreasing the human immunodeficiency virus (HIV) prevalence rate [6], total fertility rate
9 (TFR), carbon dioxide (CO₂) emission rate, and prison population rate significantly
10 contribute to increasing the average HALE at birth. But these factors may vary from one
11 geographic region to the others which need to be examined. Robine and Ritchie reviewed and
12 evaluated the usefulness of HALE as a global indicator of changes in a population's health
13 [7]. Saito and others provided a brief overview of health expectancy and the issues to be
14 considered in operationalizing and interpreting health expectancy. They introduced the
15 concept of health expectancy, discussed the measures used to compute health expectancy, and
16 methods of calculation [8]. Mathers and others displayed the global patterns of HALE in the
17 year 2002 [9]. Several studies are conducted on HALE, viz, Summary measures of population
18 health: methods for calculating HALE [1]; HALE [2]; HALE: comparison of OECD
19 countries in 2001 [10]; Health-Adjusted Life Expectancy [11]; A comparison of self-rated
20 health, health status, and health promotion behaviors between low- and non-low-income
21 elderly women [12]; HALE and the correlates of self-rated health in Bangladesh in 1996 and
22 2002 [13]; HALE and the correlates of self-rated health in an ageing population in Rajshahi
23 district of Bangladesh [14]. However, no study has been conducted to identify the
24 determinants of HALE with a specific focus on the economic status or income groups.
25 Therefore, the present study is conducted to identify the influential factors that are associated

1 with HALE in low- and lower-middle-income countries by using the secondary data. The
2 findings may help the policy-makers and researchers to determine the influential factors of
3 HALE in low- and lower-middle-income countries and thereby take appropriate measures as
4 to how to raise HALE in these countries.
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10 **Methodology**

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14 **Data:** Most of the variables that had the significant effects on HALE in the previous studies
15 were selected for this study. Data on low- and lower-middle-income countries were obtained
16 from the specialized agencies of the United Nations (UN) systems. The UN agencies rely on
17 an extensive peer review process, which is conducted through leading regional and national
18 statistics offices and international organizations, thus ensuring the highest level of data
19 consistency and accuracy. Seventy-nine countries were classified as low- and lower-middle-
20 income countries by the World Bank (WB) (see Appendix A). Several indicators of HALE
21 including HLAE for these 79 countries were obtained from several sources, e.g., WHO [3,
22 15], United Nations Development Program (UNDP) [16], Population Reference Bureau
23 (PRB) [17], WB [18], Transparency International (TI) [19], Heritage Foundation (HF) [20],
24 Freedom House (FH) [21], and International Center for Prison Studies [22].
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42 **Dependent variable:** HALE at birth is considered as the dependent variable, which is the
43 measurement of how many years that a person might live in a healthy state.
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48 **Independent variables:** Different demographic, socioeconomic, social structural, health-
49 related, and environmental factors were considered as the independent variables.
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52 Demographic variable includes the TFR. Socioeconomic variables include mean years of
53 schooling, GNI per capita, and health expenditure. Social structural variables encompass the
54 freedom of the press, CPI, prison population rate, and economic freedom. Worldwide known
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1 HIV prevalence rate, achieving a level of health-related MDGs, and physician density are
2 considered as the health-related factors. Environmental factors include improved drinking-
3 water sources using rate, improved sanitation using rate, and CO₂ emission rate per capita
4 (tonnes) (for details see Appendix B). A level of health-related MDGs was calculated using
5 the following ten variables or targets named: percent reduction in under-five mortality rate,
6 1990-2013 (T= 67); Measles immunization coverage among 1 year old (%), 2013 (T= 90);
7 percent reduction in maternal mortality ratio, 1990-2013 (T= 75); births attended by skilled
8 health personnel (%) (T= 90); antenatal care coverage (%): at least one visit (T= 100); unmet
9 need for family planning (%) (T= 0); percent reduction in HIV incidence, 2001-2013 (T=
10 >0); percent reduction in mortality rate of tuberculosis (among HIV-negative people), 1990-
11 2013 (T= >50); percent reduction in proportion of population without access to improved
12 drinking-water sources, 1990-2012 (T= 50); percent reduction in proportion of population
13 without access to improved sanitation, 1990-2012 (T= 50). The extent of progress for a
14 country has been classified into three categories named: (i) met or on track, (ii) substantial
15 progress, and (iii) no or limited progress [see [15] for details]. Each of the above targets is
16 labeled as '1' when it satisfies the 'met or on track' category of the achievement progress of
17 the MDGs; otherwise, it is labeled as '0'. Then the row total was performed to get an
18 achieving level of health-related MDGs for a country.

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45 **Statistical analyses:** Descriptive statistics were used to describe the situations of all low- and
46 lower-middle-income countries. After this, the Pearson's correlation analysis was performed
47 to see the relationships among the selected variables. To examine the effects of the
48 independent variables on the dependent variable, several multiple linear regression models
49 were fitted. Next multicollinearity problem was checked in the regression analyses by
50 examining the tolerance values. The tolerance values less than 0.40 indicate a strong
51 multicollinearity [23], and there was a strong multicollinearity among physician density,
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1 TFR, GNI per capita, and health expenditure. Therefore, all the collinear variables were
2 dropped one by one except TFR because it is very close to 0.40. And finally, a regression
3 analysis was performed to identify the most influential factors that are associated with HALE.
4 Here noted that the logarithm values of the two variables were used which were GNI per
5 capita and physician density. The entire analysis of the study was done with the statistical
6 software Stata /MP Version 13 (Stata Corporation LP, College Station, Texas; USA). The
7 HALE of the study countries is presented with the help of the geographical software ArcGIS
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20 **Results**

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24 Table 1 presents the current situation of HALE (see Fig. 1) and associated factors in 79 low-
25 and lower-middle-income countries. Fig. 2 shows the HALEs of the countries for two-time
26 points (2013 and 2015 years). The HALEs of these countries are arranged in descending
27 order. The HALEs of these countries are seen increased in 2015 compared to the year 2013.
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29 The HALE, mean years of schooling, health expenditure, physician density, improved
30 sanitation using rate, freedom of the press, economic freedom, and achieving a level of
31 health-related MDGs are observed very low among the African countries. On the other hand,
32 the highest HALE, mean years of schooling, health expenditure, physician density, improved
33 drinking-water sources using rate, improved sanitation using rate, freedom of the press, CPI,
34 economic freedom, and achieving a level of health-related MDGs are seen in the Asian
35 countries. The GNI per capita, prison population rate, and CO₂ emission rate per capita
36 (tonnes) are found very low among the African countries. On the other hand, the highest GNI
37 per capita, and prison population rate are seen in the American countries. And the CO₂
38 emission is found the highest among the European countries. The lowest HALE is seen in
39 Sierra Leone (44.40 years) and the highest HALE is seen in Sri Lanka (67.00 years). The
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1 lowest mean years of schooling are found in Burkina Faso (only 1.10 years) and the highest
2 mean years of schooling are found in Kyrgyzstan (13 years). The TFR is seen very low in the
3 European countries. In the Republic of Moldova, it is only 1.30 births per woman. In the
4 Asian countries, the HIV prevalence rate is seen very low than other countries except for
5 Egypt and Morocco. The lowest value of HIV prevalence rate is 0.10, i.e., there is only one
6 HIV-infected person per thousand people in Egypt, Morocco, Bangladesh, Bhutan, Pakistan,
7 Philippines, Sri Lanka, and Yemen. Again, the highest TFR (7.60 in Nigeria, 6.20 in Mali)
8 and HIV (27.70 % in Swaziland, 23.40 % in Lesotho, 16.70 % in Zimbabwe) prevalence rates
9 are seen among the African countries. On the other hand, in Uzbekistan, the freedom of the
10 press is very low (5.00) and in Micronesia, the freedom of the press is the highest (79.00)
11 among the other low- and lower-middle-income countries. In the case of achieving a level of
12 health-related MDGs, Comoros and South Sudan (0.00) hold the lowest position and Viet
13 Nam (8.00) hold the highest position. Among the low- and lower-middle-income countries,
14 lowest and highest urban populations were found in Burundi (12.36%) and Djibouti
15 (77.43%), respectively.

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48 Table 2 shows the significant positive relationships of HALE with mean years of schooling (r
49 = 0.58, $p < 0.01$), GNI per capita ($r = 0.65$, $p < 0.01$), health expenditure ($r = 0.58$, $p < 0.01$),
50 physician density ($r = 0.70$, $p < 0.01$), CO₂ emission ($r = 0.50$, $p < 0.01$), improved drinking-
51 water sources using rate ($r = 0.62$, $p < 0.01$), sanitation using rate ($r = 0.75$, $p < 0.01$), CPI (r
52 = 0.31, $p < 0.01$), prison population rate ($r = 0.44$, $p < 0.01$), and economic freedom ($r =$
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1 0.32, $p < 0.01$), and achieving a level of health-related MDGs ($r = 0.50$, $p < 0.01$). On the
2 other hand, significant negative relations are found of TFR ($r = -0.75$, $p < 0.01$) and HIV
3 prevalence rate ($r = -0.43$, $p < 0.01$) with HALE in the low- and lower-middle-income
4 countries of the world.
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13 Table 3 represents the results of multiple linear regression models. The regression analyses
14 identified the mean years of schooling, TFR, HIV prevalence rate, CO₂ emission rate,
15 freedom of the press, CPI, and prison population rate, economic freedom, and achieving a
16 level of health-related MDGs are as the correlates of HALE. The multiple regression model
17 (Model 1) ($R_a^2 = 0.61$) gives the most influential factors that are associated with HALE
18 which are mean years of schooling, TFR, freedom of the press, and achieving a level of
19 health-related MDGs (see Fig. 3). Among all these correlates the mean years of schooling,
20 freedom of the press, and achieving a level of health-related MDGs have shown positive
21 effects and only the TFR has shown negative effects on HALE. The other variables which
22 were included in the analysis have shown the general relations with outcome variable, HALE.
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24 So, we can say that among all the independent variables the higher mean years of schooling,
25 freedom of the press, and achieving a level of health-related MDGs; and the lower TFR are
26 the most influential factors which increase the nation's average HALE.
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52 Discussion 53 54 55 56 57 58 59 60 61 62 63 64 65

1 In this first representative study of low- and lower-middle-income countries, an attempt is
2 made to identify the correlates that are associated with HALE. We found the mean years of
3 schooling, TFR, freedom of the press, and achieving a level of health-related MDGs as the
4 significant correlates of HALE. The effects of other independent variables on HALE are
5 statistically insignificant.
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12 The level of education of the respondents is an important factor of HALE. The findings of
13 this study are consistent with the results of other studies conducted in developed and
14 developing countries [4, 24]. This may be due to the fact that the higher education levels are
15 typically related with well-timed receiving healthcare, and also more awareness about the
16 health. The higher rate of receiving prenatal care, optimize the use of maternal healthcare
17 services also found to be the higher among the educated individuals which are found as the
18 influential factors of developing HALE. We know that the educated individuals earn higher
19 real wages. The higher real wages indicate the high average household income and enabling
20 people to enlarge the quality and quantity of the purchased healthcare services. Additionally,
21 educated people have knowledge about proper nutrition, hygiene, and healthcare services, as
22 well as common illness-preventative measures [25] and thus they seem to enhance their
23 HALE. So, we see that HALE increases due to increase in mean years of schooling. A study
24 conducted in the United Nations of America (USA) also supported that the increasing mean
25 years of schooling is an important factor of widening the HALE [4]. Valkonen *et al.* also
26 supported by saying that the LE, as well as disability-free life expectancy (HALE), showed
27 systematic relationships with the level of education: the higher the level of education, the
28 higher LE and disability-free life expectancy [26]. This finding is also supported by Deka
29 and Nath [27], and Shin *et. al* [12]. Thus, it is theorized that as mean years of schooling
30 increases, average HALE will increase.
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1 The coefficients for TFR and HIV prevalence rate are statistically significant and shown
2 negative effects on HALE in all the regression models. The TFR of Nigeria and Mali are 7.60
3 and 6.20 respectively whereas it is on an average 1.60 in the high-income countries [18]. The
4 increase in an average number of births to a woman means the decrease in HALE. Mondal
5 and Shitan suggested that increases in TFR are likely to decrease average LE in a country
6 [28]. As the TFR decreases the average LE so the HALE is also decreasing due to the TFR.
7 Hence it is needed to reduce the TFR to maximize the average HALE of the population. HIV
8 has become a major public health problem in many countries and one of the world's most
9 serious health and development challenges. Eventually, the HIV attacks the immune system
10 of the infected individual which is a non-curable virus. Without treatment, the net median
11 survival time with HIV is 9-11 years [29], meaning that individuals who have tested positive
12 for HIV face a drastically reduced lifespan. A greater percentage of infected adults could also
13 mean higher HIV transmission rates to children. This virus reduces a country's average
14 HALE. The HIV prevalence rate was identified as a responsible factor of lowering HALE by
15 the authors in the previous studies, like [6]. HIV prevalence rate is likely to decrease average
16 LE due to the increase in HIV prevalence [28]. As the HIV prevalence rate decreases the
17 average LE, so we can say that the HIV prevalence rate also decreases the HALE at birth.
18 Thus, it is seen that as the percentage of HIV-infected adult increases, average HALE will
19 decrease. So, it is needed to control the HIV prevalence rate to maximize the average HALE
20 of the population. Greater health expenditure, physician density, improved drinking-water
21 sources using rate, freedom of the press, and CPI mean the greater HALE. Thus, it is
22 hypothesized that if the values of these variables increase, the average HALE will be
23 increased. On the other hand, if both the CO₂ emission rate and prison population rate
24 decrease, the average HALE at birth will increase. The above findings have significant
25 effects on increasing HALE. HALE increases throughout the countries at a more rapid rate

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than LE, advising to reduce the disability for reducing mortality [6]. Wolfson, and Tareque *et al.* also supported by saying that HALE increases more rapidly than LE [11, 13].

Another measure of a country's standard of living is freedom of the press, and obviously, it is related to HALE. The freedom of communication and expression through various mediums like electronic media and published materials is known as the freedom of the press or freedom of the media. In the 20th century, Liebling, an American journalist, was excellently abridged the idea of "freedom of the press", who wrote, "Freedom of the press is guaranteed only to those who own one" [30]. In which place, it exists mostly implies the absence of interference from the government and other powerful organizations; it is maintained through the constitution or other legal protections. Freedom House, the US-based non-governmental organization, is published a yearly report on freedom of the press by measuring the level of freedom and editorial independence enjoyed by the press in every nation and significant disputed territories around the world. Levels of freedom are scored on a scale from 0 (most free) to 100 (least free) [21]. But we converted this scale to 100 (most free) to 0 (least free). Depending on the basics, the nations are then classified as "Free", "Partly Free", or "Not Free". The impact of freedom of the press on HALE has never been measured. It is difficult, though not impossible, to calculate such impact. However, freedom of the press always has a positive influence on HALE. To achieve the high HALE, and MDGs a freer press has a great contribution [31]. In 2015, the countries where the press was the freest were Micronesia, Vanuatu, Solomon Islands, Cabo Verde, and Sao Tome and Principe [21], and in these countries, the HALE is high than others [3]. The country with the least degree of press freedom was Uzbekistan, Eritrea, Syrian Arab Republic, Gambia, and Sudan [21], and in these countries, the HALE is low than others [3]. By promoting the level of freedom of the press, Government and international organizations provide a powerful development tool. A free press establishes an instrument of development, as such in the same way as education or

1 investment, which promotes the HALE of the country's population [30]. Thus, it is concluded
2 that as the level of freedom of the press increases, average HALE will increase.
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6 One of the most important factors of a country's standard of living is achieving a level of
7 health-related MDGs which is highly significant with HALE and has the great influences on
8 HALE [15]. The MDGs are eight international development goals that all 194 UN member
9 states and at least 23 international organizations have agreed to achieve by the year 2015
10 [15]. In 2015, the MDGs have come to the end of their term. Progress towards the MDGs, on
11 the whole, has been remarkable. Country progress towards the achievement of the health-
12 related MDGs and targets has also been considerable. During the MDG era, many of the
13 health-related MDGs were achieved, with the corresponding targets. The results of this study
14 demanded that the HALE is low in those African countries where the achieving a level of
15 health-related MDGs is observed very low, and the HALE is high in those Asian countries
16 where the achieving a level of health-related MDGs is observed very high [15]. In a study,
17 Lomazzi and others also supported that the achieving a level of health-related MDGs has a
18 positive impact on HALE [32]. Thus, it is assumed that as the achieving a level of health-
19 related MDGs increases, average HALE will increase.
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41 A limitation of this work is that we only studied the data for the most common affecting
42 factors, i.e., those factors which are found to be significantly related to HALE. We did not
43 consider the mortality-related factors which will be our next study. Also, the study is limited
44 to the low- and lower-middle-income countries. Again, the sources and quality of data are
45 different in different countries. Some low- countries have complete civil registration and vital
46 statistics and regular censuses of the entire population as the data sources. On the other hand,
47 many lower-middle-income countries have an incomplete birth and death registration systems
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1 as well as the lack of continuous realistic data on mortality and HALE. But, all data which
2 are analyzed in this study collected from the very reliable sources.
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5 **Conclusions**

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9 An investigation is made to find out the main powerful factors affecting HALE from the
10 demographic variables, socioeconomic status, social structural indicators, health-related
11 factors and environmental issues which have the significant effects on HALE in the low- and
12 lower-middle-income countries. The study signifies that among all the associated factors,
13 mean years of schooling, TFR, freedom of the press, and achieving a level of health-related
14 MDGs are the principal factors which have the most important effects on a nation's average
15 HALE. Our results have some policy implications for these countries, especially those in
16 Africa. Urgent action is necessary to enhance HALE. The national and international efforts
17 should be designed at increasing average HALE to raise the awareness about the mean years
18 of schooling, TFR, freedom of the press, and achieving a level of health-related MDGs
19 among the country's population. By setting up a required number of schools the whole nation
20 has to invest all its energies to ensure quality primary education for all for the extension of
21 universal primary education to enhance the education level of a country. The viable options
22 to lower the TFR are to develop education system, the family planning programs in the small-
23 towns especially in the rural areas, and the nationwide compulsory premarital contraception
24 counseling. To expand the freedom of the press it is essential to increase the legislation and
25 institutions that safeguard the independence of the media by the government and upgrade the
26 training for journalists in the fields of human rights, ethical journalism, quality journalism,
27 and safety. Moreover, immediate intensive actions are needed to achieve the health-related
28 development goals. We analyzed data from 79 countries and measured the effects of 15
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1 factors. To identify the factors that influence HALE, future research should evaluate larger
2 datasets and a wider range of factors.
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6 **Availability of data and materials:** The datasets generated and analyzed during the current
7 study are publicly available. Data for this study were sourced from the World Health
8 Organization (WHO) [3,15], United Nations Development Program (UNDP) [16], Population
9 Organization (WHO) [3,15], United Nations Development Program (UNDP) [16], Population
10 Reference Bureau (PRB) [17], World Bank (WB) [18], Transparency International (TI) [19],
11 Heritage Foundation (HF) [20], Freedom House (FH) [21] and International Center for Prison
12 Studies (ICPS) [22].
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25 **Authors' contributions:** MSI, MNIM, MIT, MAR and MNH conceived the paper; MSI,
26 MNIM, MIT and MAR analysed the data; MSI and MIT wrote the first draft of the paper;
27 MMA and HTAK refined the draft; all authors critically reviewed the manuscript, provided
28 feedback and approved the final submission.
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36 **Ethics approval and consent to participate:** Not applicable.
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43

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Abbreviations: CO₂: Carbon Dioxide, CPI: Corruption Perception Index, FH: Freedom House, Fig.: Figure, GNI: Gross National Income, HALE: Healthy Life Expectancy, HF: Heritage Foundation, HIV: Human Immunodeficiency Virus, LE: Life Expectancy, MDGs: Millennium Development Goals, PRB: Population Reference Bureau, TFR: Total Fertility Rate, TI: Transparency International, UNDP: United Nations Development Program, UN: United Nations, US: United States, USA: United States of America, WB: World Bank, WHO: World Health Organization

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Figure Legends

Fig. 1: Healthy life expectancy at birth for the study countries

Fig. 2: Trend of healthy life expectancy at birth in two data points for the study countries

Fig. 3: Correlates of healthy life expectancy at birth

Table 1: Descriptive statistics of the selected variables for the low- and lower- middle income countries

Variables	N	Mean	Median	Standard deviation	Minimum Value	Country	Maximum Value	Country
Healthy life expectancy	79	57.05	56.60	5.81	44.40	Sierra Leone	67.00	Sri Lanka
Mean years of schooling ^a	79	5.60	5.10	2.67	1.10	Burkina Faso	12.50	Kyrgyzstan
GNI per capita ^a	79	1795.08	1400.00	1307.05	127.90	Somalia	6930.00	Guyana
Health expenditure ^a	79	101.87	76.00	82.69	0.00	Somalia	415.00	Micronesia
Total fertility rate ^a	79	3.90	4.00	1.38	1.30	Republic of Moldova	7.60	Niger
Physician density ^b	73	5.65	1.80	9.05	0.10	Liberia	42.70	Georgia
CO ₂ emission rate ^c	79	0.77	0.40	0.98	0.00	Burundi and Chad	6.30	Ukraine
HIV prevalence rate ^a	72	2.59	0.75	4.95	0.10	Afghanistan, Egypt, Morocco, Bangladesh, Bhutan, Pakistan, Philippines, Sri Lanka, Syrian Arab Republic, and Yemen	27.70	Swaziland
Improved drinking-water sources using rate	79	77.97	79.00	15.98	32.00	Somalia	100.00	Armenia, Bhutan and Georgia
Improved sanitation using rate	79	47.14	42.00	27.16	7.00	South Sudan	100.00	Uzbekistan
Freedom of the press	79	41.73	42.00	18.13	5.00	Uzbekistan	79.00	Micronesia
Corruption perceptions index	79	30.49	30.00	10.21	8.00	Somalia	65.00	Bhutan
Prison population rate	75	110.72	84.00	89.12	16.00	Central African Republic	517.00	El Salvador
Economic freedom	74	54.70	54.80	6.40	37.60	Zimbabwe	73.00	Georgia
Achieving a level of health-related MDGs	79	3.20	3.00	1.71	0.00	Comoros and South Sudan	8.00	Viet Nam
Urban population (% of total)	78	39.98	39.30	15.79	12.36	Burundi	77.43	Djibouti

Notes: ‘N, Number of countries’; ‘GNI, Gross National Income’; ‘CO₂, Carbon dioxide’; ‘HIV, Human Immunodeficiency Virus’; ‘MDGs, Millennium Development Goals’; ‘^a, 2014’; ‘^b, 2007-2013’; ‘^c, 2011’

Table 2: Pearson’s correlation coefficients between the selected variables

	Y	X ₁	X ₂	X ₃	X ₄	X ₅	X ₆	X ₇	X ₈	X ₉	X ₁₀	X ₁₁	X ₁₂	X ₁₃	X ₁₄	X ₁₅
Y	1															
X ₁	0.58**	1														
X ₂	0.65**	0.55**	1													
X ₃	0.58**	0.58**	0.75**	1												
X ₄	-0.75**	-0.57**	-0.65**	-0.54**	1											
X ₅	0.70**	0.71**	0.63**	0.50**	-0.73**	1										
X ₆	0.50**	0.59**	0.55**	0.49**	-0.59**	0.64**	1									
X ₇	-0.43**	0.02	-0.06	0.04	0.15	-0.28*	-0.11	1								
X ₈	0.62**	0.44**	0.51**	0.51**	-0.62**	0.56**	0.48**	-0.11	1							
X ₉	0.76**	0.65**	0.60**	0.53**	-0.72**	0.82**	0.65**	-0.21	0.65**	1						
X ₁₀	0.16	0.08	0.28*	0.33**	-0.02	-0.12	-0.02	-0.02	0.22*	-0.16	1					
X ₁₁	0.31**	0.14	0.35**	0.35**	-0.26*	0.05	0.11	0.13	0.51**	0.22*	0.42**	1				
X ₁₂	0.44**	0.38**	0.42**	0.56**	-0.49**	0.39**	0.28*	0.10	0.3**	0.52**	0.03	0.44**	1			
X ₁₃	0.32**	0.18	0.25*	0.29*	-0.22	0.27*	0.03	-0.13	0.37**	0.31**	0.24*	0.60**	0.46**	1		
X ₁₄	0.50**	0.27*	0.22	0.28*	-0.50**	0.31**	0.22	-0.11	0.52**	0.43**	-0.02	0.37**	0.45**	0.32**	1	
X ₁₅	0.18	0.13	0.29*	0.29*	-0.26*	0.31**	0.32**	-0.25*	0.29*	0.21	0.04	0.16	0.15	0.14	0.09	1

Notes: ‘*’, $p < 0.05$, and ‘**’, $p < 0.01$; ‘Y, Healthy life expectancy’; ‘X₁, Mean years of schooling’; ‘X₂, Gross national income per capita’; ‘X₃, Health expenditure’; ‘X₄, Total fertility rate’; ‘X₅, Physician density’; ‘X₆, Carbon dioxide emission rate’; ‘X₇, Human immunodeficiency virus prevalence rate’; ‘X₈, Improved drinking water sources using rate’; ‘X₉, Improved sanitation using rate’; ‘X₁₀, Freedom of the press’; ‘X₁₁, Corruption perceptions index’; ‘X₁₂, Prison population rate’; ‘X₁₃, Economic freedom’; ‘X₁₄, Achieving a level of health-related Millennium Development Goals’; ‘X₁₅, Urban population (% of total)’

Table 3: Multiple linear regression models explaining the healthy life expectancy

Explanatory Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Adjusted β	SE of β (95 % CI)	Unadjusted β	SE of β (95 % CI)	Unadjusted β	SE of β (95 % CI)	Unadjusted β	SE of β (95 % CI)	Unadjusted β	SE of β (95 % CI)	Unadjusted β	SE of β (95 % CI)
Mean years of schooling	0.46	0.19* (0.09, 0.85)	1.25	0.20** (0.85, 1.66)								
Total Fertility Rate	-2.26	0.42** (-3.09, -1.43)			-3.14	0.32** (-3.77, -2.50)						
Freedom of the Press	0.05	0.02* (-0.002, 0.09)					0.05	0.04 (-0.02, 0.12)				
Achieving a level of health-related MDGs	0.60	0.28* (0.04, 1.17)							1.69	0.34** (1.03, 2.36)		
Urban population (% of total)	-0.004	0.03 (-0.06, 0.05)									0.07	0.04 (-0.02, 0.15)
R_a^2		0.61		0.32		0.55		0.01		0.24		0.02

Notes: ‘ β , Regression coefficient’; ‘SE, Standard error’; ‘CI, Confidence interval’; ‘** Significant at $p < 0.01$ ’; ‘* Significant at $p < .05$ ’; ‘MDGs, Millennium Development Goals’

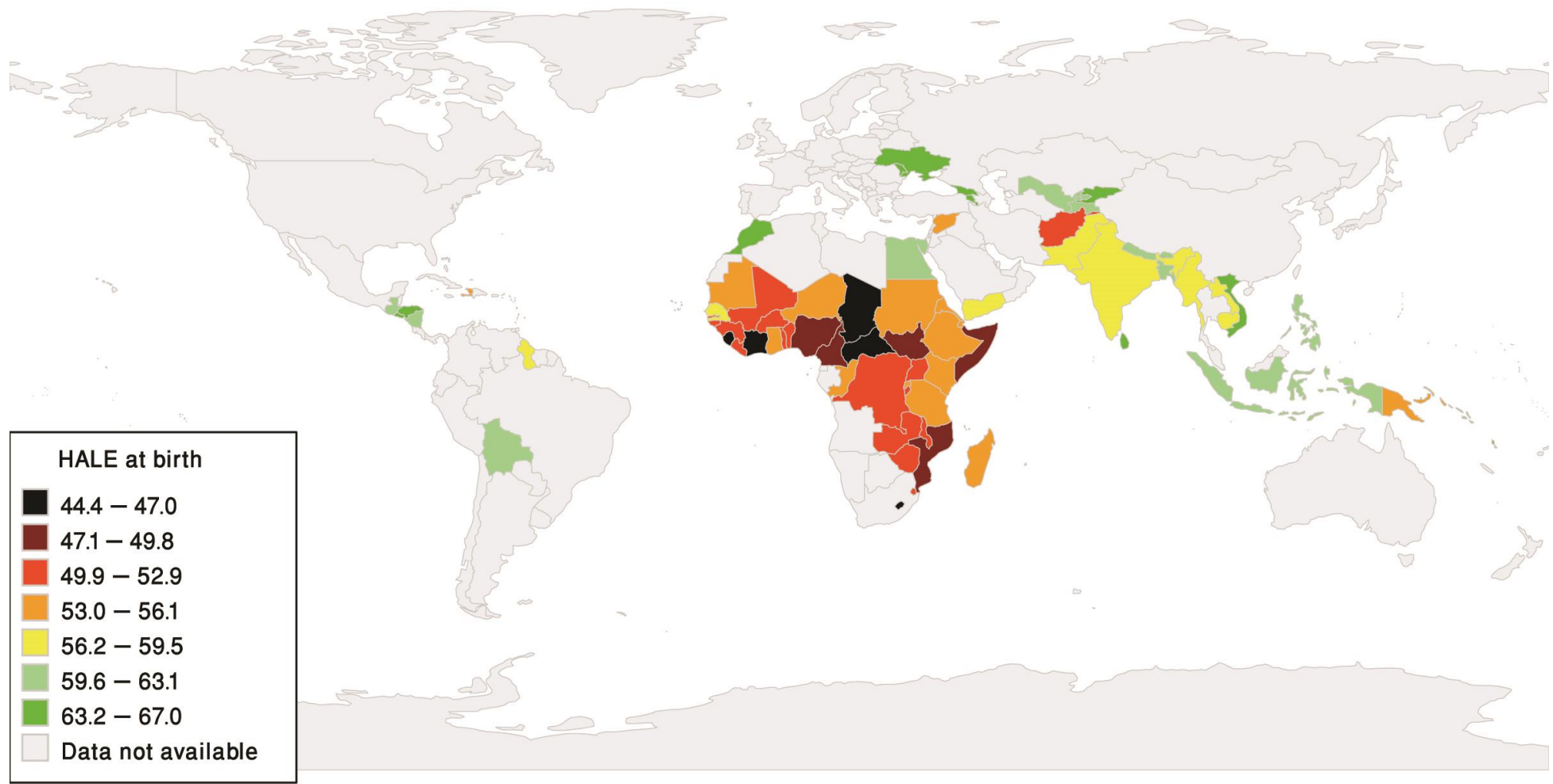


Fig. 1: Healthy life expectancy at birth for the study countries

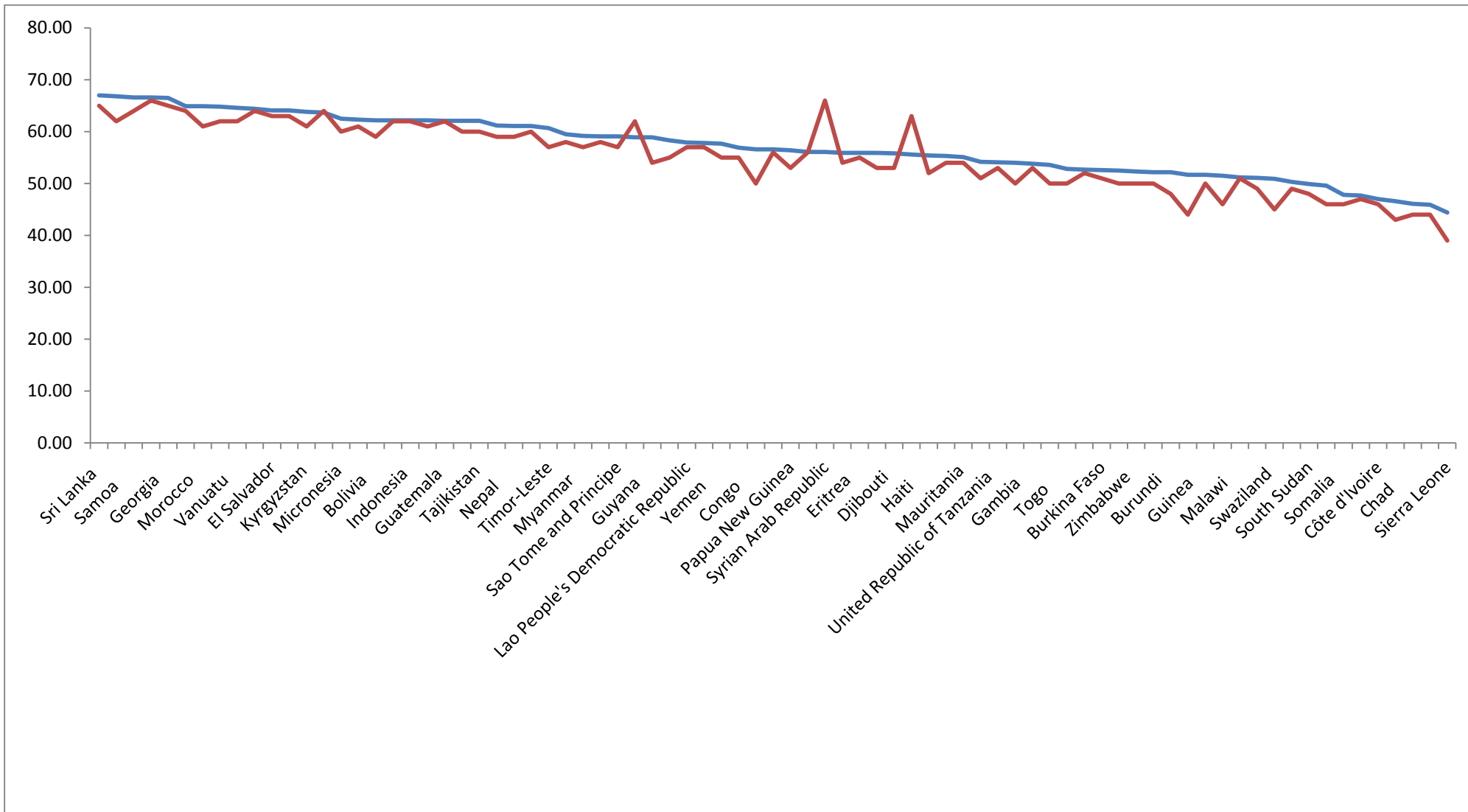


Fig. 2: Trend of healthy life expectancy at birth in two data points for the study countries

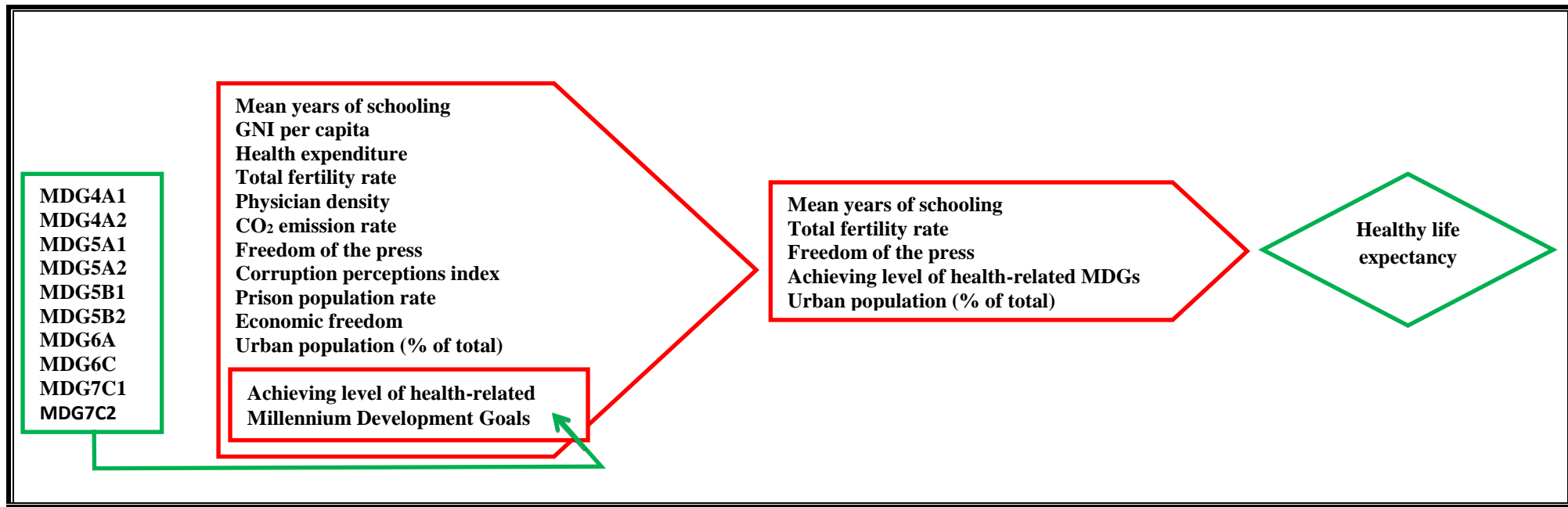


Fig. 3: Correlates of healthy life expectancy at birth

Notes: ‘MDG4A1, Percent reduction in under-five mortality rate, 1990-2013’; ‘MDG4A2, Measles immunization coverage among 1-year-olds (%), 2013’; ‘MDG5A1, Percent reduction in maternal mortality ratio, 1990-2013’; ‘MDG5A2, Births attended by skilled health personnel (%)’; ‘MDG5B1, Antenatal care coverage (%): at least one visit’; ‘MDG5B2, Unmet need for family planning (%)’; ‘MDG6A, Percent reduction in HIV incidence, 2001-2013’; ‘MDG6C, Percent reduction in mortality rate of tuberculosis (among HIV negative people), 1990-2013’; ‘MDG7C1, Percent reduction in proportion of population without access to improved drinking-water sources, 1990-2012’; ‘MDG7C2, Percent reduction in proportion of population without access to improved sanitation, 1990-2012’; ‘GNI, Gross national income’; ‘CO₂, Carbon dioxide’



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