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ORIGINAL ARTICLE

Effect of healthcare spending on the relationship between the Human Development Index and maternal and neonatal mortality

Kaamel M. Nuhu[a,b,*], Justin T. McDaniel[a,b], Genevieve A. Alorbi[a] and Juan I. Ruiz[a]

[a]*International Center for Community Health Promotion and Education, 1606 N. Truman St., Robinson, IL 612454, USA;* [b]*Department of Public Health and Recreation Professions, Southern Illinois University, Carbondale, IL, USA*

*Corresponding author: Tel: +1 618 303 7103; E-mail: nnmkaamel@gmail.com

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Background: Several factors affect morbidity and mortality the world over. Previous research shows mortality rates are higher among individuals of lower socio-economic status. We investigated the trajectory of neonatal (NM) and maternal (MM) mortality between 2010 and 2014 and the effect of healthcare spending on the relationship between the Human Development Index (HDI) and NM and MM.

Methods: Data were obtained from the United Nations Development Program and World Bank. Latent growth curve models (LGCMs) were estimated to determine the trajectory of NM and MM across the study period and the effect of the HDI on NM and MM. Mediation analysis was used to determine if healthcare expenditure mediated the relationship between HDI and NM and MM rates. ArcGIS (Esri, Redlands, CA, USA) was used to generate a choropleth map of changes in NM and MM between 2010 and 2014.

Findings: Results showed many countries in Africa enjoyed decreases in NM and MM between 2010 and 2014, but other countries (Algeria, Libya and Sudan) showed little or no improvement. The LGCM for NM (Comparative Fit Index=0.956) and MM (CFI=0.963) demonstrated good fit to the data and showed that the HDI was negatively related to NM and MM. Mediation analysis showed that healthcare spending mediated the relationship between NM and MM in each year.

Conclusions: Given that healthcare spending can mediate the relationship between HDI and NM and MM, increases in healthcare spending among countries with low HDI could improve NM and MM outcomes.

Keywords: Health care expenditure, Human Development Index, Maternal mortality, Neonatal mortality

Introduction

Several factors contribute to morbidity and mortality statistics the world over.[1,2] While some of these contributory factors may be specific to various diseases and geographic locations, they interact variously in their determination of disease distribution and outcomes. In particular, health inequities, as influenced by the social determinants of health, such as income and educational status, continue to contribute to differential disease outcomes.[3] Previous researchers have shown that mortality rates are higher among individuals of lower socio-economic status compared with individuals of higher socio-economic status.[4,5] Despite temporal variations of standard risk factors between individuals of higher and lower socio-economic groups, which by themselves are influenced by the prevailing differences in socio-economic conditions (such as a relative lack of access to quality healthcare among those in the lower socio-economic brackets), they continue to influence the relatively higher mortality rates among these individuals compared with the more privileged populations within and without a given geographical space.[6]

The Human Development Index (HDI) is a statistical tool used to assess the degree of well-being and quality of life of a population. First published by the United Nations Development Program in 1990, the HDI takes into account three indicators: education, health and income. In this aggregated index, the education component is represented by the adult literacy rate, the health component is represented by life expectancy at birth and the per capita gross domestic product (GDP) represents income.[7] Various countries across the world have been ranked using the HDI, with findings of several previous studies showing that countries with higher HDIs have relatively better disease outcomes and lower overall burden of preventable causes of death, such as some infectious diseases.[8,9]

Health care spending as a percentage of GDP has also been shown to have a positive correlation with health outcomes.[10,11] Specifically, countries that spend a higher percentage of their GDP on healthcare have been shown to have relatively better health outcomes compared with countries spending less on healthcare.

The maternal mortality (MM) rate and neonatal mortality (NM) rate are two especially important healthcare indicators used by institutions such as the World Bank and the WHO in assessing the overall health and quality of life of a nation.[12,13] Both of these indicators (MM and NM) are sensitive to the proximal determinants of health such as access to and quality of healthcare services and delivery, as well as distal factors such as education and income levels (social determinants) of the people concerned.[14] Some researchers have shown that both MM and NM are lower in countries with higher HDIs and are higher among poor, less educated populations.[9,15] The current study sought to evaluate the trajectory of the NM and MM between 2010 and 2014 and the effect of healthcare spending as a mediator variable on the relationship between NM and MM as dependent variables and HDI as an independent variable.

Methods

Data collection

Country-level data for the present study were downloaded for a 5-year period from several sources. First, the yearly estimated HDI was downloaded from the United Nations Development Programme for the period 2010–2014.[16] Second, health expenditure data per capita were downloaded from the World Bank for the period 2010–2014.[17] Third, NM data per 1000 were downloaded from the World Bank for the period 2010–2014.[18] Fourth, data for MM per 100 000 live births were downloaded from the World Bank for the period 2010–2014.[19]

Data analysis

Analysis of data in the present study proceeded in three steps. First, descriptive statistics—means and standard deviations with 95% confidence intervals based on 1000 bootstrapped resamples—were generated for each study variable. Changes in the mean NM and MM rates across the 5 years of the study were represented in maps created in ArcGIS version 10 (Esri, Redlands, CA, USA) (Figures 1 and 2). Second, two maximum likelihood latent growth curve models (LGCMs) were calculated in order to determine the trajectories of NM and MM, across the period 2010–2014 based on one time-varying covariate: the HDI. Variances for the NM and MM observed variables across the 5 study years were set to be equal. Model fit was assessed with the χ^2 statistic and the Comparative Fit Index (CFI). Third, in order to determine if healthcare expenditures per capita mediated the relationship between NM and MM and the HDI for each of the 5 study years, Baron and Kenny's regression approach to mediation analysis was used.[20] Aroian's test statistic was calculated in order to determine if the mediator carried the influence of the independent variable to the dependent variable.[21]

Results

Descriptive results

The descriptive results showed that improvements were made with regard to all four study variables during the study period 2010–2014 (Table 1). Specifically, human development increased globally by 1.91%, health expenditure per capita (HE) increased from US$968.26 (global average) in 2010 to US$1108.42 (global average) in 2014, NM decreased by 10.19% and MM decreased by 10.84%. Some of the greatest improvements, in terms of average change per year, in NM and MM were observed on the continent of Africa and within the Asia–Pacific region (Figures 1 and 2); however, substantial variation in the trajectories of these location-specific

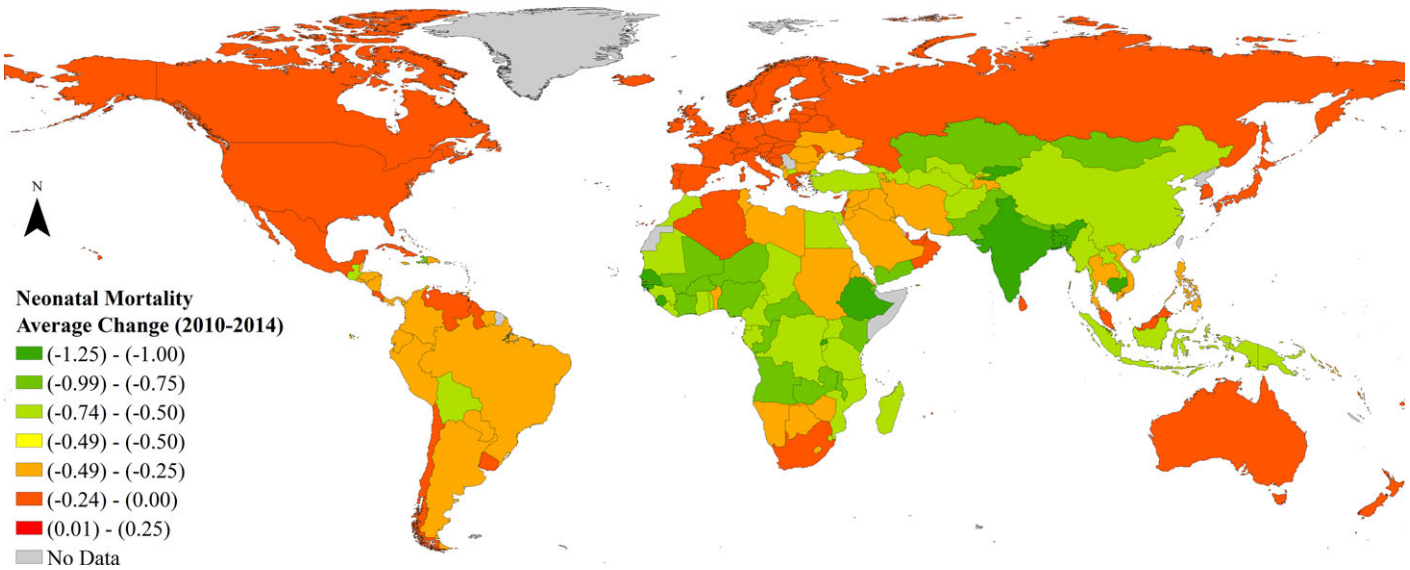

Figure 1. Average change in neonatal mortality between 2010 and 2014.

health outcomes were evident. In particular, while many countries in Africa enjoyed decreases in NM and MM between 2010 and 2014, other countries, such as Algeria, Libya and Sudan, made little to no improvement in these areas.

Two LGCMs were generated, one for NM and one for MM, in order to inferentially determine the trajectory of NM and MM between 2010 and 2014 (Figure 3). Regarding NM, while the χ^2 statistic showed statistical significance, indicating that the

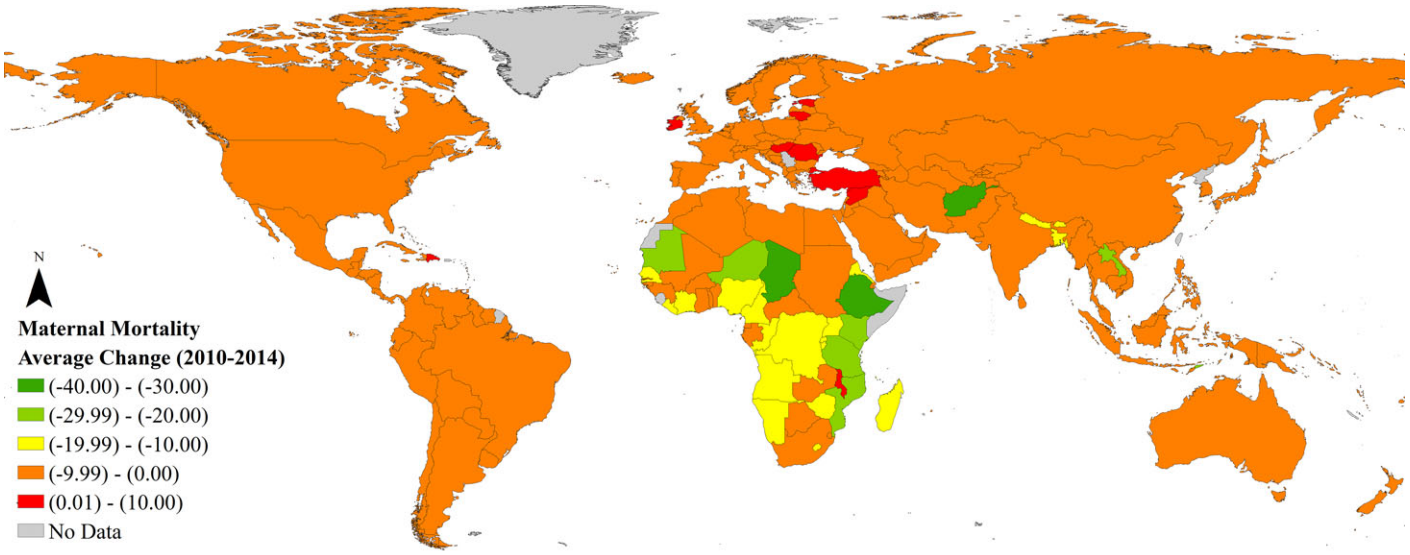

Figure 2. Average change in maternal mortality between 2010 and 2014.

Table 1. Means and standard deviations for all study variables from 2010 to 2014

			95% CI[a]			95% CI[a]	
Variable	NM	MM	Lower	Upper	SD	Lower	Upper
HDI 10	188	0.680	0.658	0.704	0.157	0.144	0.168
HDI 11	188	0.684	0.662	0.708	0.156	0.143	0.167
HDI 12	188	0.688	0.666	0.711	0.156	0.143	0.167
HDI 13	188	0.690	0.669	0.713	0.155	0.142	0.166
HDI 14	188	0.693	0.671	0.715	0.155	0.142	0.165
HE 10	184	968.259	725.840	1221.214	1672.013	1265.541	2011.296
HE 11	184	1057.798	784.767	1338.757	1845.208	1373.240	2225.546
HE 12	184	1053.714	787.925	1327.452	1803.841	1345.101	2185.272
HE 13	184	1099.435	830.981	1382.057	1875.999	1414.519	2276.137
HE 14	184	1108.420	839.045	1393.633	1979.902	1413.176	2278.816
NM 10	185	15.519	13.795	17.292	12.449	11.224	13.429
NM 11	185	15.103	13.395	16.856	12.190	10.983	13.155
NM 12	185	14.702	13.004	16.432	11.948	10.758	12.912
NM 13	185	14.315	12.639	16.017	11.721	10.548	12.684
NM 14	185	13.938	12.292	15.608	11.493	10.337	12.450
MM 10	179	193.168	155.925	232.661	263.864	216.453	314.478
MM 11	179	187.229	151.282	224.905	255.860	209.296	305.564
MM 12	179	181.637	146.755	218.377	248.873	203.724	296.086
MM 13	179	176.782	142.744	212.902	242.566	198.546	287.712
MM 14	179	172.229	138.986	207.770	236.638	193.468	279.785

[a]CIs are based on 1000 bootstrapped resamples.
HE: health expenditure per capita; MM: maternal mortality rate per 100 000 live births; NM: neonatal mortality rate per 1000.

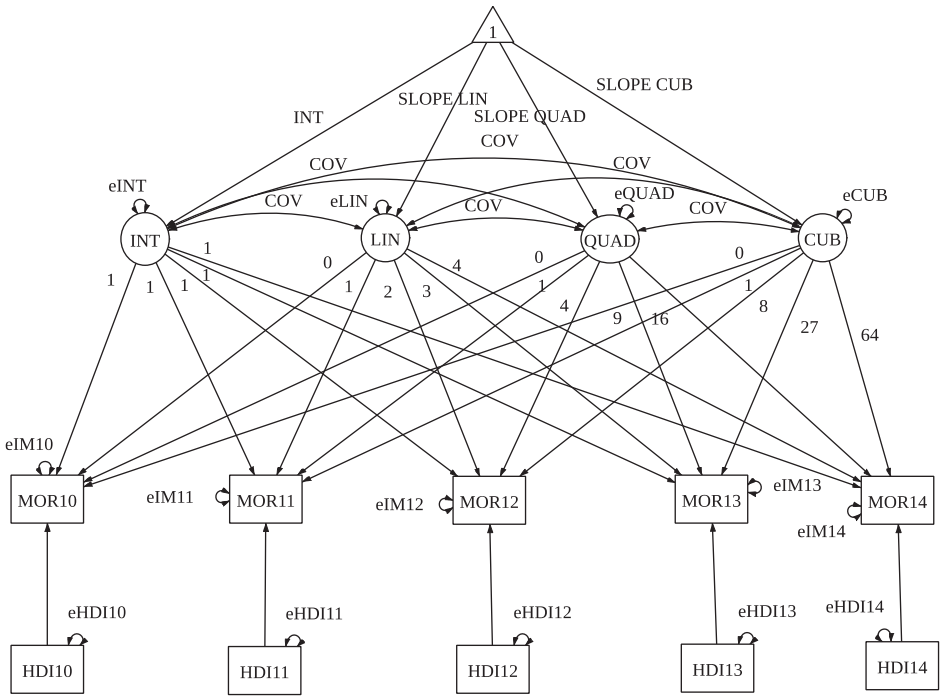

Figure 3. Theoretical model for the latent growth of neonatal and maternal mortality between 2010 and 2014. MOR: either neonatal or maternal mortality.

hypothesized model did not fit the data well with the inclusion of a cubic term, χ^2 (25)=323.017 (p<0.001), the CFI was >0.95 with the cubic term, indicating a good fit to the data (CFI=0.956). Similarly, regarding MM, while the χ^2 statistic showed statistical significance with a cubic term, indicating a lack of good fit, χ^2 (25)=228.346 (p<0.001), the CFI was >0.95 with a cubic term (CFI=0.963).

As shown in Table 2, the latent slopes in both the NM and MM models were negative, indicating that global NM and MM exhibited statistically significant decreases during the study period. While the second- and third-order polynomials in both models did not demonstrate statistical significance, the inclusion of these terms improved the predictive ability of the model. To the extent that the covariance between the latent intercept and the latent slope was negative in both models, countries with higher intercepts (initial incidence rates) exhibited steeper slopes across the study period. So to explain the latent growth factor, a time-varying covariate was added to the model: the HDI. The results showed that in both models the HDI served as a statistically significant predictor of mortality at each year in the study period. Because the sign of the coefficient for the HDI was negative, the following interpretation is tenable: countries with higher human development had lower NM and MM rates between 2010 and 2014.

In order to explore the relationship between human development and mortality (both neonatal and maternal) further, mediation analysis was conducted, where healthcare expenditures per capita served as the mediating variable between the HDI and NM and MM. The first step in Baron and Kenny's[20] regression method for demonstrating mediation involves calculating correlations between each of the variables of interest. Correlations between the HDI, HE and NM and MM between 2010 and 2014 are shown in Table 3. Across all 5 years of the study, the correlations between each variable were statistically significant and carried the same sign. Specifically, (a) higher levels of human development were associated with higher levels of healthcare expenditures, (b)

Table 2. Latent growth curve models for neonatal and maternal mortality, 2010–2014

	Neonatal mortality		Maternal mortality	
Parameter	Estimate	SE	Estimate	SE
HDI 10 -> MOR	−3.995**	0.191	−534.749**	49.866
HDI 11 -> MOR	−2.957**	0.084	−517.457**	48.736
HDI 12 -> MOR	−2.114**	0.033	−502.712**	47.682
HDI 13 -> MOR	−1.447**	0.094	−489.103**	46.861
HDI 14 -> MOR	−0.933**	0.154	−475.186**	46.207
INT ~~ LIN	−1.310**	0.316	−1141.282**	134.835
INT ~~ QUAD	−0.055	0.115	31.868	71.196
INT ~~ CUB	−0.007	0.016	2.291	11.250
LIN ~~ QUAD	−0.030**	0.005	18.177*	7.160
LIN ~~ CUB	0.003**	0.001	−3.889**	1.087
QUAD ~~ CUB	−0.002**	0.000	2.111*	0.700
INT	18.460**	0.015	553.871**	36.784
LIN	−1.192**	0.114	−16.520**	3.080
QUAD	0.077	0.042	1.265	1.593
CUB	−0.002	0.006	−0.144	0.253

*p<0.01; **p<0.001.
CUB: cubic term; INT: intercept; LIN: linear term; MOR: either neonatal or maternal mortality; QUAD: quadratic term.
->=Predicting/explaining; ~~=covariance between two variables.

higher levels of human development were associated with lower levels of NM and MM and (c) higher healthcare expenditures were associated with lower NM and MM.

Baron and Kenny[20] suggested that after correlations have been generated, three regressions should be computed in order to demonstrate mediation: regression of the mediator variable on the independent variable, regression of the dependent variable on the independent variable and regression of the dependent variable on the mediator and the independent variable. Coefficients and standard errors for the aforementioned regressions are shown in Table 4. In each of the study years and in both the NM and MM situations, Aroian's test statistic was statistically significant, indicating mediation.[21] However, given that the direct and indirect effects had opposite signs owing to the product of the three paths in the model and the direct effect dominated each model, only competitive or inconsistent mediation was evident.[22] Hair et al.[23] explained that competitive mediation 'provides support for the hypothesized mediating effect but also suggests that another mediator may be present whose sign equals that of the direct effect'.

Table 3. Correlations between human development, health expenditure and mortality

	2010	2011	2012	2013	2014
HDI -> HE	0.645**	0.643**	0.644**	0.643**	0.646**
HDI -> NM	−0.891**	−0.888**	−0.892**	−0.882**	−0.879**
HE -> NM	−0.510**	−0.502**	−0.469**	−0.500**	−0.499**
HDI -> HE	0.645**	0.643**	0.644**	0.643**	0.646**
HDI -> MM	−0.825**	−0.824**	−0.824**	−0.822**	−0.820**
HE -> MM	−0.359**	−0.355**	−0.359**	−0.359**	−0.360**

**p<0.001.
->=correlation between variables.

Discussion

Disparities in health outcomes have been a focus of many global health intervention programs and strategies the world over.[24–26] While some of these disparities may be tied to the proximal determinants of healthcare, such as access to and quality of healthcare services, there seem to be important links between these disparities and the relatively distal factors such as education and income levels, with populations in the lower socio-economic belts worse affected.[27] In many developing countries, where the burden of MM and NM are disproportionately high,[28,29] proximal factors such as lack of access to healthcare and poor quality of healthcare services,[30] as well as distal factors such as poverty and low literacy rates,[31] are pervasive. Appropriately diagnosing both the remote and immediate factors that accentuate the MM and NM in these countries may allow for both short-term solutions to reduce these rates and long-term solutions to sustain any gains from intervention efforts.

As mentioned earlier in the descriptive results, the MM and NM decreased by 10.48% and 10.19%, respectively, for the period under study, 2010–2014. HDI also increased by 1.91% and HE increased by 14.48% for the same period. A closer look at the results as well as the maps in Figures 1 and 2 for NM and MM, respectively, indicates that the greatest mean reductions in NM and MM for the study period were recorded in countries in sub-Saharan Africa, which had relatively higher initial rates of

Table 4. Unstandardized beta coefficients for mediation analysis

	β (SE)				
	2010	2011	2012	2013	2014
Neonatal					
HDI -> HE	6887.564 (604.490)	7630.096 (674.321)	7462.713 (655.901)	7779.655 (684.556)	7851.296 (686.574)
HE -> NM	0.001 (0.0003)	0.001 (0.0003)	0.001 (0.003)	0.001 (0.0003)	0.001 (0.0003)
HDI′ -> NM	−75.672 (3.404)	−74.569 (3.404)	−74.038 (3.400)	−72.340 (3.395)	−71.124 (3.385)
HDI -> NM	−70.661 (2.663)	−69.413 (2.663)	−68.091 (2.647)	−66.761 (2.639)	−65.479 (2.625)
Aroian test	3.190 (2.160)	3.190 (2.390)	3.190 (2.340)	3.190 (2.440)	3.190 (2.460)
p-value	0.001	0.001	0.001	0.001	0.001
Maternal					
HDI -> HE	6887.564 (604.490)	7630.096 (674.321)	7462.713 (655.901)	7779.655 (684.556)	7851.296 (686.574)
HE -> MM	0.047 (0.008)	0.041 (0.007)	0.041 (0.007)	0.038 (0.007)	0.037 (0.007)
HDI′ -> MM	−1675.109 (83.726)	−1631.040 (81.940)	−1613.956 (81.156)	−1570.197 (80.039)	−1534.823 (79.129)
HDI -> MM	−1371.412 (70.669)	−1337.092 (69.177)	−1307.389 (67.476)	−1274.381 (66.359)	−1244.232 (65.340)
Aroian test	5.210 (62.180)	5.190 (60.330)	5.190 (58.930)	4.880 (60.540)	4.780 (60.740)
p-value	<0.001	<0.001	<0.001	<0.001	<0.001

->=Variable on the left is predicting the variable on the right; HDI′=Effect of HDI on the dependent variable after controlling for the mediating variable; HDI=Unadjusted effect of HDI on the dependent variable.

NM and MM compared with other places such as North America and countries in Western Europe. The study period coincided with the terminal phases of the Millennium Development Goals (MDGs), which had goals dedicated to significantly reducing child and maternal mortality rates, with huge attendant investments to attain the same from member countries of the United Nations as well as international organizations such as the WHO.[32] To this extent, developing countries, particularly in sub-Saharan Africa, that had higher initial burdens of neonatal and maternal deaths, had greater room for improvement and so responded more significantly to intervention measures that improved access to and quality of healthcare delivery, such as better access to skilled delivery services, improved antenatal services, improved childhood immunizations and integrated management of childhood illnesses.[33]

In developed countries, such as the USA, Canada and some countries in Western Europe, where the initial MM and NM are already low, quality of healthcare may not have been a big contributor to neonatal and maternal deaths despite these rates being higher among individuals of lower socio-economic status. These realities point to the importance of the relatively distal factors such as education and income levels that influence health insurance status and, by extension, health-seeking behaviours and access to available quality healthcare among the poor, uneducated residents in these countries. The negative latent slopes observed in Table 2 across both NM and MM for all 5 years under study further support the general downward trend of both indicators across the study span. When HDI was added as a time-varying covariate to both models, it yielded a negative coefficient, which implied that countries with higher human development had lower NM and MM rates between 2010 and 2014. The most likely explanation for this observation is that countries with higher HDIs are better educated, have relatively higher income levels when inequalities are controlled for and have a longer life expectancy. With higher levels of education and better access to healthcare services, use of such services and better health-seeking behaviours are more likely, leading to better overall health outcomes, including maternal and neonatal outcomes.

The correlation analysis for NM and MM as dependent variables, healthcare expenditure as a mediator variable and HDI as an independent variable yielded statistically significant correlations for all relations across all years under study, as presented in Table 3. More specifically, HDI was positively correlated with HE, which means countries with higher HDIs spent a greater percentage of their GDP per capita on healthcare. Both HDI and HE also had negative, statistically significant correlations with NM and MM, which means countries with better-educated populations and higher per capita GDP spent more on healthcare, which yielded the desired dividends of lower MM and NM rates.

The regression models for the mediation analysis yielded statistically significant results for all the years under study and for all the models of interest as presented in Table 4. The results therefore suggest that HE as a mediator variable carries an influence from HDI as an independent variable to NM and MM as dependent variables. Along the trajectory of this finding, it is tenable to say that HE can influence HDI through targeted improvements in overall quality of life and life expectancy, the latter being an integral component of HDI. Ultimately this improvement in HDI as a consequence of increased HE will then reflect lower NM and MM rates, as depicted by the findings of this study. The foregoing discussion notwithstanding, it is important to note that since the direct and indirect effects had opposite signs owing to the product of the three paths in the model, with the direct effect dominating each model, only competitive mediation is suggestive, such that there is likely another mediator variable present whose sign equals that of the direct effect.

This study has important strengths, including the use of geographic information systems to highlight mean changes in NM and MM across the study span for the various geographic regions under study as well as the careful selection of variables based on existing literature and our research questions to try to evaluate the relations among these variables. In spite of finding statistically significant results that suggest HE mediates the relationship between HDI and NM and MM, we consider the likely presence of another unidentified mediator variable as a limiting factor for this study.

Conclusions

Based on the findings of this study, we can conclude that countries that have a higher HDI spend a greater percentage of their GDP per capita on healthcare and countries that have a higher HDI have lower NM and MM rates. In the final analysis, the observation that healthcare expenditure mediates the relationship between HDI and NM and MM suggests that targeted increases in healthcare spending among countries with low HDI could improve NM and MM outcomes.

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References

1 Moriyama IM. Social and economic factors affecting mortality. Am J Public Health 1967;57(11):2044–44.

2 Benjamin B. Social and economic factors affecting mortality Paris: Mouton & Co.; 1965.

3 Berkman LF. Social epidemiology: social determinants of health in the united states: are we losing ground? Ann Rev Public Health 2009;30:27–41.

4 Feinstein JS. The relationship between socioeconomic status and health: a review of the literature. Milbank Q 1993;71(2):279–322.

5 Adler NE, Ostrove JM. Socioeconomic status and health: what we know and what we don't. Ann NY Acad Sci 1999:896(1):3–15.

6 Adler NE, Newman K. Socioeconomic disparities in health: pathways and policies. Health Aff 2002;21(2):60–76.

7 United Nations Development Programme. Human development reports 2013: inequality-adjusted Human Development Index New York, NY: United Nations Development Programme; 2013.

8 López-Herce, J, Del Castillo J, Matamoros M, et al. Factors associated with mortality in pediatric in-hospital cardiac arrest: a prospective multicenter multinational observational study. Intensive Care Med 2013;39(2):309–18.

9 Lee K, Park SC, Khoshnood B, et al. Human development index as a predictor of infant and maternal mortality rates. J Pediatr 1997;131(3):430–433.

10 Nixon J, Ulmann P. The relationship between healthcare expenditure and health outcomes. Euro J Health Econ 2006;7(1):7–18.

11 Crémieux P, Ouellette P, Pilon C. Health care spending as determinants of health outcomes. Health Econ 1999;8(7):627–39.

12 Currey B. Maternal mortality and mothers' deaths as development indicators. BMJ 2000;321(7264):835.

13 Reidpath DD, Allotey P. Infant mortality rate as an indicator of population health. J Epidemiol Community Health 2003;57:344–346.

14 Bhutta ZA, Chopra M, Axelson H, et al. Countdown to 2015 decade report (2000–2010): taking stock of maternal, newborn, and child survival. Lancet 2010;375:2030–44.

15 Ruiz JI, Nuhu K, McDaniel JT, et al. Inequality as a powerful predictor of infant and maternal mortality around the world. PLoS One 2015; 10:e0140796.

16 United Nations Development Programme. Human development reports: Human Development Index [dataset]. http://hdr.undp.org/en/content/human-development-index-hdi [accessed 5 June 2016].

17 World Bank. Health expenditure per capita [dataset]. http://data.worldbank.org/indicator/SH.XPD.PCAP [accessed 5 June 2016].

18 World Bank. Mortality rate, neonatal [dataset]. http://data.worldbank.org/indicator/SH.DYN.NMRT [accessed 5 June 2016].

19 World Bank. Maternal mortality ratio [dataset]. http://data.worldbank.org/indicator/SH.STA.MMRT [accessed 5 June 2016].

20 Baron RM, Kenny DA. The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. J Pers Soc Psychol 1986;51(6):1173–82.

21 Aroian LA. The probability function of the product of two normally distributed variables. Ann Math Statist 1947;18(2):265–71.

22 MacKinnon DP, Krull JL, Lockwood CM. Equivalence of the mediation, confounding and suppression effect. Prev Sci 2000;1(4):173–81.

23 Hair JF, Hult GTM, Rinale CM, et al. A primer on partial least squares structural equation modeling, 2nd ed. Thousand Oaks, CA: Sage; 2016.

24 Sullivan-Bolyai S, Bova C, Harper D. Developing and refining interventions in persons with health disparities: the use of qualitative description. Nurs Outlook 2005;53(2):127–33.

25 Brondolo E, Gallo L, Myers HF. Race, racism and health: disparities, mechanisms, and interventions. J Behav Med 2009;32(1):1–8.

26 Gehlert S, Sohmer D, Sacks T, et al. Targeting health disparities: a model linking upstream determinants to downstream interventions. Health Aff 2008;27(2):339–49.

27 Chu KC, Miller BA, Springfield SA. Measures of racial/ethnic health disparities in cancer mortality rates and the influence of socioeconomic status. J Natl Med Assoc 2007;99(10):1092.

28 World Health Organization. Maternal mortality fact sheet. http://www.who.int/mediacentre/factsheets/fs348/en/ [accessed 7 April 2017].

29 World Health Organization. Children: Reducing mortality fact sheet. http://www.who.int/mediacentre/factsheets/fs178/en/ [accessed 7 April 2017].

30 Peters DH, Garg A, Bloom G, et al. Poverty and access to healthcare in developing countries. Ann NY Acad Sci 2008;1136(1):161–71.

31 United Nations Children's Fund. Monitoring the situation of children and women. https://data.unicef.org/topic/education/literacy/ [accessed 7 April 2017].

32 World Health Organization. Millennium development goals (MDGs). http://www.who.int/topics/millennium_development_goals/en/ [accessed 8 April 2017].

33 Black RE, Laxminarayan R, Temmerman M, et al. Reproductive, maternal, newborn, and child health: disease control priorities Washington, DC: International Bank for Reconstruction and Development; 2016.