Original Article

Measuring Geographic and Wealth Inequalities in Health Distribution as Tools for Identifying Priority Health Inequalities and the Underprivileged Populations

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Abstract

Background: Currently, there is no consensus on standard measure that can be routinely part of the health information systems to alert countries to inequalities in health and identify the priority health inequality conditions.

Objectives: To identify the health inequality measures relevant for assessing geographic and wealth inequalities; use the measures as a demonstration to what can happen in practice to recognize the geographic and wealth-related priority health inequalities within a country; and identify the geographic and wealth underprivileged populations.

Method: Egypt data were used as demonstration. Pearson coefficient of correlation was calculated to compare the various geographic and wealth health inequality measures. T test was used to identify significant correlations. The relevant inequality measures were used to rank geographic and wealth health inequalities and identify the underprivileged populations.

Results: The wealth inequalities in health measured by the concentration index provide a familiar and perform adequately in identifying economic inequalities in health. However, the geographic health inequalities identified by the index of dissimilarity appear to provide a more comprehensive profile of health inequalities within a country.

Conclusion: There is a need for a feasible inequality measure in the health information systems. A country's geographic health distribution measured by the index of dissimilarity appears to provide a feasible first-step alarm to inform and guide the uptake of equity-sensitive policies.

Introduction

Persistent differences in health have long been a serious health policy concern in many countries of the world. Even more, health inequities have been put at the heart of the global political agenda.[1–3] This global vision calls for pushing health inequity to the forefront and recommends the adoption of Health in All Policies as the best strategy to halt the unintended negative impact of public policies on health. Fundamental to achieving the health equity goal is the ability of countries to identify and monitor progress on the health front for all people "leaving no one behind."

However, inequities in health are not measurable but can be judged from the existence of systematic inequalities in health distribution. But still, measuring inequalities in health is complex because it requires a method that encompasses many considerations.[4–6] The chief pillars of this method include identifying the social dimensions that render people underprivileged, quantifying the unanticipated health inequalities across the population subgroups, as well as analyzing and conceptualizing the policy influence for such health differences. These basic requirements are rarely in place notably in low- and middle-income countries where the

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health information systems (HIS) are not designed to generate information on health inequalities or their association to the social root causes of ill health. Furthermore, very few of the health indicators in the Sustainable Development Agenda[7] have defined social dimensions including wealth, education, gender, and rural–urban residence. Even for these indicators, very simplistic gap measures are recommended which hardly portrait the factual signals.[8,9] These limitations coupled by the traditional focus on aggregate averages of health outcomes keep health inequality relatively invisible and public policies unaccountable. Without an explicit picture of the distribution of health across the various population subgroups, it is not surprising that awareness and responsibility of "whole of government" remain constrained and countries remain silent on whether health inequalities increase, decrease, or remain stagnant over time.

It became evident that monitoring average achievement is no longer considered a sufficient indicator of a country's progress on the health front. It is apparent that the extent of inequality in the distribution of health across the population subgroups is a complimentary key imperative piece of information in a country's HIS. This imposes a quest of paramount importance that remains unanswered "How can a country monitor inequalities in health and most importantly, how can the country identify and monitor the priority health inequality conditions"? It is customary known that prevalence and incidence measures act as an alarm to alert countries to the priority health conditions, which are further investigated within a country to identify the causes behind their spread. Nevertheless, priority health conditions are not necessarily those with priority health inequality distributions. Numerous research[4–6,10–13] presented various social dimensions and measures to quantify inequalities in health. However, currently, there is no consensus on a standard measure, more informative than the gap measure, that can be routinely part of the HIS data to alert countries to inequalities in health and identify the priority health inequality conditions.

The overall aim of this article is to contribute to the ongoing discourse on a feasible measure which could be used to alert countries to inequalities in the distribution of health consequent to the negative impact of public policies. Two social dimensions—geographic and wealth distributions—were used to identify the underprivileged geographic and social population subgroups. The choice of these 2 dimensions reside in the fact that they are available is almost all data sets, used in national and international reports to represent social vulnerabilities and are good candidates for proposing public policy reframing. The objectives of the study were to identify the health inequality measures relevant for assessing geographic and wealth inequalities; use the measures as a demonstration to what can happen in practice to recognize the geographic and wealth-related priority health inequalities within a country; and identify the geographic and wealth underprivileged populations.

The article uses Egypt as a demonstration to what can be done in practice. Relatively, recent data indicate that in Egypt health inequalities are clear and appreciated.[14–17] Egypt has many positive achievements on the physical health front, but the challenge of inequalities remains invisible in many social dimensions.[15,18] While Egypt strategy, reflected in the Ministry of Planning Strategy 2030 and the Ministry of Heath White Paper, did refer to inequities in health, yet Egypt HIS is not adequately positioned to guide its policies and strategies.[18]

The exercise and the lessons inferred from this illustrative application on Egypt are quite relevant to propose a practical standard measure that help countries report more systematically on the unequal distribution in health and identify the priority health inequality conditions. This method if standardized can help in monitoring progress overtime and allow for comparison between countries. Most importantly, following a standard monitoring method can unmask the negative impact of public policies as well as monitor the change in public policies and their impact on the health front.

Method

In this exercise, geographic and wealth-related health inequalities in Egypt were measured as an illustrative practical example. The study was conducted in 3 steps: first, a search for the recent reliable data sources with health indicators and social dimensions; second, analysis of geographic and wealth inequalities in health distribution using the frequently used measures; and third, a correlation analysis between the results to identify the relevant inequality measures which were further used to identify the geographic and wealth priority health inequality conditions and the underprivileged population subgroups.

Data Sources

The analysis made use of the data reported from Egypt Demographic and Health Survey in 2014 (EDHS 2014)[19] and Egypt Health Issues Survey in 2015 (EHIS 2015).[20] EDHS is conducted on behalf of the Ministry of Health by El-Zanaty and Associates. They are part of the Demographic and Health Surveys (DHS) Program funded by the United States Agency for International Development. Egypt DHS Series of Surveys started in Egypt since 1988 and the latest was in 2015. EDHS series are the only country population-based data

sources for a wide range of monitoring and impact evaluation indicators in the areas of population and health. Furthermore, they provide individual- and household-level information which also reflects the health-care services and geographic locality characteristics.

A total of 36 health-related indicators were selected from EDHS 2014 and EHIS 2015. The conceptual frameworks of the Commission on the Social Determinants of Health[21] and the World Health Organization Operational Health Systems Monitoring Framework[22] served as the departure point to classify the health-related indicators into 10 health impact indicators and 26 intermediate determinants indicators (14 risk factors and 12 health system determinants).

The 6 administrative regions in Egypt (Urban governorates, Urban Lower Egypt, Rural Lower Egypt, Urban Upper Egypt, Rural Upper Egypt, and Frontier governorate) were used, as they capture the conditions in the geographic locality in which people live with its urban and rural divisions. The wealth index classified into 5 quintiles was used as it reflects the household living conditions as well as socioeconomic status of individuals.

Health Inequality Measures

A literature review was conducted to understand the health inequality measures and their use.[4-6,8,9,10-13,23,24] Eleven health inequality measures commonly used in literature were identified, they include the following:

- Inequality measures relevant to ordered and nonordered social dimensions
  - Weighted absolute mean difference (wMD), weighted standard deviation (wSD), and coefficient of variation (CV):

$$wMD = \sum_{j=1}^{J} \frac{n_j}{n} |y_j - \mu|$$

$$wSD = \sqrt{\sum_{j=1}^{J} \frac{n_j}{n} (y_j - \mu)^2}$$

$$CV = \frac{\sqrt{\sum_{j=1}^{j} \frac{n_i}{n} (y_j - \mu)^2}}{\mu}$$

where
n_j = population size of social groups
n = population size
y_j = the rate in group j
μ = the population average rate

- Population attributable fraction (PAF):

$$PAF = \frac{\sum_{i=1}^{i} P_i \left(\frac{R_1}{R_i} - 1 \right)}{1 + \sum_{i=1}^{i} P_i \left(\frac{R_1}{R_i} - 1 \right)}$$

where
P_i = proportion of population at exposure level i
R_i = relative risk at exposure level i

- Index of dissimilarity expressed in percent (ID%):

$$ID \% = 100 \times \left(\frac{1/2 \sum |S_0 - S_p|}{\sum S_0} \right)$$

where
S_0 = observed share
S_p = population share

- Theil index of inequality (Theil T)

$$Theil\ T = \sum_{i=1}^{N} p_i r_i \ln(r_i)$$

where
p_i = proportion of the population in subgroup i
r_i = ratio of the health indicator prevalence in the subgroup i to the overall health indicator prevalence in the population

- Inequality measure relevant to ordered health dimensions
  - Gini coefficient (Gini)

$$Gini = \sum \frac{1}{2} \{ L_i + (L_i - 1) \} \times \{ P_i - (P_i - 1) \}$$

where
L_i = corresponding cumulative health risk for the ith population group
P_i = cumulative percent of the population

- Inequality measures relevant to ordered social dimensions
  - Slope index of inequality (SII) and relative index of inequality (RII) based on linear regression $y = \beta_0 + \beta_1 x_1 + e$:

$$SII = -\beta_1$$

$$RII = (-\beta_1)/\breve{y}$$

where
y = outcome

β_0 = intercept of the regression line and the Y-axis
x_1 = independent variable
e = error
β_1 = slope of regression line
$\check{Y}$ = average outcome

- ○ Concentration index (CI) and concentration index percent redistribution need (rCI%)[24]

$$CI = (P1\ L2 - P2\ L1) + (P2\ L3 - P3\ L2)$$
$$+ \cdots + (P_i - 1\ L_i - P_i\ L_i - 1)$$

$$rCI\% = CI \times 75$$

Data Analysis

The analysis aimed at identifying the inequalities in the 36 health-related indicators presented as proportions in EDHS 2014[19] and EHIS 2015.[20] The tabulated data in the reports of the 2 surveys were used to identify the inequality measure most relevant to reflect geographic and wealth-related inequalities. Pearson coefficient of correlation (r_p) was calculated to compare the correlation between the various geographic and wealth-related health inequality measures. T test was used to identify significant correlations between the various measures in each situation. SPSS version 24 was used to conduct the analysis.

The relevant inequality measures were further used to identify and rank the geographic and wealth-related health inequalities and the underprivileged geographic and social population subgroups.

Results

Health Inequality Measures

The 7 inequality measures relevant to unordered data were calculated for the 36 health-related conditions to identify geographic health inequalities (Table 1). The wMD and wSD were highly significantly correlated to each other but were not significantly correlated to any of the other measures. The Gini and PAF had high positive correlation with CV, Theil, and ID% ($r_p = .708$–$.805$). The CV and ID% showed perfect positive significant correlation ($r_p = .994$), and both had strong positive significant correlation with the Theil T ($r_p = .928$–$.938$).

The Theil T responds to the skewness toward large values by using the "ln" of the ratio to smoothen the differences in data. However, the Theil T was not suitable for very low prevalence/incidence health-related conditions where a risk of zero value for a category was encountered, as it did not provide a value.

Table 1. Correlation Between the Geographic Health Inequality Measures for 36 Health Indicators in Egypt.

	Pearson Coefficient of Correlation						
	wMD	wSD	CV	PAF	ID%	Theil T	Gini
wMD	1						
wSD	.994**	1					
CV	0.155	0.122	1				
PAF	0.002	−0.01	.794**	1			
ID%	0.166	0.125	.994**	.775**	1		
Theil T	0.065	0.033	.938**	.708**	.928**	1	
Gini	0.183	0.151	.796**	.754**	.805**	.804**	1

Abbreviations: CV, coefficient of variation; Gini, Gini coefficient; ID%, index of dissimilarity expressed in percent; PAF, population attributable fraction; Theil T, Theil index of inequality; wMD, weighted absolute mean difference; wSD, weighted standard deviation.
*$P < .05$; **$P < .01$.

The Gini depends only on the ranking of the health-related condition and does not consider the social stratification distribution. The PAF depends on the relative risk for each category as compared to the best-of. Thus, as the Theil is not suitable for low prevalence/incidence health-related conditions. The CV is weighed by the average health condition but depends on the standard deviation rather than the population distribution. The ID% respects the population distribution and is weighed by the total observed health condition. The advantage of ID% over the other measures is that its value expressed in percentage provides a measure of the magnitude of inequalities expressed as the amount of redistribution required to make estimated geographic inequality equal to zero.

The 11 inequality measures suitable for wealth as a gradient stratifier were calculated for the 36 health-related indicators. The r_p was calculated to detect the correlation between the results of the inequality measures (Table 2). The wMD and wSD still either did not present significant correlation or had weak correlation with the other measures. The CV, ID%, and Theil T still showed very high positive significant correlation ($r_p = .935$, $.942$, and $.987$). The PAF was very highly correlated to CV and ID% ($r_p = .935$ and $.942$, respectively). Furthermore, the CI and the RII were perfectly correlated ($r_p = .999$). Both the CI and RII were moderately but inversely correlated to CV, PAF, ID%, and Theil T ($r_p = -.698$ to $-.771$) as well as weakly and inversely correlated to the Gini ($r_p = -0.386$ to $-.372$). The rCI% showed highest significant correlation with the ID% ($r_p = .939$) and the CV ($r_p = .914$).

As the ID%, the CI respects the population distribution and its value represents the deviation from inequality. The advantage of the CI over the other measures is

Table 2. Correlation Between the Wealth Inequality Measures for 36 Health Indicators in Egypt.

	Pearson Coefficient of Correlation										
	wMD	wSD	CV	PAF	ID%	Theil T	Gini	SII	RII	CI	rCI%
wMD	1										
wSD	0.993**	1									
CV	0.242	0.221	1								
PAF	0.334*	0.313	0.935**	1							
ID%	0.295	0.262	0.987**	0.942**	1						
Theil T	0.187	0.158	0.942**	0.870**	0.935**	1					
Gini	0.167	0.128	0.444**	0.424**	0.465**	0.436**	1				
SII	−0.400*	−0.381*	−0.236	−0.305	−0.278	−0.220	−0.111	1			
RII	−0.266	−0.227	−0.755**	−0.725**	−0.772**	−0.774**	−0.363*	0.629**	1		
CI	−0.282	−0.24	−0.745**	−0.718**	−0.768**	−0.764**	−0.364*	0.638**	0.999**	1	
rCI%	0.349*	0.31	0.914**	0.891**	0.939**	0.877**	0.362*	−0.342*	−0.798**	−0.798**	1

Abbreviations: CI, concentration index; CV, coefficient of variation; Gini, Gini coefficient; ID%, index of dissimilarity expressed in percent; PAF, population attributable fraction; rCI%, concentration index percent redistribution need; RII, relative index of inequality; SII, slope index of inequality; Theil T, Theil index of inequality; wMD, weighted absolute mean difference; wSD, weighted standard deviation.
*$P < .05$; **$P < .01$.

that it offers a direction for the inequality and helps in identifying the disadvantaged social groups. It also offers graphical presentation through concentration curve and a redistribution measure (rCI%) highly correlated to the ID%. Moreover, if raw data are available, the CI can be decomposed to show the magnitude of the contribution of the various root causes of ill health through multiple regression analysis (decomposition of CI) using more than 1 social dimension.

Illustration of Geographic-Related Health Inequalities Using Egypt Data

The ID% was identified as the most relevant measure for geographic inequalities and was used as an illustration to identify priority geographic health inequalities. Furthermore, it may also alert Egypt to some geographic health inequalities within its territories.

According to the ID%, the highest health impact inequality conditions were hepatitis B viral (HBV) infection, hepatitis C viral (HCV) infection, child ever injured or involved in accident, and early neonatal mortality (Table 3). Despite that these 4 health impact conditions showed relatively low prevalence, they require over 10% geographic redistribution. It was also evident that the underprivileged geographic locations vary according to the health condition. HBV infection was clustered in the Urban governorates and Urban Upper Egypt. HCV infection and child ever injured or involved in accident were clustered in Rural Lower Egypt. Moreover, Lower Egypt (urban and rural areas) carried the burden of early neonatal mortality. The other health impact conditions, except self-reported symptoms of sexually transmitted

infections (STIs), showed moderate geographic redistribution needs ranging from 5% to 10%. Despite that the self-reported symptoms of STIs had the highest prevalence, yet they had the least inequalities with 2.6% redistribution needs.

As shown in Table 3, the highest risk factors inequality conditions with over 10% geographic redistribution needs were adolescent child bearing, consanguineous marriages, and child wasting. Adolescent child bearing was concentrated in rural areas whether in Lower Egypt or in Upper Egypt. Consanguineous marriages were intense in Rural Upper Egypt and the Frontier governorate. Child wasting was more prevalent in Upper Egypt (urban and rural areas) and the Frontier governorate. Furthermore, child stunting showed high moderate inequality in distribution (ID% = 9.2%) and was more intense in Upper Egypt with its urban and rural divisions. The other risk factors had low inequality redistribution needs with ID% less than 5%.

Six health system determinants showed high geographic inequality needs (Table 3). Lack of skilled birth attendance was on the top of the list with 30.6% redistribution needs. Lack of birth registration, lack of heel sample examination at birth, lack of antenatal care coverage, family planning unmet need, and no full immunization coverage came next with redistribution needs ranging from 12.4% to 21.9%. Rural Upper Egypt carried the burden of the unequal distribution of these health system determinants. The Frontier governorate, also, carried the burden of the lack of skilled birth attendance, lack of heel sample examination at birth, and lack of antenatal care coverage. The Urban governorates suffered from lack of heel sample

Table 3. Geographic-Related Health Inequalities in Egypt.

	Urban Governorate	Urban Lower Egypt	Rural Lower Egypt	Urban Upper Egypt	Rural Upper Egypt	Frontier Governorate	National Average	ID%
Impact								
Hepatitis B infection among men and women (%)	1.7	0.8	0.7	1.6	1.0	0.6	1.0	14.7
Hepatitis C infection among men and women (%)	4.7	6.2	8.4	3.6	5.5	2.2	6.3	12.3
Child ever injured or involved in accident (%)	3.8	4.3	5.6	2.5	3.5	2.3	4.3	11.8
Early neonatal mortality per 1000	3.7	4.9	8.4	10.9	10.7	6.5	8.6	10.5
Anemia among women in reproductive age (%)	21.2	23.9	21.6	28.9	31.4	20.2	25.2	8.2
Child diarrhea (%)	11.1	12.7	12.8	12.7	17.7	10.1	14.0	7.8
Anemia in male and female youth (%)	19.8	14.0	17.3	18.4	23.0	27.1	19.1	6.7
Anemia in children (%)	21.4	25.1	28.1	22.0	30.2	44.5	27.2	5.1
Acute respiratory infections in children (%)	11.2	14.1	14.1	10.3	15.0	5.1	13.6	5.0
Women self-reported sexually transmitted infections (%)	27.1	30.2	32.0	33.3	34.7	27.6	32.0	2.6
Risk factors								
Adolescent child bearing (%)	3.6	6.5	14.3	5.1	14.2	11.0	10.9	19.5
Consanguineous marriage (%)	20.7	19.2	27.7	30.0	47.9	37.2	31.5	13.8
Child wasting (%)	4.3	4.3	4.2	8.1	6.9	6.7	5.5	13.2
Child stunting (%)	19.0	19.3	17.6	29.8	24.8	15.1	21.4	9.2
Low birthweight (%)	14.5	11.7	15.0	17.3	17.7	19.1	15.5	4.8
Female genital cutting (%)	74.5	71.9	91.2	85.9	94.7	74.7	87.2	4.0
Overweight and obesity among men and women (%)	70.9	72.6	72.9	70.0	59.7	60.4	68.9	3.4
Hypertension among men and women (%)	17.6	19.8	16.7	18.2	15.3	13.2	17.0	3.3
Current smoking among men and women (%)	23.9	20.5	19.9	23.1	19.8	20.9	20.9	3.2
Violence against women (%)	29.0	30.1	28.8	29.5	33.8	25.5	30.3	3.0
No breast feeding within 1 day of birth (%)	21.3	21.4	22.1	17.5	22.3	13.1	21.4	2.5
Women's not own health care decision (%)	89.3	88.2	82.0	87.5	76.6	79.3	82.7	2.3
No AIDS knowledge among men and women (%)	89.6	90.7	93.9	88.1	93.8	93.4	92.3	1.1
Child violent discipline (%)	93.0	93.1	93.5	90.9	93.1	93.8	93.0	0.3
Health system determinants								
Lack of skilled birth attendance (%)	2.6	1.9	5.6	5.6	16.9	10.8	8.5	30.6
No birth registration (%)	0.3	0.5	0.5	0.3	1.1	0.5	0.6	21.9
Heel sample not taken at birth (%)	8.5	4.8	3.3	4.0	7.3	7.3	5.3	18.0
No antenatal care coverage (%)	9.1	9.9	13.7	17.1	27.2	21.3	17.2	17.0
Family planning unmet need (%)	17.7	17.0	15.7	21.2	29.7	19.1	20.0	12.4
Child not fully immunized (%)	8.7	13.6	9.0	8.9	15.1	9.6	11.3	12.4
Birth not protected against tetanus (%)	36.2	33.2	22.9	27.1	22.0	35.4	25.6	8.2
Cesarean section deliveries (%)	49.8	58.8	45.0	46.1	32.8	42.4	43.8	6.8
Women encountering problem accessing health care (%)	56.9	59.3	65.3	72.7	79.0	78.3	68.1	5.1
Child diarrhea with no oral rehydration therapy (%)	77.3	62.9	66.8	75.7	72.0	77.5	70.2	2.6
No health insurance coverage among women (%)	88.5	86.0	93.3	88.2	95.6	85.9	91.9	1.7
Women never had clinical breast examination	95.5	96.7	98.4	97.1	99.6	96.0	97.9	0.6

Abbreviation: ID%, index of dissimilarity expressed in percent.

examination at birth. Family planning unmet need was more concentrated in Urban Upper Egypt, while lack of full immunization coverage was concentrated in Urban Lower Egypt.

Lack of tetanus protection at birth in addition to cesarean section deliveries and women reporting at least 1 problem accessing health care showed moderate inequalities with redistribution needs ranging from 5% to 10%. Lack of tetanus protection at birth was more intense in Urban governorates, Urban Lower Egypt, and Frontier governorate. Cesarean section deliveries were more concentrated in Urban governorates, Lower Egypt (urban and rural areas), and Urban Upper Egypt. However, women reporting at least 1 problem accessing health care were more pronounced in Upper Egypt and the Frontier governorate.

Illustration of Wealth-Related Health Inequalities Using Egypt Data

The CI and the rCI% were identified as the relevant measures to unmask wealth-related inequalities. The benefit of the rCI% was to identify the priority health inequalities, while the benefit of CI was to point to the underprivileged population subgroups. This illustration provides a practical exercise that can be carried by a country. Still, Egypt may benefit from this exercise to identify some priority wealth-related inequalities as well as the unprivileged social subgroups.

According to the rCI% (Table 4), the highest health impact inequality condition was early neonatal mortality (rCI% = 11.1%) and was more concentrated among the poor. The HBV infection came next with a redistribution need of 9.7% but was more concentrated among the rich. The other health impact conditions showed moderate to low inequality distribution between the wealth quintiles and are more intense among the poor.

The highest risk factors inequality conditions (Table 4) with over 10% wealth redistribution needs were women's having no control on their health-care decision (rCI% = 17.0%) and consanguineous marriages (rCI% = 11.5%), both were more concentrated among the poor. The other risk factors showed moderate to low inequality distribution, 4 of them (lack of breastfeeding within the first day of birth, overweight/obesity, child wasting, and hypertension) were more concentrated among the rich.

Three health system determinants show high wealth inequality redistribution needs (Table 4). Lack of skilled birth attendance (rCI% = 29.7%), lack of birth registration (rCI% = 21.2%), and lack of antenatal care (rCI% = 17.7%) were on the top of the list and concentrated among the poor. The other health system determinates had moderate to low wealth inequality. It is worth mentioning that cesarian section deliveries and

lack of tetanus protection at birth were more concentrated among the rich with redistribution needs of 8.3% and 5.7%, respectively.

Discussion

Health equity is a challenge faced by almost all countries.[1–3,25] The move toward identifying a feasible measure that can alert countries to the priority health inequality conditions and allow for more informed evidence-based policies is a pressing feature of the HIS. All previous efforts call for major reform in HIS and additional burden of data collection. They end by being narrowed down to gap measures for several faces of social dimensions which do not allow for a prioritization exercise. This article did not intend to call for more data collection but for the addition of a feasible measure in the HIS, which can alert countries to the unequal distribution in health and allows for monitoring progress overtime. The administrative geographic classification and wealth are good candidates for reflecting the health inequalities. The reasoning for this builds on the availability of data on these 2 dimensions in almost, if not all countries. Furthermore, they provide an easy way in interpreting inequalities, which is appealing for policy makers.

A country's administrative geographic classification reflects the experience of the entire population within a geographic area and captures the potential vulnerabilities to health and social services coverage within a locality. Most importantly, the geographic administrative classification in almost all countries, if not all, is used for planning services and allows policy makers to identify the underprivileged geographic locations. Furthermore, the geographic administrative classification attracts attention to the health inequalities within the country as well as produces a standard method for monitoring progress overtime and even comparison between countries.

The wealth index classified into 5 quintiles reflects the household living conditions as well as the socioeconomic status of individuals. Wealth quintiles allow for identifying within country social inequality in health as well as help in detecting the socially disfavored groups. Furthermore, the wealth classification allows policy makers to promote the package of social policies in a country.

It is evident from our results that the ID% presents the most adequate solution to the problem of measuring geographic health inequalities. Although it is significantly related to CV, PAF, Theil T, and rCI%, the ID% is not a customary health inequality measure in literature and only few illustrates its use.[8] The reasoning behind the appropriateness of ID% lies mostly with the easiness in carrying out all possible comparisons between

Table 4. Wealth-Related Health Inequalities in Egypt.

	Poorest	Poorer	Middle	Richer	Richest	CI	rCI%
Impact							
Early neonatal mortality per 1000	12.3	8.7	10.2	6.4	5.0	−0.148	11.1
Hepatitis B infection among men and women (%)	0.6	0.9	1.0	1.3	1.2	0.129	9.7
Hepatitis C infection among men and women (%)	7.9	7.2	6.0	6.0	4.4	−0.103	7.7
Anemia in children (%)	34	32.9	23.8	25.3	21.3	−0.091	6.8
Child ever injured or involved in accident (%)	5.2	4.8	4.1	4.2	3.0	−0.085	6.4
Child diarrhea (%)	17.1	15.6	13.3	13.8	10.3	−0.080	6.0
Acute respiratory infection in children (%)	15.7	14.6	13.8	14.4	8.9	−0.071	5.4
Anemia in male and female youth (%)	22.8	18.7	17.5	16.1	19.1	−0.046	3.4
Anemia in women in reproductive age (%)	29.6	26.3	23.4	21.8	26	−0.036	2.7
Women self-reported sexually transmitted infections (%)	32.6	32.9	33.1	32.8	28.4	−0.021	1.6
Risk factors							
Not women's own health care decision (%)	28.1	22.7	16.5	12.6	7.9	−0.226	17.0
Consanguineous marriage (%)	44.6	37.5	31.7	26.0	19.3	−0.153	11.5
No breast feeding with 1 day of birth (%)	4.1	3.7	3.6	4.6	5.7	0.073	5.5
Low birthweight (%)	18.7	17.3	15.9	14.2	12.8	−0.072	5.4
Violence against women (%)	36.7	32.0	29.6	30.0	24.1	−0.068	5.1
Female genital cutting (%)	94.4	92.6	92.2	87.2	94.4	−0.050	3.8
Adolescent child bearing (%)	9.2	10.8	19.0	13.1	4.0	−0.047	3.5
Overweight and obesity among men and women (%)	62.1	66.6	71.4	70.9	73.4	0.031	2.3
Child wasting (%)	7.4	8.1	8.8	9.3	8.2	0.028	2.1
Hypertension among men and women (%)	14.9	18.9	15.5	17.0	18.6	0.027	2.1
Child stunting (%)	24.1	23.1	18.1	20	23.4	−0.019	1.4
No AIDS knowledge among men and women (%)	95.8	95.2	91.7	91.4	87.7	−0.017	1.3
Currently smoking among men and women (%)	20.2	21.2	19.2	22.5	21.0	0.011	0.8
Child violent discipline (%)	92.6	93.8	93.6	93.6	91.0	−0.002	0.2
Health system							
Lack of skilled birth attendance (%)	17.6	14.1	6.5	3.5	1.0	−0.396	29.7
No birth registration (%)	1.5	0.5	0.4	0.6	0.2	−0.283	21.2
No antenatal care coverage (%)	28	23.3	16.5	11.9	6.9	−0.236	17.7
Cesarean section deliveries (%)	30.3	39.2	44.2	48.8	56.7	0.110	8.3
Child not fully immunized (%)	17.6	9.9	10.9	9.7	9.1	−0.107	8.0
Heel sample not taken at birth (%)	8.8	4.3	4.3	4.4	5.5	−0.086	6.4
Birth not protected against tetanus (%)	26.0	20.9	22.0	24.5	37.3	0.076	5.7
Family planning unmet need (%)	23.9	23.2	17.7	18.1	18.1	−0.064	4.8
Women encountering problem accessing health care (%)	75.1	72.2	68.6	67.1	58.2	−0.044	3.3
No health insurance coverage among women (%)	97.3	96.7	93.0	90.2	82.5	−0.031	2.3
Child diarrhea with no oral rehydration therapy (%)	70.6	67.3	69.1	71.4	75.2	0.011	0.8
Women never had clinical breast examination (%)	99.4	99.0	98.6	97.7	95.2	−0.008	0.6

Abbreviations: CI, concentration index; rCI%, concentration index percent redistribution need.

the geographic localities using disaggregated data, providing an easy way in interpreting inequalities and the redistribution needs that can be linked to public policies in a country and the health and nonhealth services offered in a geographic area. Most importantly, the ID% is self-weighted as its calculation is based on the population distribution and is weighed by the total observed health-related condition. The same applies for the CI, which is a very familiar tool in the study of socioeconomic health inequalities,[4–6,8–11] and performs adequately, as verified by the analysis in this study. It provides a redistribution measure[24] (rCI%)

and has an interpretation which is easily captured by policy makers.

The illustration exercise on Egypt mainly aimed at demonstrating how such measures can be used in practice to alert countries to the priority health inequalities and identify the unprivileged populations. Furthermore, the exercise compares between the geographic and wealth-related inequalities and the benefit of such population subgroupings. It is true that the exercise does not provide an exhaustive list of health-related conditions, such exercise can serve in alerting Egypt to several existing health inequalities and unprivileged subgroups within the country. The ID% has allowed to identify the priority geographic inequalities in health status and intermediate determinants with over 10% redistribution needs. The highest geographic health impact inequality conditions are apparently chronic communicable diseases (HBV and HCV infections), child injury, and reproductive health problems reflected in early neonatal mortality. The highest risk factors geographic inequality conditions were mainly reproductive health problems (adolescent child bearing and consanguineous marriages) and child growth and development reflected in child wasting and stunting. In addition, our results confirm previously cited health-care coverage pitfalls.[14–17] The inequalities in reproductive health care and child immunizations reflect a serious planning problem in the country. It is also evident that all localities suffer, with clustering of different health-related problems. HBV infection and cesarean section deliveries are clustered in Urban governorates and Urban Upper Egypt. Rural Lower Egypt carries the burden of HCV infection and child injury. Furthermore, reproductive and child health-related conditions are more intense in Rural Upper Egypt and the Frontier governorate.

It is evident that the geographic inequalities provide a longer list of priority health inequality conditions as compared to the wealth-related health inequalities. As only early neonatal mortality and HBV infections were identified as priority health impact conditions, women having no control on their health-care decision ($rCI\% = 17.0\%$) and consanguineous marriages were identified as priority risk factor inequality condition; moreover, lack of skilled birth attendance ($rCI\% = 29.7\%$), lack of birth registration ($rCI\% = 21.2\%$), and lack of antenatal care were identified as priority health system determinants. This is because the geographic inequalities in health reflect the locality characteristics that impact health which go beyond the household or individual economic factor.

However, the geographic inequalities in health do not point to the socially disfavored populations and their needs as can be captured in the wealth inequalities in health distribution. As shown in our results, the women empowerment indicator measured as women having no control on their health-care decision was on the top of the risk factors list with a redistribution need of 17% across the social gradient from the rich to the poor but was not identified as a geographic inequality. Furthermore, the direction of the CI has highlighted the fact that some health-related inequality conditions may be more concentrated among the rich as HBV infection, lack of breast feeding with first day of birth, cesarian section deliveries, and birth not protected against tetanus. The health conditions prevailing among the rich should not be ignored, as they may unfold root public policies and culture norms which start in the rich and creep unperceived to the whole population.

Nevertheless, the difference in geographic and wealth priority health-related inequality conditions favor the use of the geographic dimension in acting as a first-step alarm to the prevailing health inequality conditions, as it provides a more comprehensive profile which reflects the locality specific characteristics. As the localities are not homogenous in their composition and their social and health needs, there is no point in focusing solely on the economic dimension as the public policies may have different manifestations. Wealth and other social dimensions can act as second step response to identify the root causes of ill health specific to the locality's sensitivity to the pitfalls in public policies.

In nutshell, the need for a feasible measure of inequalities in health distribution is no more an optional decision. The HIS must be able to alert countries to the negative impact of public policies on health and monitor progress in improving health and well-being for all. The illustrative exercise on Egypt provides evidence that the geographic inequalities in health are self-lending in this respect. A country's administrative geographic classification applies to all countries and is more comprehensive in drawing the health inequality profile. The ID% is relevant to measuring health inequalities across a country's administrative geographic classification. This inequality measure is easy to interpret and allows countries to identify the underprivileged localities, which can be further thoroughly investigated for the potential specific root causes to guide the uptake of equity-sensitive policies. The success of using this track resides in the ability of countries to adapt it to the national context as well as their willingness to invest in the national capacities to carry the same illustration exercise.

Declaration of Conflicting Interests

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