Analyzing socioeconomic related health inequality in mothers and children using the concentration index

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ABSTRACT

BACKGROUND: We measured socioeconomic status using an asset index and defined 16 health related outcomes. The inequality in the distribution of these health outcomes by socioeconomic status was examined using concentration index.

METHODS: This cross-sectional study was conducted in 2012 in Hamadan City, the west of Iran, on 1400 households enrolled through a stratified cluster random sampling method. The effect of inequity on health outcomes was investigated via a three-stage procedure including: (a) definition of health outcomes; (b) measuring socioeconomic status using an asset index; and (c) measuring inequality of health outcome using concentration index.

RESULTS: There was inequality for all outcomes of interest. The prevalence of low birth weight, underweight, stunting, wasting, minor injuries, moderate injuries, consanguineous marriage, children with disability, short birth spacing, and adolescent pregnancy was disproportionately more common among the poor. On the other hand, the prevalence of preterm birth, nonexclusive breastfeeding, severe injuries, incomplete health care, cesarean section, and advanced maternal age was disproportionately more common among the rich.

CONCLUSIONS: According to our results, there is a health inequality between the poor and the rich subgroups which may increase the risk of mothers and infant mortality and morbidity rates among the poor while the majority of the conditions related to the health outcomes are preventable.

Key words: Inequality, socioeconomic factors, health status disparity, mother, child

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INTRODUCTION

Maternal and under-five child mortality rates are among the most important public health indices that are widely used as key indicators of the population health and of social and economic development (1, 2). These indices are substantially different and higher in

low-income countries compared to high-income countries, so that 98% or more of these adverse outcomes occur in low-income countries (3, 4).

To emphasize these differences and define country-specific goals for improvement, United Nations member states have adopted the Millennium Development Goals (MDGs) (5). These goals include, to reduce the mortality rate by two-thirds of children younger than 5 years between 1990 and 2015, and to reduce maternal mortality by three-quarters between 1990 and 2015 (6). The social determinants of health (SDH) provide a relevant synthesis of current research on health inequality. Numerous bodies in the United Nations are evaluating SDH. The first review, in July 2012, revealed that SDH carries great potential for the design of sustainable development goals in regard to what follows the MDGs after 2015 (7).

Despite progress made in recent years, health status in most developing countries is still unsatisfactory and remains below that enjoyed by people in developed countries. Global inequalities in health status reflect the socioeconomic disparities that exist between rich and poor countries (8). The gross inequalities in health that exist within and between regions and countries present a global challenge (9). As an instance, life expectancy at birth ranges from 34 years in Sierra Leone to 81.9 years in Japan (10). There are also large inequalities within countries, a 20-year gap in life expectancy between the richest and poorest populations in the USA, for example (11).

The social stratification processes in many low income countries differ considerably from those in high income countries. Although many measures of socioeconomic positions (SEP) have been proposed for epidemiological studies; the aspects of SEP captured by these measures are slightly different and may vary according to the specific research question. Thus no single measure of the SEP will be ideal for all studies and contexts (12). Accordingly, local surveys across and within countries can help countries identify the effect of programs in reducing disparities in coverage, progress towards achievement of MDGs, and especially, where program changes need to be made (13). The present study was conducted to measure the individual- and household-level of socioeconomic factors on maternal and infant mortality rates using an asset index and to assess the effect of inequality in the socioeconomic status on the distribution of these health outcomes using a concentration index.

METHODS

This cross-sectional study was conducted in 2012 in Hamadan City, the west of Iran. The parents having at least one under-5-year child were invited to refer to the health centers and participate in this study. Hence, only voluntary parents, who accepted our invitation, participated in this study. Since no intervention was carried out in this study, we just took participants' verbal informed consent. The Research Committee of Hamadan University of Medical Sciences approved this consent procedure as well as the whole study (No. 2611).

Assuming the prevalence of low birth weight to be 7% in Iran (14), we arrived at a sample size of 1276 households at 0.05 significant levels and error level of 0.2. Because of the cluster random sampling, the calculated sample size was rounded up to 1400 including 1050 urban households and 350 rural households. The households were selected through a stratified cluster random sampling method considering regions (urban and rural) as stratum and health centers as clusters (28 clusters), then a sample of 50 households was randomly selected from each cluster. Four additional households were added accidentally to the sample size and the overall sample size reached 1404.

This study recruited households with at least one child under 5 years of age who had medical records in urban and rural health centers. The primary data on mothers and children were extracted from the medical records using a predetermined checklist of items including gender, birth date, weight and height at birth, mode of delivery, growth chart, duration of breastfeeding, vaccination, number of health care visits, and parents' education. Additional data were collected through interview with parents and anthropometric measurement of the participants including children's weight and height, consanguinity, history of injury, and information regarding the economic level of the family.

In this study, the effect of inequity on health outcomes was evaluated using a three-stage

procedure: (a) definition of health outcomes; (b) geographical and socioeconomic status; and (c) measuring inequality of health outcome.

Definition of health outcomes

Sixteen major health outcomes or events related to the mothers' or children's health were identified, classified, and defined as shown in Table 1.

The nutritional status of all children under 5 years of age were evaluated using WHO Anthro and macro computer software (15). The three main nutritional indices were measured: (a) wasting (weight-for-height index); (b) stunting (height-for-age index); and (c) underweight (weight-for-age index).

Wasting or acute protein-energy malnutrition indicates inadequate nutrition during the period immediately before the survey, resulting from recent episodes of illness and diarrhea in particular or from acute food shortage (16).

Stunting or chronic protein-energy malnutrition results from inadequate intake of calories and protein over a long period of time or persistent and recurrent ill-health. This index is less sensitive to temporary food shortages and thus seems to be considered as the most reliable indicator (16).

Underweight status is a composite of the two preceding ones and can be due to either chronic or acute protein-energy malnutrition (16).

In the Islamic Republic of Iran, all infants receive health care at birth, 1st, 2nd, 4th, 6th, 9th, 12th, 18th, 24th months and then at 4 years of age. If a woman or child had received a perfect health care was classified as “complete” otherwise as “incomplete”.

Geographical and socioeconomic status

According to the residential area, the households were categorized into urban and rural subgroups. Furthermore, based on their educational levels, mothers were classified

TABLE 1

DEFINITION OF MATERNAL AND CHILDREN’S HEALTH OUTCOMES

OUTCOME	DEFINITION
Adolescent pregnancy	Pregnancy in a woman aged 10-19 years (27).
Advanced maternal age	Pregnancy in a woman aged 35 years or older (32).
Cesarean section	An incision on the mother’s abdomen to deliver one or more babies (33).
Short birth spacing	The interval before between a live birth and the next pregnancy less than 24 months (34).
Low birth weight	Weight at birth of less than 2,500 grams (35).
Preterm birth	Gestational age less than 37 weeks (35).
Underweight	Below minus two standard deviations from median weight for age of reference population (36).
Wasting	Below minus two standard deviations from median weight for height of reference population (36).
Stunting	Below minus two standard deviations from median height for age of reference population (36).
Minor injury	Needs home treatment during the last month (37).
Moderate injury	Needs outpatient treatment or hospitalization less than 24 hours during the last three months (37).
Severe injury	Needs hospitalization more than 24 hours during the last 12 months (37).
Regular health care	Perfect health care according to the age of child.
Consanguinity	Relationship by descent from a common ancestor (3rd or 4th relatives).
Child with disability	A blind, deaf, mentally retarded, or physically disabled child.
Exclusive breastfeeding	The infant only receives breast milk without any additional food or drink, not even water for 6 months (38).

into four groups including: primary school (1-5 years); secondary school (6-8 years); high school (9-12 years); and academic level.

To measure the socioeconomic status of households, we used the presence of selected main durable assets in a sample household, because these types of assets are less sensitive to temporal fluctuation in individual income or expenditure (17). The assets we considered in houses included refrigerator, freezer, washing machine, sofa furniture, microwave, computer, radio, television, line or mobile phone, car or truck, and internet access. We also assessed having a permanent house or floor, the number of rooms, private toilet, bathroom, heating and cooling systems. Households with these assets were considered to be rich compared to those without. We used principal component analysis (PCA) of all household samples to generate "asset index" as follows (18):

$$A^i=\hat{Y}_1 a_{i1} + \ldots \hat{Y}k a_{ik}$$
$$\text{and } a_{ik}= (x_{ik}-x_k)/S_k$$

where Ai is the standardized asset index score per household *i*, the $_k$s are the factor loadings or weights of each asset *k*, estimated by PCA, and the a_{ik}s are the standardized values of asset k for household i (i.e., x_{ik} is the ownership of asset k by household i, where 0 represents not owning the asset and 1 represents owning the asset, and x_k and S_k are the sample mean and standard deviation (SD) of asset *k* for all households).

Measuring inequality of health outcome

In this study, we assessed the relationship between socioeconomic status and mothers' and children's inequality using concentration index which was first introduced by Kakwani in 1997 (19). The concentration index expresses inequality of health outcomes across ordered social groups, such as income or social class, and therefore, reflects the direction of the social gradient in disease (20). The value of the concentration index normally varies between -1 and +1 but it is not limited to the range of [-1, 1] if the health variable of interest takes negative or positive values. Therefore, the health outcome should be such that it is restricted to positive values. In addition,, the range of the concentration index depends upon the mean (i.e. overall prevalence) of the indicator when applied to binary indicators (21).

Concentration curve visualizes the concentration index. In this curve, x-axis indicates the cumulative percentage of the sample, ranked by an indicator of socioeconomic position, such as living standards, or income beginning with the poorest and y-axis indicates the cumulative percentage of the health outcome corresponding to each cumulative percentage of the distribution of the socioeconomic indicator. The concentration index takes a negative value when the curve lies above the line of equality, indicating the disproportionate concentration of the health outcome among the poor, and a positive value when it lies below the line of equality (22).

Concentration index can be calculated as twice the covariance of the health variable and a person's relative rank in terms of socioeconomic status, divided by the mean health as follows (20):

$$CI=2/\mu\ cov_w\ (y_i\ R_i)$$

where y_i represents the health status of the ith subject and R_i represents the fractional rank of the $_i th$ subject in the distribution of socioeconomic status (i.e. $R_i=1/N$ for the poorest individuals and $R_i=N/N$ for the richest individuals) assuming the welfare as a continuous variable.

Further analyses were conducted to assess the effect of the residential area (rural versus urban) and educational level (low-educated versus high-educated) on health outcomes were evaluated using risk ratio estimate. We considered the 0.05 confidence level for analysis. However, for the sake of 16 multiple comparisons, the significance level was corrected using Bonferroni's multiple testing method. We obtained a significance level of 0.003 for 16 comparisons. Accordingly, the P values greater than 0.003 were considered statistically non-significant. All statistical analyses were performed by statistical software Stata 11 (StataCorp, College Station, TX, USA).

RESULTS

Absolute and relative frequencies of the characteristics of the participants are shown in Table 2. According to these

TABLE 2

ABSOLUTE AND RELATIVE FREQUENCIES OF THE PARTICIPANTS' CHARACTERISTICS

	PRESENT		ABSENT	
VARIABLE	NUMBER	PERCENT	NUMBER	PERCENT
Premature birth (<37 w)	75	5.34	1329	94.66
Low birth weight (<2500 gr)	76	5.41	1328	94.59
Nonexclusive breastfeeding (4 months)	231	16.45	1173	83.55
Stunting	56	3.99	1348	96.01
Underweight	60	4.27	1344	95.73
Irregular health care	558	60.26	846	74.26
Minor injury	75	5.34	1329	94.66
Moderate injury	41	2.92	1363	97.08
Severe injury	36	2.56	1368	97.44
Child with disability	46	1.78	1358	98.22
Wasting	97	6.92	1307	93.08
Cesarean section	685	48.79	719	51.21
Adolescent pregnancy (<19 yr)	73	5.20	1331	94.80
Advanced maternal age (>35 yr)	158	11.25	1248	88.75
Short birth spacing (<24 months)	60	4.27	1344	95.73
Consanguinity	334	23.79	1070	76.21

results, the most common risk factors were nonexclusive breastfeeding (16.45%), irregular health care (60.26%), cesarean section (48.79%), advanced maternal age (11.25%), and consanguinity (23.79%).

The results of assessing the disproportionate concentration of the health outcome based on concentration index analysis are shown in Table 3 and Figure 1. There were various degrees of disproportionality among the health outcomes. The concentration index with a negative value and the curve lies above the line of equality indicates the disproportionate concentration of the health outcome among the poor. On the other hand, the concentration index with a positive value and the curve above the line of equality indicates the disproportionate concentration of the health outcome among the rich.

The concentration index was negative for low birth weight, underweight, stunting, wasting (P=0.037), minor and moderate injuries, consanguineous marriage, child with disability (P=0.001), short birth spacing, and adolescent pregnancy (P=0.001) indicating the disproportionate concentration of these health outcomes among the poor. On the other hand, the concentration index took positive value for preterm birth, nonexclusive breastfeeding, severe injuries, incomplete health care (P=0.001), cesarean section (CS) (P=0.001), and advanced maternal age indicating the disproportionate concentration of these health outcomes among the rich.

The effect of residential area on health outcomes are shown in Table 4. The distribution of health outcomes was different between rural and urban regions. The risk of preterm birth, low birth weight, moderate injuries, child with disability, and adolescent pregnancy (P=0.001) was higher in rural area. Whereas the risk of underweight, stunting (P=0.017), wasting (P=0.021), nonexclusive breastfeeding (P=0.003), minor injuries, severe injuries, incomplete health care (P=0.001), consanguineous marriage, short birth spacing, CS (P=0.001), and advanced maternal age was higher in urban area. However, some of the differences were not statistically significant.

The effect of educational level on health outcomes are shown in Table 5. The distribution of health outcomes varied between low- and high-educated mothers. The risk of underweight, wasting, moderate (P=0.044) and severe injuries, consanguineous marriage (P=0.002), child with disability (P=0.029), adolescent pregnancy (P=0.001), and advanced maternal age (P=0.001) was higher among low-educated mothers. On the other hand, the risk of preterm birth, low birth

TABLE 3

CONCENTRATION INDEX FOR MATERNAL AND CHILDREN HEALTH OUTCOME BASED ON THE INDEPENDENT VARIABLES "ASSET INDEX"

HEALTH OUTCOME	PREVALENCE IN 1000	CONCENTRATION INDEX			P VALUE
		STATISTICS	95% CI		
Preterm birth	54	0.02	-0.15	0.20	0.785
Low birth weight	53	-0.01	-0.17	0.14	0.885
Underweight	43	-0.14	-0.32	0.03	0.118
Stunting	40	-0.03	-0.22	0.15	0.690
Wasting	69	-0.13	-0.20	-0.01	0.037
Nonexclusive breastfeeding	164	0.02	-0.05	0.10	0.539
Minor injuries	53	-0.13	-0.31	0.05	0.154
Moderate injuries	29	-0.20	-0.43	0.02	0.078
Severe injuries	26	0.01	-0.19	0.20	0.977
Incomplete health care	602	0.13	0.06	0.20	0.001
Consanguineous marriage	238	-0.04	-0.14	0.05	0.347
Child with disability	18	-0.26	-0.51	-0.01	0.036
Short birth spacing	43	-0.06	-0.19	0.05	0.286
Adolescent pregnancy	52	-0.39	-0.51	-0.28	0.001
Cesarean section	488	0.15	0.10	0.20	0.001
Advanced maternal age	112	0.13	-0.10	0.29	0.079

weight, stunting, nonexclusive breastfeeding (P=0.039), minor injuries, incomplete health care (P=0.001), short birth spacing, and CS (P=0.001) was higher high-educated others. Nevertheless, the majority of the differences were not statistically significant.

DISCUSSION

The results of this survey indicated a fairly disproportionate concentration of a majority of health outcomes among the poor while most of the conditions related to the health outcomes are preventable. For example, educational program and premarital counseling may improve of knowledge of the general population and help to reduce the number of consanguineous marriage, short birth spacing, adolescent pregnancy, incomplete health care, CS, and advanced maternal age (23-25).

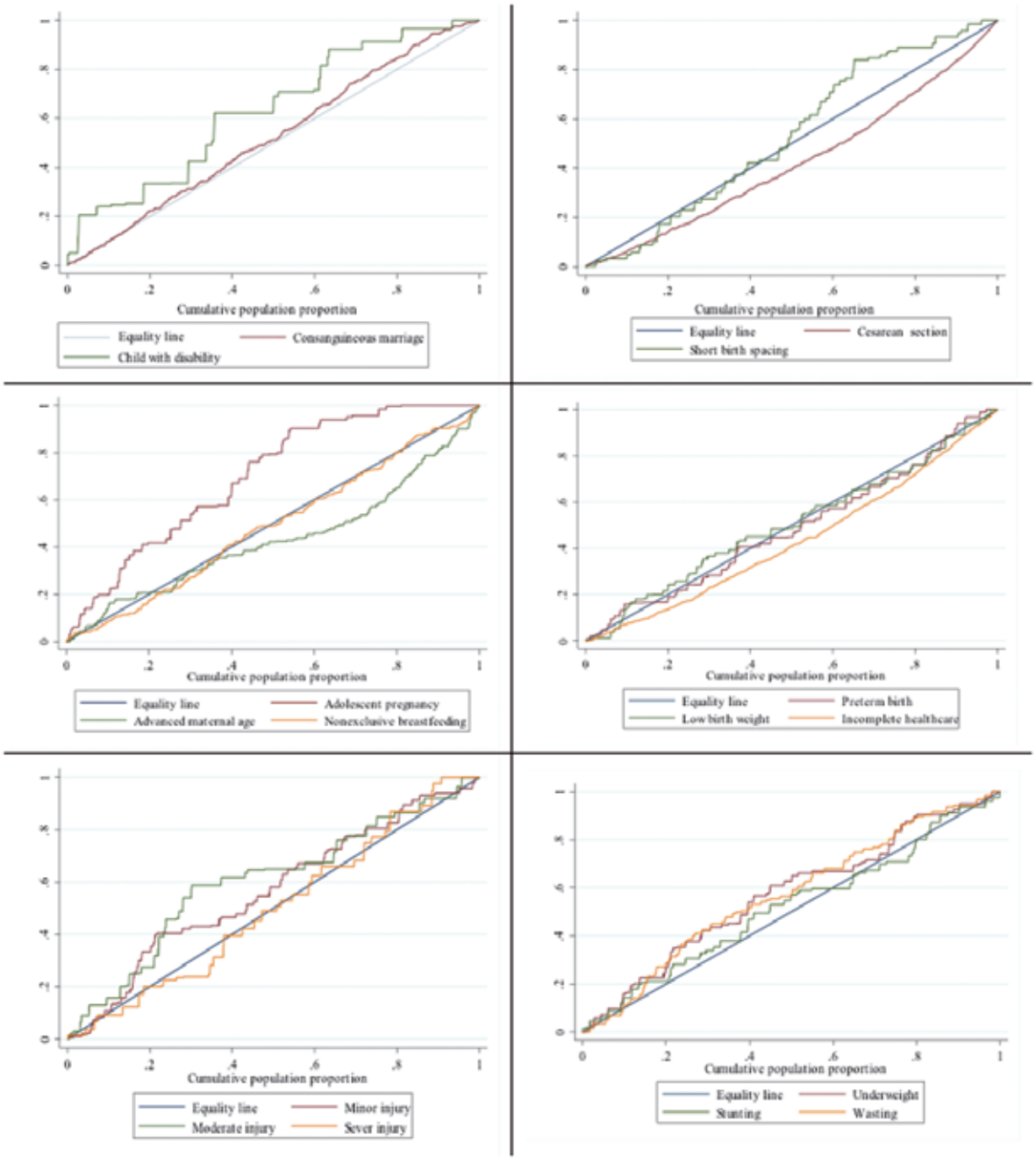
Advanced maternal age is associated with a range of adverse pregnancy outcomes including stillbirth, premature birth, and macrosomia (26). We showed a disproportionate concentration for some health outcomes among the rich, the most dominant of which were CS and advanced maternal age. One reason that may explain this disproportionality is that the rich are more likely to be educated at higher levels and to involve in social activities. Furthermore, a large proportion of the adolescent period is spent for education and hence inevitably may postpone the age at marriage and pregnancy (27).

CS rate has been steadily rising in Iran. The CS rate was reported up to 38.2% in some parts of Iran in 2007 (24). Recent surveys have revealed a six-fold rise in the CS rate in Iran while a remarkable proportion of them are inappropriate (28). WHO reported that the CS rate above 15% is associated with high rates of inappropriate CS, which not only endangers maternal and neonatal health but also imposes a financial burden on the health system (29).

Child malnutrition is a symptom of inadequate food supply. We indicated that 39 to 69 per 1000 under-five children had at least one type of malnutrition with a disproportionate concentration of among the poor. Malnourished children develop more slowly, enter school later, and perform less well (16). On the other hand, a considerable number of mothers had not undergone exclusive breastfeeding and the majority of children had not received a complete healthcare whereas encouraging breastfeeding programs can improve both the nutritional condition of both mothers and children. Furthermore, good nutrition

FIGURE 1

CONCENTRATION CURVE OF THE VARIOUS HEALTH OUTCOMES BASED ON THE INDEPENDENT VARIABLES "ASSET INDEX"



and vaccinations can improve mothers' and children's health outcomes (16).

Adolescent pregnancy, so call teen pregnancy, is considered as a risk factor for both mother and child. Our results revealed a disproportionate concentration of adolescent pregnancy among the poor. Limwattananon et al (17) reported similar results and showed that teenage pregnancy was undesirably concentrated in the poorer subgroups. Compared with births to adult women, births to adolescents are at greater risk of low birth weight, preterm labor, and infant mortality(30). Furthermore, teen childbearing imposes considerable financial burden on the health system each year (31).

TABLE 4

RISK RATIO FOR MATERNAL AND CHILDREN HEALTH OUTCOMES BY RESIDENTIAL AREA (RURAL AREA VERSUS URBAN AREA)

	RURAL		URBAN		RISK RATIO		
HEALTH OUTCOME	PRESENT (%)	ABSENT (%)	PRESENT (%)	ABSENT (%)	STATISTIC	95% CI	P VALUE
Preterm birth	20 (5.92)	318 (94.08)	55 (5.16)	1011 (94.84)	1.14	0.69, 1.88	0.589
Low birth weight	22 (6.51)	316 (93.49)	54 (5.07)	1012 (94.93)	1.28	0.79, 2.07	0.307
Underweight	11 (3.25)	327 (96.75)	49 (4.60)	1017 (95.40)	0.71	0.37, 1.34	0.287
Stunting	6 (1.78)	332 (98.22)	50 (4.69)	1016 (95.31)	0.37	0.16, 0.87	0.017
Wasting	14 (4.14)	324 (95.86)	83 (7.79)	983 (92.21)	0.53	0.30, 0.92	0.021
Nonexclusive breastfeeding	38 (11.24)	300 (88.76)	193 (18.11)	873 (81.89)	0.62	0.44, 0.86	0.003
Minor injuries	14 (4.14)	324 (95.86)	61 (5.72)	1005 (94.28)	0.72	0.41, 1.27	0.260
Moderate injuries	10 (2.96)	328 (97.04)	31 (2.91)	1035 (97.09)	1.01	0.50, 2.05	0.961
Severe injuries	6 (1.78)	332 (98.22)	30 (2.81)	1036 (97.19)	0.63	0.26, 1.50	0.292
Incomplete health care	22 (6.47)	318 (93.53)	536 (50.28)	530 (49.72)	0.13	0.08, 0.19	0.001
Consanguineous marriage	79 (23.37)	259 (76.63)	255 (23.92)	811 (76.08)	0.97	0.78, 1.21	0.836
Child with disability	9 (2.66)	329 (97.34)	16 (1.50)	1050 (98.50)	1.77	0.79, 3.97	0.159
Short birth spacing	13 (3.85)	325 (96.15)	47 (4.41))	1019 (95.59)	0.87	0.47, 1.59	0.655
Adolescent pregnancy	37 (10.95)	301 (89.05)	36 (3.38)	1030 (96.62)	3.24	2.08, 5.04	0.001
Cesarean section	138 (40.83)	200 (59.17)	547 (51.31)	519 (48.69)	0.79	0.69, 0.91	0.001
Advanced maternal age	36 (10.65)	302 (89.35)	122 (11.44)	944 (88.56)	0.93	0.65, 1.32	0.687

TABLE 5

RISK RATIO FOR MATERNAL AND CHILDREN HEALTH OUTCOMES BY MOTHERS EDUCATIONAL LEVEL (LOW-EDUCATED VERSUS HIGH-EDUCATED)

	LOW-EDUCATED*		HIGH-EDUCATED*		RISK RATIO		
HEALTH OUTCOME	PRESENT (%)	ABSENT (%)	PRESENT (%)	ABSENT (%)	STATISTIC	95% CI	P VALUE
Preterm birth	34 (4.81)	673 (95.19)	41 (5.88)	656 (94.12)	0.81	0.52, 1.27	0.371
Low birth weight	35 (4.95)	672 (95.05)	41 (5.88)	656 (94.12)	0.84	0.54, 1.30	0.440
Underweight	33 (4.67)	674 (95.33)	27 (3.87)	670 (96.13)	1.20	0.73, 1.98	0.462
Stunting	26 (3.68)	681 (96.32)	30 (4.30)	667 (95.70)	0.85	0.51, 1.42	0.548
Wasting	53 (7.50)	654 (92.50)	44 (6.31)	653 (93.69)	1.18	0.80, 1.74	0.382
Nonexclusive breastfeeding	102 (14.43)	605 (85.57)	129 (18.51)	568 (81.49)	0.78	0.61, 0.98	0.039
Minor injuries	36 (5.09)	671 (94.91)	39 (5.60)	658 (94.40)	0.91	0.58, 1.41	0.675
Moderate injuries	27 (3.82)	680 (96.18)	14 (2.01)	683 (97.99)	1.90	1.01, 3.59	0.044
Severe injuries	20 (2.83)	687 (97.17)	16 (2.30)	681 (97.70)	1.23	0.64, 2.35	0.527
Incomplete health care	202 (28.57)	505 (71.43)	356 (51.08)	341 (48.92)	0.56	0.48, 0.64	0.001
Consanguineous marriage	193 (27.30)	514 (72.70)	141 (20.23)	556 (79.77)	1.35	1.11, 1.63	0.002
Child with disability	18 (2.55)	689 (97.45)	7 (1.00)	690 (99.00)	2.53	1.06, 6.03	0.029
Short birth spacing	30 (4.24)	677 (95.76)	30 (4.30)	667 (95.70)	0.98	0.60, 1.61	0.955
Adolescent pregnancy	59 (8.35)	648 (91.65)	14 (2.01)	683 (97.99)	4.15	2.34, 7.37	0.001
Cesarean section	290 (41.02)	417 (58.98)	395 (56.67)	302 (43.33)	0.72	0.64, 0.80	0.001
Advanced maternal age	103 (14.57)	604 (85.43)	55 (7.89)	642 (92.11)	1.84	1.35, 2.51	0.001

* Low-educated: educational level of primary and secondary school; high-educated: educational level of high school and academic

An important limitation of this survey was the limited sample size. There was a fairly disproportionate concentration for the most health outcomes among the poor compared to the rich, however, the relationship between some health outcomes and socioeconomic status was not statistically significant. If the sample size was large enough, the observed relationship might be statistically significant. Another limitation of this study was that, the data on the economic status of the families was collected through self-reporting. This might introduce information bias. Furthermore, the study population was limited to one city in Iran. This may also introduce selection bias and limit the generalizability of the results.

However, despite its limitation, this study revealed that socioeconomic inequality exists in some health sector variables. Furthermore, we quantified and compared the degree of socioeconomic related inequality in two important health indices including child mortality rate and maternal mortality rate. Since distribution of the health expenditures are strongly ties with social justice, the results of this study may be useful for health policy makers such as Ministry of Health that compile a strategic plan for equality distribution of the health cares.

CONCLUSION

As conclusion, there is a health inequality between the poor and the rich subgroups which may increase the risk of mothers and infant mortality and morbidity rates among the poor while the majority of the conditions related to the health outcomes are preventable. This should be the focus of special attention of the health policy makers who plan for equality distribution of the health cares toward social justice.

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