

# Socioeconomic inequality in infant mortality in Iran and across its provinces

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**Objective** To measure the socioeconomic inequality in infant mortality in Iran\*.

**Methods** We analysed data from the provincially representative Demographic and Health Survey, which was done in Iran in 2000. We used a dichotomous hierarchical ordered probit model to develop an indicator of socioeconomic status of households. We assessed the inequality in infant mortality by using the odds ratio of infant mortality between the lowest and highest socioeconomic quintiles at both the provincial and national levels, and the concentration index, an inequality measure based on the entire socioeconomic distribution.

**Results** We found a decreasing trend in the infant mortality rate in relation to socioeconomic quintiles. The poorest to richest odds ratio was 2.34 (95% CI = 1.78–3.09). The concentration index of infant mortality in Iran was -0.1789 (95% CI = -0.2193–0.1386). Furthermore, the inequality of infant mortality between the lowest and highest quintiles was significant and favoured the better-off in most of the provinces. However, this inequality varied between provinces.

**Conclusion** Socioeconomic inequality in infant mortality favours the better-off in the country as a whole and in most of its provinces, but the degree of this inequality varies between the provinces. As well as its national average, it is important to consider the provincial distribution of this indicator of population health.

**Keywords** Infant mortality; Socioeconomic factors; Economic indicators; Odds ratio; Iran (Islamic Republic of) (source: MeSH, NLM).

**Mots clés** Mortalité nourrisson; Facteur socioéconomique; Indicateurs économiques; Odds ratio; Iran (République islamique d') (source: MeSH, INSERM).

**Palabras clave** Mortalidad infantil; Factores socioeconómicos; Indicadores económicos; Razón de diferencia; Irán (República Islámica del) (fuente: DeCS, BIREME).

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يمكن الاطلاع على الملخص بالعربية في صفحة 843.

## Introduction

More than 10 million children die each year in the world (1). That is why child mortality has received renewed attention as part of the United Nation's Millennium Development Goals (2). Furthermore, evidence worldwide suggests that children in households with a lower socioeconomic status have higher mortality rates (3–9). Few studies have been carried out on inequalities in infant and child mortality in developing countries before the last decade, but this situation has recently begun to change. Recent attention to the differences in health status between the poor and rich has led to more research on the health of different groups in developing countries (10). The inter-country projects initiated by WHO and World Bank provide basic information on the health status of different groups (11, 12).

Over the last two decades in Iran there has been a significant declining trend in infant mortality rates with 63.5, 43.5, and 26.7 per 1000 livebirths in 1988, 1994 and 2000, respectively (13, 14). However, no studies have been done on differences in infant mortality rates across socioeconomic groups in Iran. We measured the socioeconomic inequality in infant mortality in Iran overall, as well as in each of its provinces.

## Methods

### Data

We extracted data from the Demographic and Health Survey (DHS), which was conducted in Iran in 2000 (14). The sample population of DHS constituted 4000 households (2000 rural and 2000 urban) from 28 provinces of the country, plus 2000 households in the capital, Tehran. The sampling design consisted

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\* The Islamic Republic of Iran

Table 1. Estimated infant mortality rate, its odds ratio and 95% confidence interval in socioeconomic quintiles, Iran, (1995–99)

Quintiles	Infant mortality Mean (SD)	Odds ratio	95% confidence interval		P-value
			Low	High	
1	47.2 (2.3)	2.34	1.78	3.09	<0.001
2	40.7 (3.2)	2.01	1.48	2.72	<0.001
3	30.2 (2.6)	1.47	1.08	2.00	0.015
4	24.2 (3.0)	1.17	0.82	1.68	0.379
5	20.7 (2.7)	1 <sup>a</sup>	–	–	

<sup>a</sup> Reference quintile.

of a stratified single stage (equal size) cluster sampling with unequal sampling probabilities. The specific design and sample size (4000 households) make this survey representative at the sub-national level (14).

In addition, we studied 110 751 households to define the socioeconomic status of households in Iran. To define the socioeconomic inequality in infant mortality, we analysed 47 896 livebirths from 1995 to 1999 at the national level and 187 292 livebirths from 1985 to 1999 at the provincial level.

Selection of a five-year observation period at the national level and a fifteen-year observation period at the provincial level is a compromise between providing recent estimates and ensuring enough births to reduce the effects of sampling error (15).

### Analysis

We used a dichotomous hierarchical ordered probit (DIHOPIT) model to develop an indicator of the long-running economic status of households (16). It is based on the premise that wealthier households are more likely to own a given set of assets, thus providing an estimate for economic status index for households. We used the following indicators: owning a refrigerator, a television, a telephone, a car, a motorcycle, a bicycle, a bathroom, a toilet, type of heating system, use of natural gas for cooking and heating, number of rooms per capita, type of bathroom effluent disposal, status of toilet sanitation, type of solid garbage disposal, and main source of drinking water. Furthermore variables considered as predictors of the household's economic status included age, sex, education, marital status of the head of the household and migration history of the household five years prior to the interview.

In addition to creating a national index of household economic status, we estimated economic indices for each province separately based on the assumption that province-specific information would produce a more effective and accurate index. Therefore we calculated separate economic indices to discover the socioeconomic status of the sampled populations within each province.

We selected a binary outcome variable: namely whether or not each of the live born infants of the women interviewed was still alive or not in the 12 months following birth. We estimated the infant mortality rate (number of deaths among children below one year of age divided by 1000 livebirths reported during the above-mentioned periods) from birth histories for the entire country and for each province separately. We defined the socioeconomic inequality in the infant mortality rate using two parameters: the infant mortality concentration index and poorest to richest quintiles odds ratio of infant mortality rate.

Fig. 1. Estimated infant mortality rate and its 95% confidence interval in socioeconomic quintiles, Iran (1995–99)

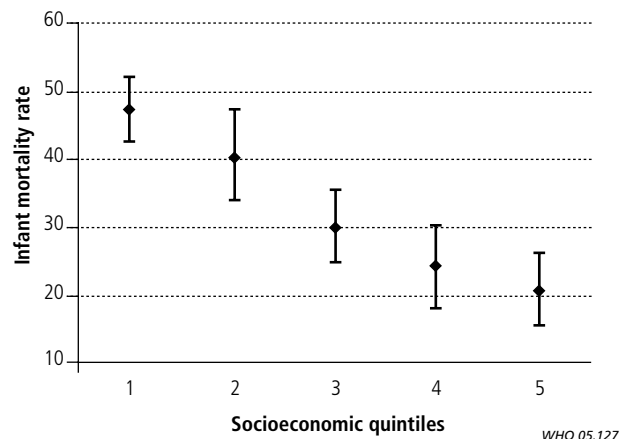
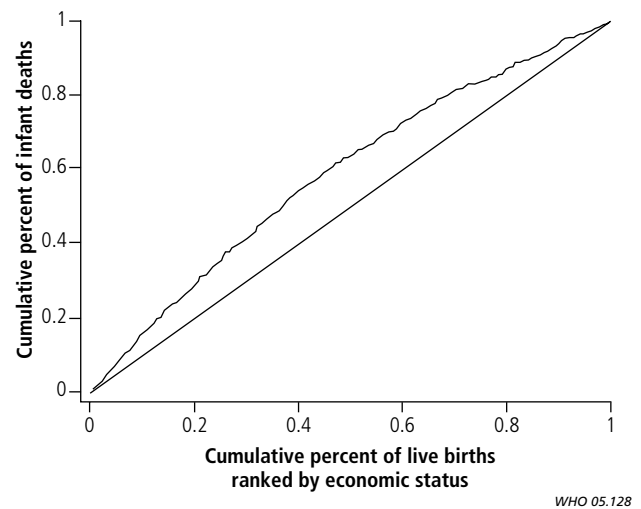


Fig. 2. The concentration curve of infant mortality, Iran (1995–99)



The concentration index, whose value can vary between –1 and +1, has frequently been used in the study of income-related inequalities (17). Its negative values imply that the health variable is concentrated among disadvantaged people while the opposite is true for its positive values. When there is no inequality, the concentration index will be zero. We used regression analysis to compute a weighted estimate of the concentration index, taking into account the clustering for the confidence interval (18).

In the analysis we considered the DHS stratification and unequal sampling weights as well as household clustering effects. To exclude any sampling variation, we used LIMDEP and STATA to calculate the DIHOPIT and odds ratios, as well as concentration indices, respectively. These programmes can take into account the specific stratified weighted and clustered design issues.

### Results

Table 1 shows the infant mortality rate and standard deviation for different socioeconomic quintiles at the national level. It also shows the odds ratio for infant mortality rate and 95% confidence interval for the different quintiles, with the richest quintile being used as the reference category. As indicated in

Table 2. Estimated infant mortality rate and standard deviation in socioeconomic quintiles, lowest to highest quintiles odds ratio, concentration index (C) and their 95% confidence intervals, by province, Iran (1985–99)

Province	Infant mortality [Mean (SD)] quintiles					Odds ratio	95% confidence interval			C	95% confidence interval	
	1	2	3	4	5		High	Low	High		Low	High
Ardebil	61.2 (7.2)	71.8 (7.3)	52.3 (6.4)	54.0 (7.0)	45.2 (7.1)	1.38	0.92	2.06	-0.0632	-0.1239	-0.0026	
Bushehr	45.1 (5.2)	43.3 (5.8)	30.2 (5.9)	37.4 (5.6)	17.4 (3.8)	2.67	1.63	4.37	-0.1351	-0.2064	-0.0639	
Chahar-Mahal & Bakhtiari	46.4 (5.4)	45.5 (5.9)	36.7 (6.3)	41.9 (7.3)	29.9 (5.9)	1.58	0.99	2.52	-0.0744	-0.1483	-0.0006	
East Azerbaijan	70.7 (7.4)	65.9 (7.5)	46.8 (6.9)	57.0 (9.2)	18.4 (5.0)	4.07	2.25	7.34	-0.1715	-0.2382	-0.1049	
Fars	59.0 (8.3)	31.5 (5.3)	25.6 (5.1)	18.5 (4.3)	30.0 (6.5)	2.03	1.20	3.44	-0.1717	-0.2740	-0.0695	
Gilan	39.5 (6.2)	41.9 (7.2)	30.2 (6.2)	33.0 (6.4)	18.9 (4.9)	2.13	1.16	3.91	-0.1122	-0.2048	-0.0197	
Ghazvin	56.8 (8.0)	51.1 (6.9)	36.5 (5.4)	37.3 (6.1)	25.1 (5.7)	2.34	1.36	4.01	-0.1502	-0.2298	-0.0707	
Golestan	57.1 (7.4)	56.0 (8.6)	41.7 (6.1)	39.0 (6.1)	39.5 (6.9)	1.47	0.94	2.31	-0.0973	-0.1772	-0.0176	
Hamedan	50.5 (6.2)	59.6 (7.1)	36.2 (5.2)	42.3 (6.5)	32.9 (7.1)	1.56	0.94	2.59	-0.0889	-0.1616	-0.0164	
Hormozgan	69.5 (6.6)	42.8 (5.4)	44.2 (5.8)	34.5 (5.9)	26.5 (5.9)	2.74	1.68	4.47	-0.1853	-0.2545	-0.1161	
Ilam	42.1 (5.3)	40.8 (5.7)	45.1 (5.6)	38.2 (6.1)	23.9 (4.5)	1.79	1.14	2.84	-0.0877	-0.1568	-0.0188	
Isfahan	59.8 (10.0)	32.3 (6.4)	28.9 (6.7)	24.2 (4.9)	25.0 (5.5)	2.48	1.41	4.36	-0.1469	-0.2526	-0.0412	
Kerman	57.8 (7.4)	43.4 (6.5)	45.7 (6.6)	29.2 (4.8)	33.0 (6.7)	1.80	1.10	2.94	-0.1452	-0.2310	-0.0594	
Kermanshah	58.2 (6.3)	57.6 (8.3)	44.4 (7.2)	37.4 <sup>a</sup> (11.2)	26.6 <sup>a</sup> (9.4)	2.26	1.08	4.77	-0.1117	-0.1909	-0.0326	
Khorasan	73.7 (8.4)	68.8 (8.0)	59.4 (8.5)	29.6 (5.2)	25.6 (6.3)	3.03	1.75	5.24	-0.2199	-0.2899	-0.1501	
Khuzestan	52.7 (5.6)	50.8 (5.6)	37.9 (5.5)	22.7 (4.5)	15.2 (3.7)	3.61	2.11	6.18	-0.2389	-0.3044	-0.1736	
Kohgiluyeh & Boyer-Ahmad	48.2 (5.2)	45.0 (5.8)	27.5 (4.1)	31.8 (5.0)	21.2 (4.6)	2.34	1.44	3.82	-0.1682	-0.2401	-0.0964	
Kordestan	75.7 (7.2)	67.6 (7.6)	79.8 (7.9)	56.3 (6.6)	33.2 (5.8)	2.40	1.59	3.60	-0.1182	-0.1728	-0.0637	
Lorestan	50.4 (5.5)	37.4 (5.8)	37.4 (5.3)	36.5 (5.5)	33.0 (6.3)	1.55	0.99	2.43	-0.0833	-0.1573	-0.0094	
Markazi	59.4 (7.5)	53.8 (8.9)	34.6 (5.8)	30.5 (6.1)	23.9 (5.3)	2.58	1.54	4.32	-0.1996	-0.2833	-0.1161	
Mazandaran	33.2 (8.5)	27.3 (5.7)	25.1 (5.6)	27.5 (6.1)	11.0 (4.7)	3.09	1.14	8.33	-0.1563	-0.2998	-0.0129	
Qom	67.6 (13.9)	42.9 (11.0)	29.7 (5.7)	24.5 (5.4)	37.3 (6.5)	1.87	1.07	3.27	-0.0479	-0.1632	0.0673	
Semnan	69.0 (11.5)	53.1 (9.1)	36.4 (6.3)	34.4 (7.6)	31.6 (5.7)	2.27	1.36	3.77	-0.1457	-0.2475	-0.0440	
Sistan & Baluchestan	70.0 (6.7)	70.7 (7.0)	67.2 (7.6)	63.0 (7.8)	46.3 (7.2)	1.55	1.06	2.26	-0.0661	-0.1218	-0.0105	
Tehran	44.4 (5.9)	33.4 (6.7)	26.3 (5.7)	21.0 (5.7)	19.5 (5.0)	2.33	1.30	4.18	-0.1609	-0.2664	-0.0554	
West Azerbaijan	74.8 (6.5)	63.6 (7.2)	55.1 (6.4)	48.8 (7.1)	32.1 (5.9)	2.44	1.61	3.70	-0.1539	-0.2147	-0.0933	
Yazd	53.3 (9.7)	30.9 (7.3)	41.5 (7.2)	27.4 (5.0)	22.6 (4.8)	2.44	1.38	4.32	-0.1306	-0.2313	-0.0300	
Zanjan	91.7 (8.2)	57.9 (6.8)	59.0 (7.3)	58.5 (8.0)	28.9 (6.0)	3.39	2.14	5.39	-0.1605	-0.2209	-0.1002	

<sup>a</sup> Live births during the last 15 years preceding the survey is less than 500.

Fig. 1, there is a descending trend in the infant mortality rate, the higher one moves up the socioeconomic quintiles. Fig. 2 illustrates the concentration curve of infant mortality for Iran, indicating the concentration of infant mortality among people of low socioeconomic status. The concentration index indicating socioeconomic inequality of infant mortality in Iran was -0.1789 (95% CI = -0.2193–0.1386).

Table 2 shows the infant mortality rate, its standard deviation for different socioeconomic quintiles, and measures of socioeconomic inequality in infant mortality rates for each province. Provinces such as Khuzestan, Markazi, Tehran and West Azerbaijan, show a descending trend in infant mortality rate as a function of socioeconomic quintiles as observed at the national level. The relative difference in infant mortality rates between lowest and highest quintiles was statistically significant in all provinces except in Ardebil, Chahar-Mahal & Bakhtiari, Golestan, Hamedan, and Lorestan. Among the provinces with a statistically significant odds

ratio, the ratio varied from 1.55 in Sistan & Baluchestan to 4.07 in East Azerbaijan. Based on the concentration index, inequality in infant mortality was also statistically significant in all provinces except for Qom. This measure ranged from -0.0632 in Ardebil to -0.2389 in Khuzestan among provinces with a statistically significant concentration index.

Fig. 3a and Fig. 3b illustrate the map of Iran according to the socioeconomic inequality in infant mortality across provinces based on odds ratio and concentration index, respectively. There is no obvious geographical clustering of inequality across provinces.

Fig. 4a and Fig. 4b plot infant mortality inequality for all provinces based on odds ratio and concentration index, respectively. According to Fig. 4a, provinces can be grouped into distinct categories:

- those with a low average and no or low inequality, such as Ilam, Lorestan and Qom;





of low welfare index in Indonesia was almost twice that of households with high welfare index (6). A Chilean study from 1990 to 1995 showed a clear gradient of infant mortality rates according to the mother's level of education. The highest rate of infant death was among those with no education (7).

In another study in a Brazilian city, the mortality rate among infants was negatively related to geo-economic classification, with poor areas of the city having the highest rates and rich areas the lowest (8). Developed countries whose overall infant mortality rate is low have demonstrated similar patterns. For instance, a population-based study in Norway showed an inverse association between socioeconomic groups and risk of infant death from 1967 to 1998. Parents' education was used as a measure of socioeconomic status. The researchers concluded that in spite of low infant mortality rates, the socioeconomic inequality in the risk of infant death is an indicator of important societal phenomena (9).

Different parameters have been used as proxy measures of the socioeconomic status of households, such as parents' education, occupation of the household's head, monetary measures and non-monetary economic indices (4–9, 12). In this study, we focused on the last approach given that the DHS has not collected data on self-reported income and expenditure, but provides information on ownership of asset indicator variables. The World Bank's Living Standards Measurement Study may be more appropriate for capturing data on living standards, but it has not been done in Iran. DIHOPIT is one of the statistical methods developed to create non-monetary economic indices for households (16). By enabling us to rank households according to their socioeconomic status, such indices provide a measure of relative economic status within a country, and are therefore invaluable in comparative analyses over time and place. This approach of establishing a household's economic status in the absence of information on income and expenditure greatly extends the possibilities for inequality analyses.

The DIHOPIT approach has been validated with nationally representative surveys carried out in three countries — Greece, Pakistan and Peru — with considerably different socioeconomic characteristics (16). This study showed that DIHOPIT correlated closely with income and expenditure.

The objective of our study is not to rank provinces according to their inequality, but to show that measuring the average health status in isolation is not sufficient enough to describe the health of a population. Moreover the distribution of health in the population is also a key concern to be considered during health planning and policy-making for promotion of health.

Gakidou King showed that the causes of inequality in child mortality rates are related to, but are quite distinct from, the causes of average level of childhood mortality (21). They suggested that variables that predict inequality need to be further researched, even if they do not predict average level of child mortality. This study demonstrates that differences across provinces exist in both the inequality as well as in the level of infant mortality.

We can deduce the reasons for the existing conditions from experts as well as from local information in some provinces, but there is little research-based evidence to provide clear explanations, especially in urban areas. For instance, utilization of health care facilities in Sistan & Baluchestan is known to be far less than the rest of the country not only because of low availability of health care, but also as a result of people's attitude (14). This study indicates the necessity of better defining the determinants

Table 3. Active health houses as a percentage of estimated health houses needed in Iranian provinces (1999)

Province	No. of active health houses	No. of health houses needed	Availability of health houses
Ardebil	493	571	86.3
Bushehr	219	226	96.9
Chahar-Mahal & Bakhtiari	286	294	97.3
East Azerbaijan	1036	1200	86.3
Fars	930	975	95.4
Gilan	972	1022	95.1
Ghazvin	211	279	75.6
Golestan	512	526	97.3
Hamedan	533	568	93.8
Hormozgan	372	452	82.3
Ilam	193	205	94.1
Isfahan	679	717	94.7
Kermanshah	547	604	90.6
Kerman	737	798	92.4
Khorasan	1669	1799	92.8
Khuzestan	733	844	86.8
Kohgiluyeh & Boyer-Ahmad	288	291	99.0
Kordestan	552	575	96.0
Lorestan	492	605	81.3
Markazi	418	425	98.4
Mazandaran	1072	1174	91.3
Qom	60	61	98.4
Sistan & Baluchestan	639	884	72.3
Semnan	144	148	97.3
Tehran	300	370	81.1
Yazd	211	211	100.0
West Azerbaijan	821	939	87.4
Zanjan	274	336	81.5
<b>National level</b>	<b>15393</b>	<b>17099</b>	<b>90.0</b>

of both inequality and levels of infant mortality as well as the contribution of each factor to different provinces.

## Conclusion

Our results suggest that socioeconomic inequality in infant mortality favours the better-off in Iran as a whole and in most of its provinces, and that this inequality varies between provinces. Investigating why inequality favours the better-off and why it is higher in some provinces deserves special attention. In addition, it is advisable to conduct provincially representative surveys to provide recent estimates of health inequalities and to allow monitoring over time. ■

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**Competing interests:** none declared.

## Résumé

**Inégalité socioéconomique en matière de mortalité infantile en Iran et dans les différentes provinces de ce pays**

**Objectif** Mesurer l'inégalité socioéconomique en matière de mortalité infantile en Iran.

**Méthodes** Les données de l'enquête démographique et de santé, représentative à l'échelle provinciale, qui a été effectuée en Iran en 2000, ont été analysées. Un modèle de Probit dichotomique et ordonné hiérarchiquement a servi au développement d'un indicateur du statut socioéconomique des ménages. L'inégalité en matière de mortalité juvénile a été évaluée à l'aide de l'odds ratio (OR) de la mortalité juvénile entre les quintiles socioéconomiques inférieur et supérieur, tant au niveau provincial que national, et de l'indice de concentration, une mesure de l'inégalité reposant sur la distribution socioéconomique dans son ensemble.

**Résultats** Une tendance décroissante a été mise en évidence entre le taux de mortalité juvénile et les quintiles socioéconomiques.

L'odds ratio entre les plus riches et les plus démunis était de 2,34 (IC à 95 % : 1,78 - 3,09). L'indice de concentration de la mortalité juvénile en Iran valait -0,1789 (CI à 95 % : -0,2193 à -0,1386). En outre, l'inégalité en matière de mortalité juvénile entre les quintiles inférieur et supérieur était significative et en faveur des plus riches dans la plupart des provinces. La valeur de cette inégalité était cependant variable d'une province à une autre.

**Conclusion** L'inégalité socioéconomique en matière de mortalité juvénile est en faveur des plus riches pour le pays dans son ensemble et dans la plupart des provinces, mais le degré de corrélation varie d'une province à l'autre. Il est donc important de prendre en compte la moyenne nationale, mais aussi la distribution à l'échelle provinciale de cet indicateur de la santé de la population.

## Resumen

**Desigualdades socioeconómicas en mortalidad infantil en el Irán y en sus provincias**

**Objetivo** Medir las desigualdades socioeconómicas en términos de mortalidad infantil en el Irán.

**Métodos** Analizamos datos de la Encuesta de Demografía y Salud realizada en el Irán en 2000, con datos representativos de las provincias. Utilizamos un modelo probit dicotómico jerarquizado para elaborar un indicador de la situación socioeconómica de los hogares, y procedimos a evaluar las desigualdades en mortalidad infantil utilizando la razón de posibilidades de esta mortalidad entre los quintiles socioeconómicos inferior y superior a nivel tanto provincial como nacional, así como el índice de concentración, una medida de desigualdad basada en la distribución socioeconómica general.

**Resultados** Hallamos una tendencia decreciente de la tasa de mortalidad infantil en relación con los quintiles socioeconómicos.

La razón de posibilidades entre el más pobre y el más rico fue de 2,34 (IC95%: 1,78-3,09). El índice de concentración de la mortalidad infantil en el Irán fue de -0,1789 (IC95%: de -0,2193 a -0,1386). Además, la desigualdad en mortalidad infantil entre los quintiles inferior y superior fue significativamente favorable a los más acomodados en la mayor parte de las provincias. Sin embargo, la magnitud de la desigualdad difería de una provincia a otra.

**Conclusión** Las desigualdades socioeconómicas en mortalidad infantil son favorables a los más acomodados tanto en el conjunto del país como en la mayoría de sus provincias, pero el grado de correlación varía según la provincia. Además de la media nacional, es importante tener en cuenta la distribución por provincias de este indicador de la salud de la población.

## ملخص

**مظاهر التفاوت الاجتماعي والاقتصادي في معدلات وفيات الرضع في إيران وفي سائر مناطقها**

بالشريحة الخمسية الاجتماعية الاقتصادية. وكانت نسبة الأرجحية للأشخاص الأكثر فقراً مقارنة بالأشخاص الأكثر غنى 2.34 (بفاصلة ثقة 95% إذ تراوحت نسبة الأرجحية بين 198 و3.09). وكانت منسب التركيز في معدلات وفيات الرضع في إيران 0.1789 (بفاصلة ثقة 95% إذ تراوحت منسب التركيز بين 0.1386 و0.1386). علاوة على ذلك، فقد كانت مظاهر التفاوت في معدلات وفيات الرضع بين المستوى الأدنى والأعلى، ضمن الشريحة الخمسية، كبيرة، وجاءت لصالح الأشخاص الأغنياء في معظم المناطق. الاستنتاج: إن تفاوت معدلات وفيات الأطفال الرضع تأتي لصالح الأغنياء في البلاد بصفة عامة، وفي معظم المناطق. إلا أن درجة العلاقة تتفاوت فيما بين المناطق. ومن المهم، على الصعيد الوطني، أخذ التوزيع ضمن المناطق لهذا المؤشر الصحي للمواطنين بعين الاعتبار.

**الهدف:** قياس مظاهر التفاوت الاجتماعي والاقتصادي في معدلات وفيات الرضع في إيران.

**الطريقة:** قمنا بتحليل المعطيات المأخوذة من المسح الديموغرافي والصحي الذي يمثل المناطق المختلفة، والذي كان قد أجرى في عام 2000. وقمنا باستخدام نموذج وحدة احتمالية ترتيبية ثنائية التفرع لتطوير مؤشر للحالة الاجتماعية الاقتصادية للأسر. وقمنا بتقييم مظاهر التفاوت في معدلات وفيات الرضع، باستخدام نسبة أرجحية لمعدلات وفيات الرضع بين أدنى وأعلى مستوى اجتماعي واقتصادي ضمن الشريحة الخمسية، على المستويين، المناطقي والوطني، مع استخدام منسب التركيز، وهو مقياس لمظاهر التفاوت، مبني على كامل التوزيع الاجتماعي والاقتصادي.

**النتائج:** وجدنا أن هناك اتجاهاً متناقصاً في معدلات وفيات الرضع فيما يتعلق



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