



The Burden of Asthma in Children Aged 0-14 Years in Asia: A Systematic Analysis for the Global Burden of Disease Study 2019

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ABSTRACT

Aim: Asthma is the most common chronic disease in children and it imposes a huge burden on the health systems of countries. The aim of the present study was to investigate the burden of asthma disease in children in Asia during the period of 1990-2019.

Materials and Methods: All data sources from the Global Burden of Disease study (2019) were used to estimate the breast cancer prevalence, mortality, disability-adjusted life years and asthma rates in children aged 0-14 years in Asia from 1990 to 2019. We estimated all-cause and cause-specific mortality, years of life lost (YLLs), years lived with disability (YLDs), disability-adjusted life years and attributable risks.

Results: There is a positive and significant correlation between the human development index (HDI) and disease incidence in both sexes ($r=0.417$, $p<0.05$), and this correlation is positive and significant in both females ($r=0.401$, $p<0.05$) and males ($r=0.420$, $p<0.05$). There is also a significant negative correlation between HDI and disease mortality in both sexes ($r=-0.475$, $p<0.05$) and this negative correlation is significant in both females ($r=-0.459$, $p<0.05$) and males ($r=-0.483$, $p<0.05$). The study of YLDs showed that there is a significant negative correlation between HDI and YLL in both sexes ($r=-0.474$, $p<0.05$), and in women ($r=-0.456$) and men ($r=-0.483$, $p<0.05$).

Conclusion: Given that YLL is higher in countries with low HDI, greater attention must be paid to reduce the incidence of and premature deaths attributable to asthma in these countries.

Keywords: Burden of disease, asthma, children, Asia

Introduction

Pediatric asthma is a serious public health problem worldwide, which can wield considerable influence on quality of life. Globally, asthma ranks 16th among the leading causes of years lived with disabilities and 28th among the primary causes of burden of disease, as assessed by disability-adjusted life years (DALYs) (1). The global

prevalence, disease, and mortality of asthma in children have increased significantly over the past 40 years. The World Health Organization (WHO) estimates that approximately 300 million people worldwide suffer from asthma, and this figure is expected to reach 400 million by 2025 (2). Globally, the mortality rate of pediatric asthma ranges from 0 to 0.7 per 100,000 people (3,4). Among children, asthma is the

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most common chronic disease, ranking among the top 20 causes of DALY worldwide in children of all ages (5).

There is considerable geographical variation in the prevalence, severity, and mortality of asthma. While the prevalence of asthma is greater in high-income countries, more asthma-related deaths are reported in low-income countries (6). It has been shown that the prevalence of asthma in children and adults may have peaked in some areas, particularly in high-income countries, but it may have experienced an upturn in low- and middle-income countries (LMICs) (7).

The prevalence of asthma varies significantly in countries worldwide (7). In particular, the lifetime prevalence of asthma has remained constant or even declined in high-income countries, while in the majority of LMICs, especially in Eastern Europe, Latin America and North Africa, it has been on the rise (7,8). In Europe, the prevalence of this disease has escalated in children (9).

Children in LMICs cope with a disproportionately higher burden of disease, especially in terms of illness and mortality. One of the main reasons of hospitalization, especially in children under 5 years of age in LMICs, is asthma, the prevalence of which has risen over the past two decades. In recent years, the prevalence of asthma symptoms in children and adolescents, especially in LMICs, has taken an upturn worldwide. It seems that host (genetics, atopy) and environmental factors (microbial exposure, passive smoking exposure, and air pollution) are involved in this process. The rising prevalence observed in metropolitan areas compared to rural areas, and generally in industrialized countries, highlights the role of air pollution in the onset of asthma (10,11).

Some of the highest rates of asthma-related deaths are reported in the Asia-Pacific region (2). Despite the availability of effective drugs since the 1990s (12), most adult and pediatric patients worldwide, especially in the Asia-Pacific region (13,14), have been unsuccessful in the control of asthma. According to a 2013 study, 7.6% of asthma patients in the study population had properly controlled their asthma, with the highest rates reported in Singapore (14%) and the lowest rates in India (0%) and China (2%) (15). Therefore, the present study aimed to investigate the burden of asthma disease in children aged 0-14 in Asia in 2019.

Materials and Methods

This is a correlational analytical study designed to investigate the burden of asthma in children in Asia during

the period 1990 to 2019. The incidence, prevalence, death toll, years of life lost (YLLs) (i.e. years that a person could have led a useful life, but were lost due to premature death), years lived with disability (YLDs) (i.e. the number of years the patient was incapacitated or disabled due to illness), the burden of disease and DALYs (i.e. the sum of YLLs and YLDs due to prevalent cases of the disease or health condition in a population) were analyzed to create an index. This index was defined and employed in the Global Burden of Disease (GBD) study to estimate disease burden based on age and sex from 1990 to 2019.

Data on pediatric asthma in Asia, which are available from the GBD 2019, were taken from online sources (<https://vizhub.healthdata.org/gbd-compare/>) and subjected to analysis. The burden of asthma was also taken into account in the Human Development Index (HDI), which is estimated annually for all developing and developed countries and is made publically available on the WHO website for researchers.

Countries are divided into several categories based on their degree of human development (very high human development, high human development, medium human development and low human development). The numerical value of HDI, which is between zero and one, exhibits how far each country has been successful in attaining the highest possible value (i.e. one), and therefore allows for comparisons between countries to be made. As an overview of human development, HDI measures the average success achieved in a country in the three main dimensions, namely a long and healthy life, access to education and living standards.

Statistical Analysis

In this study, the two-variable correlation method was used to analyze the extracted data to examine the correlation between the burden of asthma and HDI. The significance level was considered to be $p < 0.05$. The analyses were made using Stata 12 software (Stata Corp, College Station, TX, USA).

Results

The results of the study suggest that the incidence of asthma in children aged 0-14 years in the world is 1,030.3 per 100,000, with this being higher in males than females (1,109.9 vs. 945.38 per 100,000). The mortality rate of this disease in children is 0.05 per 100,000, which is almost equal in both sexes. In the study of asthma burden of disease in children, the results showed that the asthma-related YLL is 42.1 per 100,000, which is greater in females

than in males. Also, the asthma-related YLD is 167.16 per 100,000, which is higher in males than in females (184.2 vs. 150.5 per 100,000). Finally, asthma-related DALY is 210 per 100,000, and this index is higher in males than in females (Table I).

Figure 1 displays the epidemiology of incidence, mortality and burden of disease indices in each continent and globally in 1990 and 2019. As depicted in the figure, the incidence of pediatric asthma in the world and all continents (except continental Europe) was lower in 2019 compared to 1990. Additionally, the highest incidence of asthma cancer in 1990 and 2019 was reported in the Americas and the lowest in Asia.

As for the mortality rate of asthma, the results showed that the mortality rate of this disease was lower in the world and all continents (except continental Europe) in 2019 compared to 1990. The highest mortality rates in 1990 and 2019 were reported in Africa.

With regard to the burden of disease indices, the results showed that asthma-related YLDs were lower in 2019 relative to 1990 in the world and all continents (except continental Europe). The highest asthma-related YLDs in children in 1990 and 2019 were reported in the Americas.

The results also demonstrated lower YLL in 2019 compared to 1990 in the world and all continents. The highest rates of YLL in 1990 and 2019 were seen in Africa.

The results of analysis showed that the DALY index had plummeted in the world and all continents by 2019 when compared to 1990. The highest rate of pediatric asthma-related DALYs in 1990 and 2019 were reported in the Americas (Figure 1).

Table I. Burden of asthma in children 0-14 years in the world in 2019 (Source: GBD Compare)

Index	Rate per 100,000		
	Male	Female	Both
Incidence	1109.9 (736.6, 1568.3)	945.38 (627.3, 1315.1)	1030.3 (683.6, 1449.5)
Death	0.5 (0.4, 0.62)	0.511 (0.39, 0.69)	0.0505 (0.4, 0.62)
YLL	41.5 (33.3, 52.02)	42.6 (32.5, 58.03)	42.1 (33.6, 52.4)
YLD	184.2 (107.7, 298.8)	150.5 (88.66, 242.2)	167.9 (98.96, 270.3)
DALY	225.8 (145.8, 342.3)	193.2 (128.9, 289.9)	210 (137.8, 314.83)

DALY: Disability-adjusted life years, YLL: Years of life lost, YLD: Years lived with disability

Table II shows the incidence and mortality of asthma in children aged 0-14 for Asian countries in 2019. The highest incidence of pediatric asthma was reported in the Philippines (1,686.9 per 100,000), the United Arab Emirates (1,500 per 100,000) and Kuwait (1,343,700 per 100,000) and the lowest rates in Nepal (176.5 per 100,000), Bangladesh (224.4 per 100,000) and Bhutan (237.9 per 100,000).

The results show that the highest mortality rates of pediatric asthma in Asia were reported in the Philippines (2.5 per 100,000), Myanmar (2.3 per 100,000) and Timor-Leste (2.04 per 100,000) and the lowest mortality rates were in Armenia (0.008 per 100,000) and Tajikistan (0.01 per 100,000).

Table III shows the burden of asthma disease (DALY, YLL, YLD) in children aged 0-14 by country and sex in Asia. As can be seen, the highest YLL in both sexes (218.8 per 100,000), females (202.3 per 100,000), and males (220.6 per 100,000) were reported in the Philippines. The highest rates of YLD in both sexes (594.8 per 100,000), in males (686.5 per 10,000) and in females (499.1 per 100,000) were reported in Georgia. Finally, the highest DALY index in both sexes (616.9 per 100,000), in males (713.3 per 100,000) and in females (516.4 per 100,000) were also reported in Georgia.

Figure 2 shows the trend of asthma-related indices in children aged 0-14 years from 1990 to 2019. As is depicted, the incidence rate of asthma is higher in countries with high income while the mortality rate of asthma is declining in all income level countries.

During the period 1990 to 2019, the mortality rate was lower in high-income countries than in low-income countries. According to the graph of the YLD index, the highest YLD between 1990 and 2019 was reported in high-income countries. The graph of the YLL index also suggests that the highest YLL was related to low-income countries. Finally, according to the graph of the DALY index, the highest DALYs from 1990 to 2019 were recorded in low-income countries.

Figure 3 shows the relationship of HDI with incidence, mortality, disease burden (DALY), YLD and YLL in children aged 0-14 years in Asia in 2019. As depicted in this figure, there is a positive and significant correlation between HDI and the incidence of disease in both sexes ($r=0.420$, $p<0.05$) and this correlation is positive and significant in both females ($r=0.401$, $p<0.05$) and males ($r=0.417$, $p<0.05$).

According to the results, there is a significant negative correlation between HDI and disease mortality in both sexes ($r=-0.483$, $p<0.05$), and this negative correlation is

significant in both females ($r=-0.459$, $p<0.05$) and males ($r=-0.475$, $p<0.05$).

The results reflect that there is a significant negative correlation between HDI and YLL in both sexes ($r=-0.483$, $p<0.05$), females ($r=-0.456$, $p<0.05$) and males ($r=-0.474$, $p<0.05$).

The findings also suggested a positive correlation between HDI and YLD in both sexes ($r=0.219$, $p>0.05$), females ($r=0.230$, $p>0.05$) and males ($r=0.225$, $p>0.05$), but these correlations were not statistically significant.

According to the findings, there was no significant relationship between HDI and burden of disease (DALY) in both sexes ($r=0.08$, $p>0.05$), females ($r=0.05$, $p>0.05$) and males ($r=0.07$, $p>0.05$).

Table IV shows the association between the components of HDI and each asthma index in children aged 0-14 years. As can be seen, the incidence of asthma is positively and significantly related to the gross national income per 1,000 capita ($r=0.424$, $p<0.05$) and the life expectancy at birth ($r=0.409$, $p<0.05$), whereas this correlation was not significant for mean years of schooling ($r=0.281$, $p>0.05$) or expected years of schooling ($r=0.255$, $p>0.05$).

The results revealed that the asthma mortality was negatively related to gross national income per 1,000 capita ($r=-0.302$, $p<0.05$), life expectancy at birth ($r=-0.472$, $p<0.05$), mean years of schooling ($r=-0.484$, $p<0.05$) and expected years of schooling ($r=-0.397$, $p<0.05$).

Moreover, asthma-related YLD was significantly negatively correlated with gross national income per 1,000

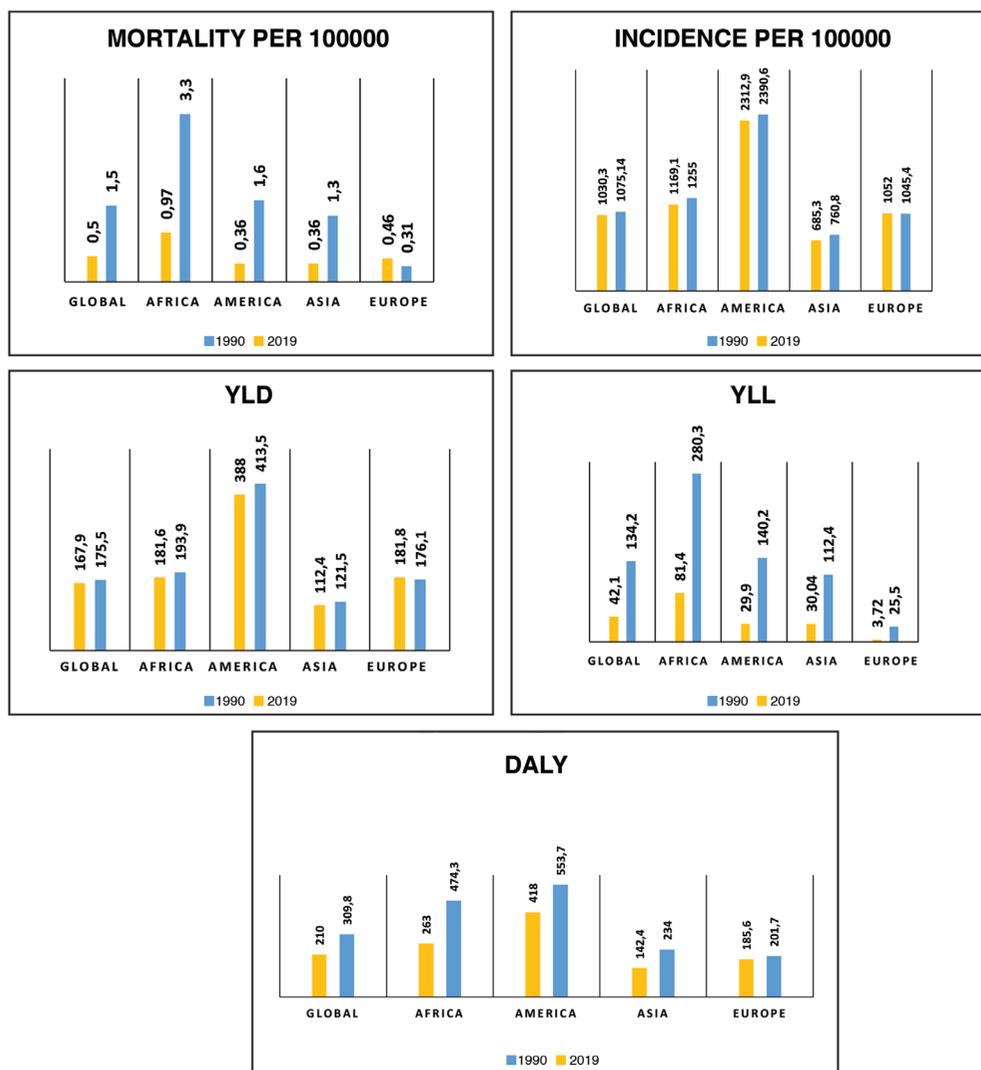


Figure 1. Distribution incidence, mortality and burden of asthma in children 0-14 years by continent (Source: GBD Compare)

YLL: Years of life lost, YLD: Years lived with disability, DALY: Disability-adjusted life years

Table II. Incidence and mortality of asthma in children aged 0-14 years in Asia in 2019 (Source: GBD Compare)

Country	Incidence			Mortality		
	M	F	Both	M	F	Both
Afghanistan	1095.57	1050.07	1138.54	0.87	0.86	0.88
Armenia	737.48	704.34	766.55	0.01	0.01	0.01
Azerbaijan	710.06	682.12	734.35	0.03	0.04	0.02
Bahrain	1180.14	1108.76	1248.46	0.23	0.32	0.14
Bangladesh	224.49	270.82	179.31	0.22	0.12	0.31
Bhutan	237.99	273.75	202.82	0.25	0.26	0.25
Brunei	1042.79	982.09	1098.53	0.10	0.07	0.13
Cambodia	853.74	778.31	925.43	0.67	0.64	0.70
China	869.18	736.66	981.91	0.02	0.02	0.03
Georgia	755.34	629.29	870.24	0.28	0.22	0.33
India	385.20	302.34	460.71	0.21	0.20	0.21
Indonesia	1024.11	839.07	1199.00	0.96	1.07	0.85
Iran	1106.55	984.06	1222.88	0.14	0.15	0.14
Iraq	1145.07	1072.42	1213.96	0.15	0.14	0.16
Israel	874.59	740.42	1001.93	0.04	0.05	0.04
Japan	1239.91	1304.99	1178.14	0.03	0.03	0.03
Jordan	1289.69	1171.23	1401.98	0.11	0.11	0.11
Kazakhstan	594.31	591.43	597.05	0.06	0.04	0.07
Kuwait	1343.76	1189.99	1488.56	0.13	0.14	0.11
Kyrgyzstan	812.35	790.94	832.70	0.02	0.02	0.01
Lao People's Democratic Republic	692.05	557.58	821.88	2.01	1.99	2.04
Lebanon	1312.68	1226.16	1392.43	0.08	0.07	0.08
Malaysia	925.17	909.90	939.54	0.13	0.13	0.14
Maldives	990.26	919.97	1056.31	0.36	0.45	0.27
Mongolia	723.72	692.47	753.82	0.06	0.05	0.07
Myanmar	604.46	473.67	731.07	2.35	2.14	2.54
Nepal	176.60	215.18	139.73	0.09	0.13	0.06
Oman	1290.30	1187.35	1389.27	0.02	0.03	0.02
Pakistan	317.93	358.60	280.05	0.39	0.15	0.60
Philippines	1686.94	1598.00	1770.21	2.53	2.41	2.65
Qatar	1163.38	1187.36	1140.40	0.10	0.08	0.12
Saudi Arabia	1002.70	815.25	1172.31	0.09	0.10	0.08
Singapore	1087.16	970.54	1202.16	0.04	0.04	0.04
Sri Lanka	852.69	805.80	898.10	0.29	0.28	0.30
Syrian Arab Republic	1036.33	1021.54	1050.44	1.40	1.00	1.79
Tajikistan	724.16	690.97	755.46	0.01	0.02	0.01
Thailand	1057.84	955.38	1154.75	0.33	0.26	0.38
Timor-Leste	988.45	948.68	1025.96	2.05	2.03	2.06
Turkey	1198.22	1173.47	1221.65	0.13	0.11	0.15
Turkmenistan	732.89	704.16	759.80	0.06	0.06	0.07
United Arab Emirates	1500.03	1386.60	1607.38	0.14	0.10	0.17
Uzbekistan	829.09	831.76	826.59	0.03	0.04	0.03
Vietnam	887.71	758.54	1007.34	0.28	0.22	0.33
Yemen	1104.65	1037.75	1168.20	0.68	0.78	0.59
Republic of Korea	1006.14	936.26	1071.96	0.02	0.01	0.02
Democratic People's Republic of Korea	952.92	822.80	1076.48	0.08	0.07	0.09

DALY: Disability-adjusted life years, YLL: Years of life lost, YLD: Years lived with disability, M: Male, F: Female

Table III. Burden of asthma in children aged 0-14 years in Asia in 2019 (Source: GBD Compare)

Country	YLL			YLD			DALY		
	M	F	Both	M	F	Both	M	F	Both
Afghanistan	71.21	70.65	71.74	167.81	157.84	177.23	239.02	228.49	248.97
Armenia	0.72	0.53	0.89	108.54	102.29	114.02	109.26	102.81	114.91
Azerbaijan	2.18	3.16	1.32	105.62	99.92	110.57	107.80	103.09	111.89
Bahrain	18.77	26.63	11.26	199.77	186.14	212.81	218.54	212.76	224.07
Bangladesh	17.50	9.63	25.18	35.09	42.90	27.47	52.59	52.53	52.65
Bhutan	20.94	21.24	20.64	36.95	43.17	30.84	57.89	64.41	51.48
Brunei	8.36	5.79	10.71	181.11	166.48	194.55	189.47	172.26	205.27
Cambodia	55.78	53.91	57.55	133.91	120.75	146.41	189.69	174.67	203.96
China	1.90	1.56	2.20	130.89	109.95	148.70	208.15	178.71	235.38
Georgia	27.34	22.06	32.15	594.84	499.20	686.54	616.95	516.45	713.32
India	22.41	18.11	26.51	542.03	453.92	626.14	87.91	67.22	106.76
Indonesia	79.43	89.05	70.33	163.75	133.43	192.42	243.18	222.48	262.75
Iran	11.60	11.93	11.29	166.53	145.02	186.96	178.13	156.95	198.26
Iraq	12.57	11.76	13.34	186.75	173.16	199.63	199.32	184.92	212.98
Israel	3.36	3.82	2.92	170.43	135.69	203.39	173.79	139.52	206.31
Japan	2.43	2.69	2.17	205.14	212.89	197.79	207.57	215.58	199.96
Jordan	8.92	8.79	9.06	219.42	195.81	241.80	228.34	204.59	250.85
Kazakhstan	4.48	3.18	5.73	83.06	81.88	84.18	87.55	85.06	89.91
Kuwait	10.40	11.56	9.31	224.70	194.79	252.86	235.10	206.36	262.17
Kyrgyzstan	1.50	1.91	1.10	117.71	113.36	121.85	119.21	115.27	122.95
Lao People's Democratic Republic	167.34	166.32	168.33	104.93	82.77	126.32	272.27	249.09	294.65
Lebanon	6.25	5.93	6.55	214.46	197.69	229.92	220.72	203.62	236.47
Malaysia	10.76	10.04	11.43	152.52	151.52	153.46	163.28	161.56	164.90
Maldives	29.90	37.40	22.86	156.73	145.04	167.72	186.63	182.44	190.58
Mongolia	4.93	3.86	5.96	100.60	95.27	105.73	105.53	99.13	111.69
Myanmar	197.21	180.44	213.44	92.07	70.48	112.97	289.28	250.92	326.41
Nepal	7.72	10.99	4.60	26.69	33.09	20.57	34.41	44.08	25.17
Oman	1.98	2.09	1.88	164.43	139.26	188.23	207.94	188.66	226.47
Pakistan	32.10	12.57	50.29	48.16	54.05	42.67	80.26	66.62	92.96
Philippines	211.81	202.37	220.66	282.30	270.34	293.51	494.12	472.71	514.16
Qatar	8.23	6.60	9.80	188.99	194.30	183.91	197.22	200.89	193.71
Saudi Arabia	7.38	8.11	6.72	160.72	126.88	191.33	168.09	134.98	198.05
Singapore	2.91	2.94	2.88	181.82	157.25	206.05	184.73	160.19	208.93
Sri Lanka	23.35	22.48	24.19	142.38	133.86	150.62	165.73	156.34	174.82
Syrian Arab Republic	114.52	81.61	145.90	172.33	170.09	174.47	286.85	251.70	320.36
Tajikistan	1.01	1.23	0.81	103.08	97.04	108.76	104.09	98.28	109.57
Thailand	26.64	21.59	31.41	185.40	165.77	203.97	335.94	302.03	368.86
Timor-Leste	171.68	170.92	172.41	162.13	156.47	167.47	333.82	327.39	339.88
Turkey	10.92	9.09	12.65	205.23	199.44	210.72	216.15	208.52	223.37
Turkmenistan	5.05	4.57	5.49	105.14	99.24	110.66	110.18	103.81	116.15
United Arab Emirates	10.94	7.89	13.82	267.34	244.85	288.62	278.28	252.74	302.44
Uzbekistan	2.52	2.96	2.10	121.58	121.10	122.03	124.10	124.07	124.13
Vietnam	23.17	18.45	27.53	145.51	122.62	166.71	168.68	141.07	194.24
Yemen	55.85	63.80	48.30	175.47	162.02	188.25	231.32	225.82	236.54
Republic of Korea	1.48	1.14	1.79	176.15	159.25	192.07	177.63	160.39	193.86
Democratic People's Republic of Korea	6.38	5.70	7.02	153.62	130.97	175.12	159.99	136.67	182.14

DALY: Disability-adjusted life years, YLL: Years of life lost, YLD: Years lived with disability, M: Male, F: Female

capita ($r=-0.303$, $p<0.05$), life expectancy at birth ($r=-0.473$, $p<0.05$), mean years of schooling ($r=-0.481$, $p<0.05$) and expected years of schooling ($r=-0.393$, $p<0.05$).

According to the results, there was no significant correlation between DALY index and components of HDI ($p>0.05$). Moreover, the correlation between YLD and components of HDI was not significant ($p>0.05$).

Discussion

Global asthma deaths are estimated to have dropped by about a third between 1990 and 2010. However, there are great discrepancies between countries. Data from the United States, Canada, New Zealand, Australia, Western Europe, Hong Kong, and Japan show that the peak of their mortality rate (0.62 per 100,000 people) in the mid-1980s in children and adults had declined progressively by the mid-

2000s, dropping to less than 0.23 per 100,000 people. These findings, accompanied by the formation of national and international asthma management guidelines, demonstrate the potential positive impact of policy measures to reduce asthma mortality (16,17). Most asthma deaths are reported in low-income countries (6). In this regard, the results of the study showed that the mortality rate of this disease was lower in 2019 compared to 1990 in the world and all continents (except continental Europe), with the highest mortality rate in 1990 and 2019 being seen in Africa. On the other hand, while the general asthma mortality rate in the United States declined between 1999 and 2015, the mortality rate in children aged 1 to 14 years remained unchanged (18).

The prevalence and incidence of asthma varies considerably in different countries. The incidence of pediatric

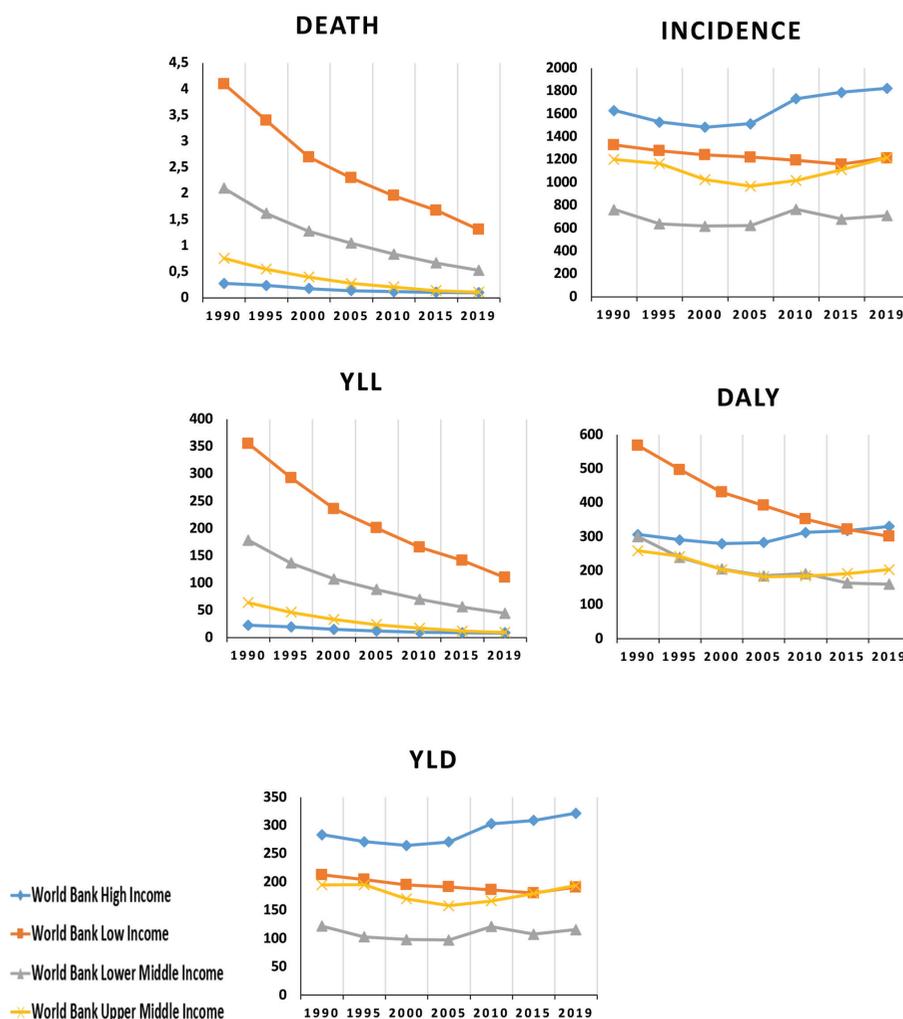


Figure 2. Trend incidence, mortality and burden (YLL, YLD, DALY) of asthma in children aged 0-14 years by world bank income level during 1990-2019
YLL: Years of life lost, YLD: Years lived with disability, DALY: Disability-adjusted life years (Source: GBD Compare)

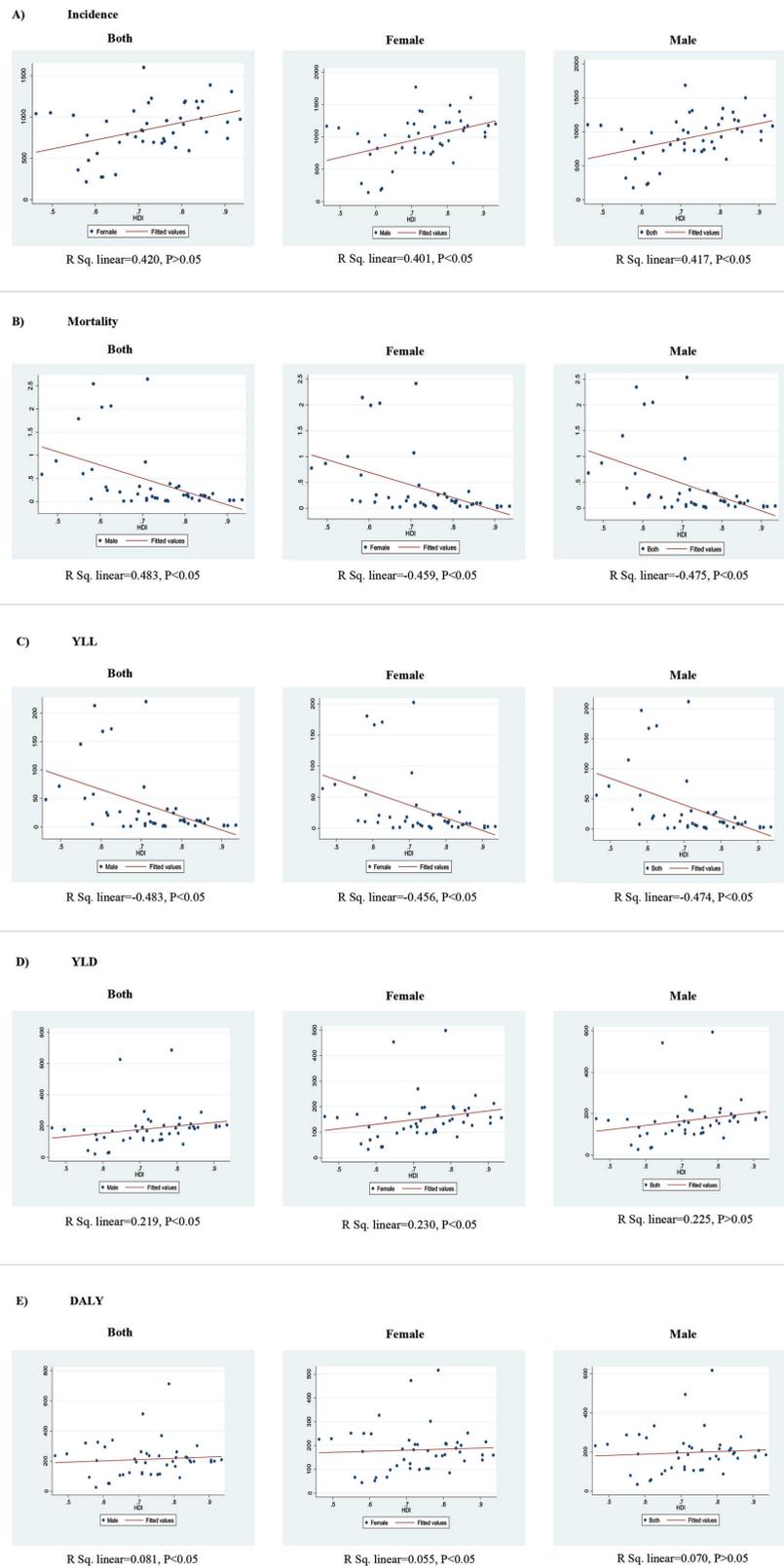


Figure 3. Relationship of HDI with: A) Incidence, B) Mortality, C) YLL, D) YLD and E) DALY in children aged 0-14 years in Asia in 2019
YLL: Years of life lost, YLD: Years lived with disability, DALY: Disability-adjusted life years

Table IV. Correlation of asthma in children aged 0-14 years white decomposites of human development index in Asia in 2019

HDI	Incidence		Mortality		DALY		YLL		YLD	
	r	P	r	P	r	P	r	P	r	P
Gross national income per 1000 capita	0.424	**	-0.302	**	0.038	*	-0.303	**	0.138	*
Mean years of schooling	0.281	*	-0.484	**	0.048	*	-0.481	**	0.232	*
Life expectancy at birth	0.409	**	-0.472	**	0.034	*	-0.473	**	0.150	*
Expected years of schooling	0.255	*	-0.397	**	0.102	*	-0.393	**	0.241	*

Significant level is less than 0.05.
 *= Not significant, **= Significant
 DALY: Disability-adjusted life years, HDI: Human development index, YLL: Years of life lost, YLD: Years lived with disability, M: Male, F: Female

asthma has risen sharply since the mid-1900s, especially in Western Europe. According to Phase 1 of the International Study of Asthma and Allergies in Children, asthma prevalence varied by more than 15 fold between English-speaking countries and other parts of the world, such as Eastern Europe and Asia in 1994 and 1995 (7). The incidence and prevalence of asthma also vary by gender during the lifetime. Pre-adolescent males have a higher incidence and prevalence of asthma as well as hospitalization rates than females of the same age, but this trend reverses during adolescence (19,20).

These results, aligned with the present study, show that the incidence of pediatric asthma is higher in males than females. This gender difference may be attributed to the more limited airway capacity of men in comparison to women in early life, which is caused by the effects of various hormonal factors (21). According to the results of the present study, the incidence of pediatric asthma had declined in the world and all continents (except Europe) by 2019 in comparison to 1990, and the highest incidence of asthma in 1990 and 2019 was reported in the Americas and the lowest in Asia.

Therefore, a decreased prevalence of asthma may reflect improved asthma control by augmented medication intake and a more rigorous follow-up or compliance. It is difficult to register the declining incidence of asthma because, in order to develop patterns that could be compared to an ideal group in the same geographical area, a parallel cohort study with specific age groups is required. These challenges may partly explain why studies in Australia and the United Kingdom have not consistently shown a fall in asthma prevalence, and why time trends in European and Asian countries between the 1970s and mid-2000s have been inconsistent (22).

According to the global ranking of asthma DALY in children in 1990 and 2010, asthma was among the top 20 causes of DALY at all ages, and the most common cause

of DALY in the 10-19 age group (20). Asthma was ranked 23rd as a cause of disease burden in 2015 (23). In keeping with these results, the present study revealed that the burden of disease had dropped in 2019 when compared to 1990.

According to the results of the 1990-2019 GBD study, the age-standardized mortality rate of asthma in 2015 was higher in men than in women. Conversely, the age-standardized DALY rates for asthma were identical in men and women. In 2015, more women than men had asthma, which indicates a reversal of the higher male-to-female ratio in adolescence. Given the prevalence of asthma at all ages, YLDs account for more than 60% of the DALYs (23). However, the results of the present study showed equal mortality rates in both sexes while DALY and YLD rates were higher in males than females.

The present study displayed a significant negative correlation between mortality and HDI. In this regard, based on the results of the global burden of asthma study in 1990-2019, the highest reduction in the prevalence and aged-standardized mortality was recorded in countries included in the high-middle socio-demographic index (SDI) quintile and low-middle-SDI quintile between 1990 and 2015 (23).

Informed by the results of the global asthma burden of disease study in 1990-2015, the age-standardized DALYs dropped between 1990 and 2015, which are consistent with the results of the present study.

This reduction in DALY was to a larger degree attributed to decreased mortality and to a lesser degree to reduced YLDs. These results reflect a huge improvement in mortality reduction rather than a change in the prevalence and incidence of asthma (23). Indeed, the reduced mortality rate observed in high-income countries reflects better access to health care following the application of the International Asthma Guidelines (24), which indicates a strong link between SDI and mortality rather than the prevalence of asthma (23).

Decreased age-standardized DALY rates of asthma were observed in the moderate-low SDI quintile. The analysis of expected association between SDI and DALY rates of all ages reflected a decrease in asthma rates with elevated SDI in both sexes. The present study, however, demonstrated a significant relationship between HDI and DALY. The age-standardized asthma rates are estimated at more than 1,200 per 100,000 in Afghanistan, Central African Republic, Fiji, Kiribati, Lesotho, Papua New Guinea and Swaziland. In Eastern and Central European countries, China, Italy and Japan, asthma DALY rates are between 100 and 200 per 100,000 people (23).

Also, based on the results of the global burden of asthma study in 1990-2019, asthma-related DALYs in both sexes fell uniformly with an increase in SDI. The relationship between asthma-induced DALY levels and SDI largely reflects changes in YLLs. In 1990 (when SDI was at its lowest), asthma-related DALYs in South Asia exceeded expectations, but later matched those projected in 2019. Asthma-related DALY rates were lower than expected in Central Europe, Eastern Asia, and sub-Saharan Africa (23).

Conclusion

Given that there is a positive correlation between the incidence of asthma and HDI, it is worth considering factors that can exacerbate pediatric asthma in some countries. Moreover, since YLL is higher in countries with low human development, greater attention should be allocated to prioritizing and planning health services in these countries to decrease premature deaths.

Ethics

Ethics Committee Approval: This study was approved by the ethics committee of Lorestan University of Medical Sciences, Ethics Committee (number: IR.LUMS.REC.1399.219, date: 2020.11.16).

Informed Consent: This is a correlational analytical study.

Peer-review: Externally and internally peer-reviewed.

Authorship Contributions

Design: E.G., K.R., Z.Z., V.M., Z.K., Data Collection and/or Processing: E.G., Z.K., Analysis or Interpretation: E.G., K.R., Z.K., Literature Review: E.G., K.R., Z.Z., V.M., Z.K., Writing: E.G., K.R., Z.Z., V.M., Z.K.

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