RESEARCH ARTICLE

The economic impact of asthma treatment on patients, 2014-2017: The Vietnamese experience from a public hospital

Nghiem Quan Le,[1] Thy Van Tran,[2] Tam Thi Minh Tran,[3] Nga ThiKieu Dang,[4] Quoc-Ky Truong,[5] Trung Quang Vo[6]

Abstract

Objectives: To estimate the economic burden of asthma treatment by quantifying direct medical expenditures at one of Southern Vietnam's public hospitals base on the hospital perspective.

Methods: A retrospective, prevalence-based, cost-of-illness analysis was developed using the hospital's electronic medical record data to calculate the economic burden of asthma (ICD-10 code J45, J46) through direct medical costs from January 2014 to December 2017. All costs were converted to US dollars and to the year 2018. Data were analysed using descriptive statistics. The potential correlations between variables were evaluated using the chi-square test and bootstrap difference.

Results: The average direct medical cost of asthma was estimated to range from $34.7 to $55.3 per - outpatient and $45.1 to $107.2 per - inpatient annually. The total economic burdens for 4 years from 2014 to 2017 were $110,387.4 from outpatients and $13,413.8 from inpatients. The most influential component was medication cost.

Conclusions: Asthma places a high economic burden on individuals and the healthcare system in Vietnam. The findings of this study provide health administrators with important evidence to enhance surveillance of the disease and to allow suitable drafting of national health policy.

Keywords: Cost of illness, Direct medical cost, Asthma, Public hospital, Vietnam. (JPMA 69: S-2 (Suppl. 2); 2019)

Introduction

Asthma is a long-term heterogeneous inflammatory disease of the airways with intermittent symptoms. It is characterised by airway hyper-responsiveness and bronchospasm that result in attacks of wheezing, breathlessness, coughing, and chest tightness, especially in the early morning or at night.[1] The World Health Organization (WHO) report indicated a worldwide prevalence of this disease of approximately 300 million cases, with 200,000 deaths attributed to annually to asthma.[2,3] Further estimates indicated that 100 million people will be afflicted by 2025.[4]

Regardless of the level of socio-economic development, asthma occurs in every country with its incidence varying.Specifically, in the latter part of the 20th century, asthma increased two-fold in ten years in Western Europe as a whole, while deaths doubled to 5,000 a year in the United States (US).[5] In the European Union, the incidence rates in 2015 for children and adults were 9.4% and 8.2%, respectively, while in the US, these rates were 8.4% and 7.6%, respectively.[1] In the Asia-Pacific region, although single-country studies indicated a considerably lower asthma incidence than in America, Oceania, or Europe, the prevalence is expected to increase.[6]

Apart from its high morbidity, asthma is also recognised as a significant health problem because of its heavy social and economic burden. Worldwide, the economic costs related to asthma are evaluated to exceed those of HIV/AIDS and tuberculosis combined.[5] Despite the marked difference in costs among various countries in the Asia-Pacific region, the relative per-asthmatic direct costs are extremely high. For example, Lai et al. found a higher economic burden in this region in relation to per capita gross domestic product (GDP), as per-patient direct costs for asthma accounted for over 30% of the per capita healthcare spending in all countries in 2000.[7] In the same year, the percentage of medical costs for asthma in Singapore (32%) was almost triple that in the US.[7] In the US, asthma was assessed as the 13th highest priced medical condition in 2002.[8] Based on the evidence available from 2008-2013, the total expenditure attributable to asthma in the American economy was $81.9 billion (US Dollars) per year and the annual per-person medical cost of asthma was $3,266.[9] In 2015-2016, nearly 2.4 million Australians had asthma, and the total cost of asthma was about $28 billion per annum.[10]

Data on asthma-linked economic costs in Vietnam are limited. The Asthma Insights and Reality in Asia-Pacific study

[1]Department of Pharmacy Industry, [2,4]Department of Pharmacy Administration,Faculty of Pharmacy, University of Medicine and Pharmacy, Ho Chi Minh City, Vietnam. [3]Department of Pharmacy, PhuNhuan District Hospital, [5]Department of Pharmaceutical Chemistry, Pham Ngoc Thach University of Medicine, [6]Department of Economic and Administrative Pharmacy, Pham Ngoc Thach University of Medicine, Ho Chi Minh City, Vietnam.

Correspondence: Trung Quang Vo. Email: trungvq@pnt.edu.vn

indicated that Vietnam had a high use of hospitalizations, with 26% in-patient stays in 2000 collated as a regional average of 15%.[7] The total per-person direct healthcare expense was $141±12 per patient, with a mean total societal spending of US$184±16, which represented 35% and 46% of the per capita GDP in Vietnam, respectively.[7]

Healthcare systems must therefore judge the economic burden of this disease in order to understand its impact and to draft a suitable national policy.[1] To fulfill this purpose, the present study was designed to calculate the economic burden of asthma through direct medical costs and their relation with some basic elements at PhuNhuan Hospital in Ho Chi Minh city (HCMC) during the 4-year period from 2014 to 2017.

Patients and Methods

A retrospective, prevalence-based, cost-of-illness study was developed using the electronic medical record data of asthmatics presenting at PhuNhuan Hospital to judge the economic healthcare effects for four years running, from January 1 of 2014 to December 31 of 2017. Data were retrieved anonymized, and cost data analysis was performed based on the hospital perspective.

Ho Chi Minh City (HCMC), the largest metropolitan area in the Southeast of Vietnam, has 19 urban districts and 5 rural districts, with a total population of about 8.3 million in 2016, and covers an area of 2,061 square kilometers.[11] HCMC is the economic center of Vietnam as well as the largest medical center in the country and will become a medical center with high technology.[12] According to the Centre of Hands-on Actions and Networking for Growth and Environment, HCMC is the biggest polluter in the southern region, as it is home to a large number of traffic vehicles, industrial parks, and construction activities; this is an alarming problem for health, especially for asthmatics as a particularly sensitive subgroup.[13,14]

Officially established in 2007 in HCMC, PhuNhuan Hospital is a public hospital with a team of experienced and high expertise doctors and healthcare specialists, as well as state-of-the-art medical facilities for diagnosis and treatment. PhuNhuan Hospital has 14 departments with size 100 beds.[15] The hospital treats 1,000 patients per day, including many asthmatics. Although it has no respiratory department, PhuNhuan Hospital still has doctors trained in this specialty. In addition, the list of asthma-related medications is also sufficient to meet patient treatment needs.

The input for patient characteristics, as well as costs, was extracted incognito from PhuNhuan Hospital's electronic database with the hospital's ethical approval. Besides demographic information, the extracted data included the medical record number, date of admission, date of discharge, and itemized cost of each case. The patient characteristic data comprised year of birth, gender, location, visit type (outpatient visit or inpatient visit), length of stay (for inpatient visit), and healthcare insurance status. In this study, patients were divided into two age groups: pediatrics and adults. According to The 2016 Law on Children in Vietnam, the pediatric group refers to people under the age of 16 (0-15) years.[15] Individual medical service details (e.g., diagnosis, image techniques, pharmaceuticals, laboratory tests, hospital beds, and other service utilizations) were also recorded, along with the quantity used, reference unit, and cost of each unit.

This study included subjects with asthma as the main diagnosis, identified by searching the database for codes J45 and J46 of the International Classification of Diseases and Related Health Problems Version 10 (ICD-10 code) between the period from January 1 of 2014 to December 31 of 2017.[16]

Cases were excluded if they were insufficient or contained faulty information due to incorrect data entry into the hospital database. In addition, patients who did not maintain treatment at PhuNhuan Hospital or who did not comply with the hospital treatment protocol were also removed.

Direct medical costs refer to the expenses of treating acute and chronic asthma. Examples are the costs of diagnosis, imaging techniques, drug treatments, laboratory tests, hospital beds, and other service utilizations. The cost of a particular service is the product of the cost of a unit multiplied by the number of uses. The total direct medical cost for one patient is the sum of the cost of the services mentioned above for the treatment of that person or the sum of the health insurance coverage and out-of-pocket payments of the patient. To reflect real values, all costs for a given year were extrapolated to 2018 Vietnam currency values using the medical care component of the Consumer Price Index.[17] All charges were then converted from Viet Nam Dong to US dollars using an exchange rate of 22,467:1, based on the average exchange rate over the first six months of 2018, according to The Viet Nam State Bank.[18]

Data were analysed with IBM SPSS Statistics version 20.0 after tabulating with Microsoft Excel 2013. Categorical variables are presented as frequencies with percentages. The Chi-square test (or Fisher's exact test, when needed) was utilized for comparisons. A P-value of < 0.05 was considered statistically significant using two-sided tests. Normality of the data was assessed with the Quantile-Quantile Plots. The continuous variables relating to costs were determined using bootstrapping procedures with 1000 replications to calculate the mean with 95% confidence intervals (CI) owing to the data's non-normal distribution. Factors with two

continuous variables were also compared by bootstrapping with mean differences and 95% CI.

In the sensitivity analysis, the impact of each component of expense (diagnosis, image techniques, medication, laboratory tests, hospital bed, and other service utilization) on the total cost was calculated using an adjustment of ± 20% of the cost elements values in relation to the total cost. The aim of this analysis was to reapportion resources for more economic effectiveness for asthmatics.

This study was granted ethical approval from the PhuNhuan Hospital ethical review committee. No patient's personal identifier was exported and all data were obtained and analyzed anonymously and de-identifiably.

Results

The sociodemographic characteristics of the sample

Table-1: Demographic characteristics of the patients with asthma [N(%)].

Variable	Outpatients					Inpatients				
	2014	2015	2016	2017	P-value	2014	2015	2016	2017	P-value
No. of patients	692	514	459	691		50	49	79	39	
Age (years)										
Mean (95% CI)	42.0 (40.0-43.8)	36.3 (34.1-38.6)	39.3 (36.9-41.6)	44.4 (42.6-46.2)		22.4 (15.6-30.0)	22.8 (15.8-31.4)	25.3 (19.3-31.2)	32.3 (23.4-41.9)	
Age group (years)										
Paediatric (<16)	168 (24.3)	190 (37.0)	142 (30.9)	134 (19.4)	< 0.001[a]	35 (70.0)	35 (71.4)	52 (65.8)	19 (48.7)	0.111[a]
Adult (≥16)	524 (75.7)	324 (63.0)	317 (69.1)	557 (80.6)		15 (30.0)	14 (28.6)	27 (34.2)	20 (51.3)	
Gender										
Male	298 (43.1)	233 (45.3)	227 (49.5)	308 (44.6)	0.192[a]	20 (40.0)	26 (53.1)	50 (63.3)	18 (46.2)	0.059[a]
Female	394 (56.9)	281 (54.7)	232 (50.5)	383 (55.4)		30 (60.0)	23 (46.9)	29 (36.7)	21 (53.8)	
Location										
HCMC	686 (99.1)	504 (98.1)	443 (96.5)	666 (96.4)	0.003[a]	50 (100.0)	49 (100.0)	78 (98.7)	38 (97.4)	0.666[b]
Others	6 (0.9)	10 (1.9)	16 (3.5)	25 (3.6)		-	-	1 (1.3)	1 (2.6)	
Length of stay (days)										
≤ 5	-	-	-	-	-	12 (24.0)	14 (28.6)	25 (31.6)	13 (33.3)	0.387[a]
6-10	-	-	-	-		28 (56.0)	32 (65.3)	47 (59.5)	21 (53.9)	
> 10	-	-	-	-		10 (20.0)	3 (6.1)	7 (8.9)	5 (12.8)	
Mean (±SD)	-	-	-	-		8.0 (3.1)	7.0 (3.3)	6.6 (2.8)	7.1 (2.9)	
Health Insurance Status (%)										
70	105 (15.2)	32 (6.2)	-	-	< 0.001[a]	5 (10.0)	5 (10.2)	-	-	0.004[b]
80	442 (63.9)	323 (62.8)	262 (57.1)	315 (45.6)		27 (54.0)	31 (63.3)	36 (45.6)	26 (66.7)	
95	56 (8.1)	25 (4.9)	35 (7.6)	37 (5.4)		2 (4.0)	1 (2.0)	2 (2.5)	4 (10.3)	
100	89 (12.8)	134 (26.1)	162 (35.3)	339 (49.1)		16 (32.0)	12 (24.5)	41 (51.9)	9 (23.0)	

Note: [a] Calculated by Chi-Square test. [b] Calculated by Fisher Exact.
CI: confidence interval; SD: Standard Deviation; HCMC: Ho Chi Minh city.

Table-2: Healthcare expenditures of treatment of asthma in 2014-2017 (**Currency in US Dollars (%)].

	Year	Diagnosis/ Hospital bed	Spirometry	Subclinical	Medication	Other*	Total expenditure	Total per-patient (Mean (95% CI))
Outpatients	2014	386.0 (1.1)	-	591.8 (1.6)	35,484.8 (97.3)	-	36,462.6 (100.0)	52.7 (47.3-57.8)
	2015	723.1 (4.1)	-	482.8 (2.7)	16,649.8 (93.2)	-	17,855.7 (100.0)	34.7 (30.8-39.2)
	2016	79.5 (0.4)	138.3 (0.8)	354.6 (2.0)	17,264.0 (96.8)	-	17,836.4 (100.0)	38.9 (34.1-44.6)
	2017	4,327.9 (11.3)	972.7 (2.6)	925.9 (2.4)	32,006.2 (83.7)	-	38,232.7 (100.0)	55.3 (50.5-60.3)
	Total	5,516.5 (5.0)	1,111.0 (1.0)	2,355.1 (2.1)	101,404.8 (91.9)	-	110,387.4 (100.0)	46.9 (44.5-49.2)
Inpatients	2014	630.4 (25.0)	-	175.0 (7.0)	1,675.1 (66.5)	38.4 (1.5)	2,518.9 (100.0)	50.4 (34.6-74.0)
	2015	687.3 (31.1)	-	205.5 (9.3)	1,285.6 (58.2)	32.0 (1.4)	2,210.4 (100.0)	45.1 (37.8-53.0)
	2016	1,774.4 (39.4)	58.5 (1.3)	300.8 (6.7)	1,911.3 (42.4)	457.7 (10.2)	4,502.7 (100.0)	57.0 (49.4-65.9)
	2017	2,499.9 (59.8)	32.6 (0.8)	159.3 (3.8)	1058.0 (25.3)	432.0 (10.3)	4,181.8 (100.0)	107.2 (89.2-127.1)
	Total	5,592.0 (41.7)	91.1 (0.7)	840.6 (6.3)	5,930.0 (44.2)	960.1 (7.1)	13,413.8 (100.0)	61.8 (54.8-69.9)

* Medical supplies,oxygen service, and aerosol therapy.
** Foreign exchange rate dated: 2018.

Table-3: Average annual direct medical cost of asthma management distributed by outpatients' characteristics in 2014-2017 (2018 US dollars, Arithmetic mean [bootstrap 95 CI]).

Outpatient	2014		2015		2016		2017	
	Mean (95 CI)	MD (95 CI)	Mean (95 CI)	MD (95 CI)	Mean (95 CI)	MD (95 CI)	Mean (95 CI)	MD (95 CI)
Age group, (years)								
Paediatric (<16)	13.4 (10.3-17.1)	-51.9 (-59.4, -44.5)*	16.3 (12.3-20.9)	-29.3 (-36.5, -22.2)*	10.7 (8.2-13.4)	-40.8 (-48.5, -33.9)*	11.2 (8.8-13.9)	-54.8 (-60.9, -48.5)*
Adult (≥16)	65.3 (59.1-71.8)		45.6 (39.8-51.9)		51.5 (45.0-58.5)		66.0 (60.2-71.8)	
Gender								
Male	48.2 (40.8-56.6)	-7.9 (-18.2, 2.9)	33.9 (28.0-40.1)	-1.5 (-10.0, 6.6)	34.9 (27.7-42.3)	-7.8 (-18.0, 2.0)	53.1 (45.7-60.5)	-4.0 (-14.1, 5.8)
Female	56.1 (48.8-63.2)		35.4 (29.8-41.7)		42.7 (36.2-50.0)		57.1 (50.4-63.3)	
Location								
HCMC	53.0 (47.7-58.2)	33.6 (20.7, 44.1)*	35.2 (31.1-39.6)	22.7 (5.2, 33.1)*	39.0 (33.7-44.2)	4.2 (-13.3, 19.2)	55.7 (51.0-60.9)	10.9 (-23.4, 35.2)
Others	19.4 (10.3-30.6)		12.5 (3.3-29.6)		34.8 (20.7-51.1)		44.8 (20.6-79.2)	
Health Insurance Status (%)								
Insurance-paid	42.1 (38.0-46.2)	31.5 (27.2, 35.9)*	29.0 (25.5-32.5)	23.3 (19.6, 27.0)*	32.8 (28.4-37.1)	26.7 (22.3, 31.2)*	46.9 (42.9-51.3)	38.5 (34.3, 42.9)*
Self-paid	10.6 (9.4-11.7)		5.7 (4.9-6.6)		6.1 (5.2-7.1)		8.4 (7.6-9.2)	

Note: Arithmetic means and mean difference are calculated by bootstrapping method.
* denotes significant difference.
CI: confidence interval, MD: mean difference, HCMC: Ho Chi Minh city.

Table-4: Average annual direct medical cost of asthma distributed by inpatient's characteristics in 2014-2017 (2018 US dollars, Arithmetic mean [bootstrap 95 CI]).

Inpatient	2014		2015		2016		2017	
	Mean (95 CI)	MD (95 CI)	Mean (95 CI)	MD (95 CI)	Mean (95 CI)	MD (95 CI)	Mean (95 CI)	MD (95 CI)
Age group								
Pediatric (<16)	29.9 (24.8-35.8)	-68.2 (-143.5, -24.1)*	35.2 (30.2-40.7)	-34.6 (-51.0, -16.2)*	45.4 (39.2-52.8)	-33.9 (-54.8, -16.3)*	98.0 (75.9-128.5)	-18.0 (-57.3, 22.5)
Adult (≥16)	98.1 (56.0-173.2)		69.8 (51.4-85.2)		79.3 (62.9-100.2)		116.0 (89.1-148.4)	
Gender								
Male	31.7 (25.4, 39.5)	-31.1 (-72.2, -4.2)*	39.9 (32.6-47.4)	-11.1 (-26.7, 2.8)	52.9 (43.5-64.3)	-11.2 (-28.3, 6.3)	86.7 (71.3-105.5)	-38.2 (-78.1, -1.1)*
Female	62.8 (37.5, 102.4)		51.0 (38.9-64.3)		64.1 (52.0-77.8)		124.9 (93.3-159.9)	
Length of stay (days)								
≤ 5	18.3 (13.3-23.5)	-	23.3 (18.4-27.9)	-	45.3 (29.9-66.5)	-	73.0 (48.0-113.3)	-
6-10	40.7 (32.5-49.3)		50.4 (41.9-59.8)		58.7 (50.5-68.5)		117.8 (96.7-150.4)	
> 10	116.1 (54.3-220.6)		90.9 (79.8-107.7)		87.5 (72.1-105.8)		151.9 (129.4-174.2)	
Health Insurance Status (%)								
Insurance-paid	44.0 (29.7-66.7)	37.6 (22.7, 61.0)*	38.4 (31.6-45.9)	31.6 (24.7, 39.4)*	51.3 (43.9-59.0)	45.6 (38.0, 53.6)*	93.0 (75.5-113.1)	78.8 (60.7, 98.6)*
Self-paid	6.4 (4.3-8.5)		6.8 (5.1-8.3)		5.7 (4.1-7.6)		14.2 (10.6-18.4)	

Note: Arithmetic means and Mean differences are calculated by bootstrapping method, *: There is a significant difference
CI: confidence interval, MD: mean difference.

diagnosed with asthma at PhuNhuan Hospital from 2014 to 2017 are presented in Table-1. In the outpatient department, the majority of patients were adults and nine out of ten patients were from HCMC ($p<0.05$). For the inpatients, almost three out of five subjects stayed for 6 to 10 days, for an average of about 7 days. In both groups, the patients were almost equally distributed between the sexes, and over half of the patients had their care paid 80% by healthcare insurance (Table-1).

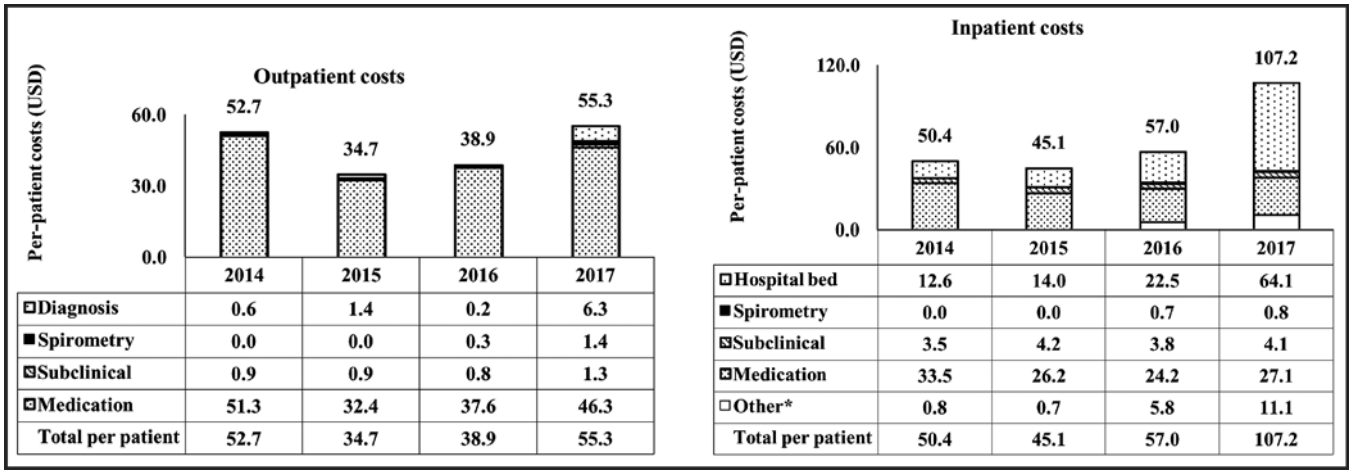
Table-2 and Figure-1 provide an estimation of the total economic burden of treating asthma and the mean cost per asthmatic in 2014-2017, respectively, from the hospital perspective. Treatment costs from the perspective of healthcare insurance and the patient for the four-year period are shown in Figure-2. Overall, the total healthcare expenditures were higher for outpatients than for inpatients. The total economic burden for the four years from 2014 to 2017 was $110,387.4 for outpatients and $13,413.8 for inpatients. In both groups, the cost of drugs (by service group), as well as the economic burden in 2017 (in terms of years), accounted for the highest proportion of costs in the period 2014-2017 (Table 2, Figure 1, and Figure 2).

Table-3 and Table-4 show how the patient demographic characteristics impacted the direct medical costs for asthma treatment of individual outpatients and

Table-5: The annual cost of medications during 2014-2017 according to drug category (2018 US dollars [%]).

Type of drugs		Outpatients				Inpatients			
		2014	2015	2016	2017	2014	2015	2016	2017
Controller medications	ICS	707.3 (2.0)	619.0 (3.7)	253.4 (1.5)	190.9 (0.6)	166.5 (10.0)	88.3 (6.9)	100.6 (5.3)	51.9 (4.9)
	ICS + LABA	23,469.7 (66.1)	10,266.6 (61.7)	10,249.6 (59.4)	23,253.7 (72.7)	97.8 (5.8)	113.2 (8.8)	13.2 (0.7)	-
	LABA	460.2 (1.3)	265.2 (1.6)	502.5 (2.9)	367.6 (1.2)	-	20.0 (1.5)	-	10.3 (1.0)
	Leukotriene modifiers	5,160.9 (14.5)	2,750.1 (16.5)	3,594.5 (20.8)	3,178.8 (9.9)	127.1 (7.6)	164.5 (12.8)	329.3 (17.2)	104.7 (9.9)
	Theophylline	327.0 (0.9)	14.9 (0.1)	89.1 (0.5)	-	10.4 (0.6)	5.2 (0.4)	5.8 (0.3)	-
Add-on controller medications	*Systemic corticosteroids	420.5 (1.2)	486.3 (2.9)	288.4 (1.7)	324.4 (1.0)	249.5 (14.9)	311.2 (24.2)	493.5 (25.8)	331.7 (31.3)
Relievers medications	SABA	2,184.4 (6.2)	708.9 (4.3)	567.3 (3.3)	974.0 (3.0)	343.8 (20.5)	380.5 (29.6)	394.2 (20.6)	135.0 (12.8)
	SABA + SAMA	2,754.8 (7.8)	1,538.8 (9.2)	1,719.3 (9.9)	3,716.8 (11.6)	680.0 (40.6)	202.7 (15.8)	574.7 (30.1)	424.4 (40.1)
Total		35,484.8 (100.0)	16,649.8 (100.0)	17,264.1 (100.0)	32,006.2 (100.0)	1,675.1 (100.0)	1,285.6 (100.0)	1,911.3 (100.0)	1,058.0 (100.0)

ICS: Inhaled corticosteroids; LABA: Long-acting β2-agonists, SABA: Short-acting β2-agonists; SAMA: Short-acting anticholinergics;
* oral therapy, intramuscular or intravenous injection.



*: Medical supplies, Oxygen service, Aerosol therapy

Figure-1: Trends over 2014-2017 in annual per-patient costs and cost components (2018 US dollars).

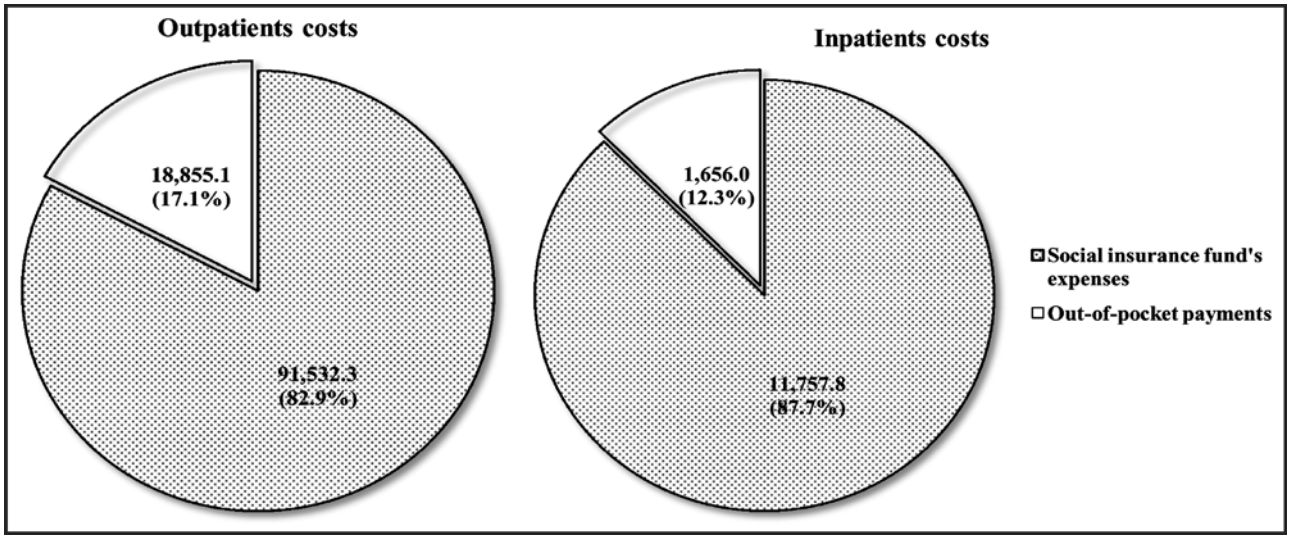
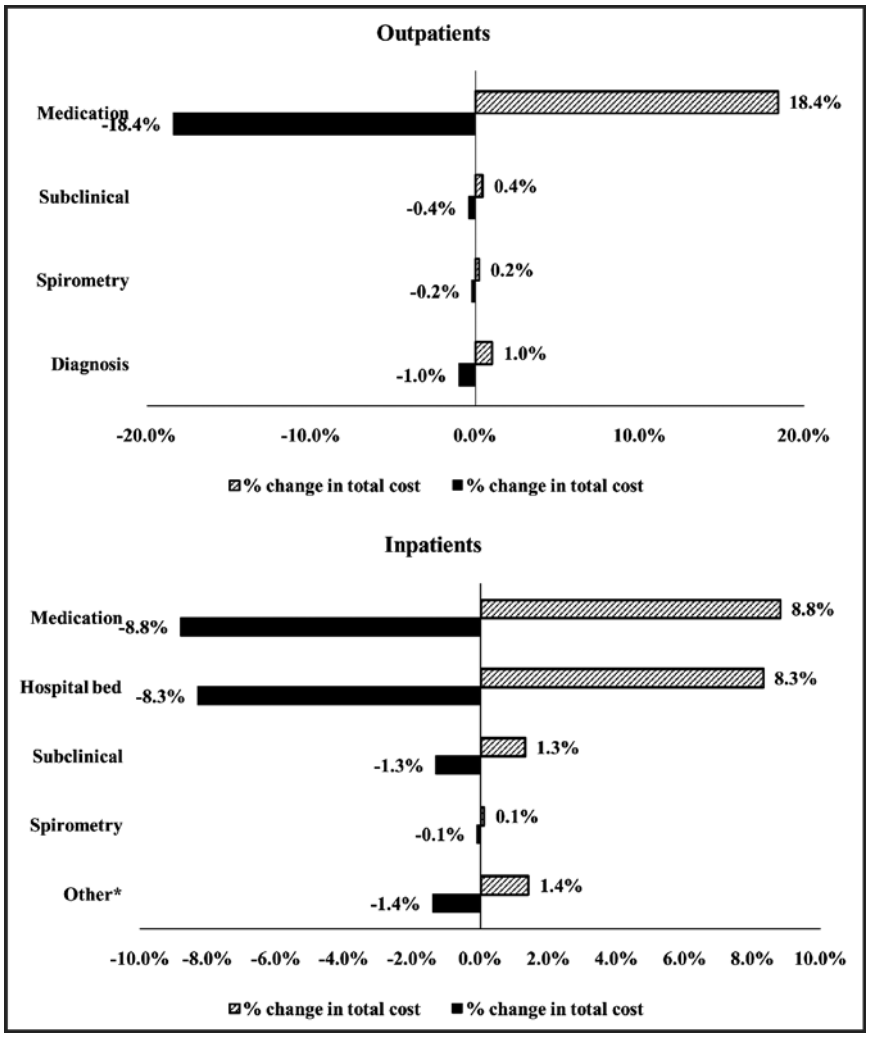


Figure-2: Treatment costs during 2014-2017 according to healthcare insurance payments (2018 US dollars [%]).



*: Medical supplies, Oxygen service, Aerosol therapy

Figure-3: Sensitivity analysis for variation of the different direct medical cost units for asthma treatment.

inpatients in each year from 2014 to 2017. In both groups, the average cost per each child was lower than that per adult. Especially in outpatient group, the cost per adult was 5 times higher than that of children. Concerning gender, the expenditure for female patient was slightly higher than that for male patient (Table 3, and Table 4).

Table-5 provides the economic burden created by medications. Although the percentage of the costs for inhaled corticosteroids (in combination and alone) for outpatients was the lowest in 2016 when compared to the remaining years, this controller drug still accounted more than half (60.9%) of the total expenditure for pharmacological treatments in that year (Table-5).

The variability of total costs, which depended on ±20% of the cost of the various service elements, is shown in the Tornado diagram (Figure-3). Among the potential effects of cost variations, the impact of medication cost on the total cost of this disease is the most significant (±18.4% for outpatient costs and ±8.8% for inpatient costs) (Figure-3).

Discussion

To the best of our knowledge, there were limited cost-of-illness studies in Viet Nam evaluated the cost of asthma by calculating the cost components and assessing their potential impact on total cost. The main findings of the present study are that (1) the economic burden of asthma was largely driven by medications, and (2) factors such as age and length of hospital stay (for inpatients) were major determinants of the asthma-related direct medical costs in this sample.

Regarding outpatients, the ratio of male to female patients was almost equal, but female patients were slightly higher in number, with the majority being adults (ranging from 63.0 to 80.6%) with a mean age range of 36.3-44.4 years. These figures are also similar to the values presented for outpatient treatment by Costa et al., in Brazil, where the patients were predominantly female (73.2%) with a median age of 49.5 years.[19] These results indicate that direct medical expenditures are higher for women than for men. This finding was strongly supported by the study by Zein et al. in the US, as well as by the study by Accordini et al. in Italy.[20,21] However, the research by Sharifi et al., carried out in Iran, indicated an opposite result, as the costs incurred were higher for a male than for a female patient ($825.4 versus $605.1, respectively); this discrepancy was explained as being related to cultural differences in Iranian women.[22]

Based on the 2014-2017 sample in the present study, the annual per-person direct medical costs for asthma were $34.7 to $55.3 for outpatient treatment and $45.1-$107.2 for inpatient treatment, while the annual per-person expenditures for prescription medications amounted to $32.4-$51.3 per outpatient and $24.2-$33.5 per inpatient. These expenses were lower than those presented in a study that analyzed the economic burden of asthma in the Asia-Pacific region; for example, in Vietnam, the

estimated per-person direct cost for both maintenance and urgent care was $206.5 ± 17.6 and the mean per-patient drug expenditure was $114.2 ± 11.7.[7] Direct per-patient costs range from $1,478.9 ± 146.4 in Hong Kong to $3,474.5 in the US, and annual per-patient cost for medications exceeded $1,946.8 in the US and was dramatically higher than in Vietnam.[7,9] Anti-asthmatic medication in our study accounted for 86.7% of the total economic burden, which is three times higher than the corresponding figure (31%) determined in a study by Kamble et al. in the US.[23] The dissimilarities in the unit price of medications and in the healthcare services systems, as well as in the studied populations, time periods, data sources, and definition of costs in each jurisdiction, restricted the comparison of results from different countries. In addition, the unit costs from 2014 to 2017 did not follow a trend, being especially high in 2017, probably due to adjustment of hospital fees by health facilities over the years, according to Joint Circular 37/2015/TTLT-BYT-BTC in 2015 and Circular 02/2017/TT-BYT in 2017.[24,25]

Pharmacological treatment was the cost component that occupied the most prominent position of direct medical costs in 2014-2017. Medication costs for asthma treatment accounted for 83.7% to 97.3% of the direct medical costs for outpatient treatment, while this proportion ranged from 25.3% to 66.5% for inpatients. This figure is far larger than that presented for the majority of studies conducted in North America and Europe, which showed that medication comprised the largest percentage of direct medical costs, varying from 51% in the study by Barnett et al. in the United States to 68% of total direct costs in Canada by Bedouch et al.[26,27] In terms of outpatient medicines, the most expensive treatment, accounting for over 60%, was inhaled corticosteroids (with or without a combination with long-acting β2-agonists). The first-ranked medication for inpatients was the relief treatment group, such as short-acting β2-agonists, accounting for 12.8-29.6% when used alone and for 15.8-40.6% when combined with short-acting anticholinergics. These percentages were higher than those reported in the study conducted in Italy, where the cost of inhaled corticosteroids ranked first (48.6%) in medication cost, and the cost of using short-acting β2-agonists accounted for 2.2%.[22]

Our sensitivity analysis revealed that the most costly influencer of direct medical cost was pharmacological treatment. Particularly for inpatients, the second most impactful expense was the cost for hospital beds, whereas the second-impact expense for outpatients was diagnosis cost. Specifically, these costs dropped to 8.8% and 18.4% for inpatient and outpatient costs, respectively, when the cost for medications fell by 20%. In addition, for inpatients, this figure fell by 8.3% when the cost of hospital beds was reduced by 20%, based on an average hospital stay of 7 days for inpatients. This result can be used as a reference for investors to develop appropriate policies to lessen the economic burden on management of patients with asthma. Some suggestions might include increasing the use of proven generic medicines rather than brand-name medicines and reducing the cost of hospital beds for long-term resident treatment.

Our study has some limitations. First, the data were obtained using electronic medical records, so the estimated result is only based on direct medical costs and does not include direct non-medical, indirect, or intangible costs of pain and suffering. Second, because of unavailability in the data, some issues, such as history and severity of asthma among responding individuals, were not included. Finally, given that our analysis was based on asthma treated at a general hospital, the total population of asthma in Vietnam may not be represented by the population studied here. Future studies should expand research on non-medical costs and indirect costs - which are also greatly affected by asthma, as well as the impact of severity of illness along with other aspects on treatment burden and economic burden.

Conclusion

This study presented valuable results for health administrators in Vietnam, as asthma can impose an enormous economic burden on each patient in particular and on society in general. The necessity of coverage of health assurance is quite obvious to reduce the individual's burden. The cost that accounts for the largest proportion of asthma-related is medical cost. Therefore, upgrading of asthma management programs and regimens and setting a policy of reducing the medication costs should be goals for reducing the economic burden. Other important measures include training for asthma management physicians, as well as for patients, in self-management of asthma and adherence to treatment regimens.

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