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The Expense of Insulin in Individuals with Insulin-Dependent Diabetes in Fars Province based on Prescribed Prescriptions including Insulin

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ABSTRACT

Background: Diabetes is considered one of the most prevalent chronic diseases in the world, and if it is not cured, it can have many side effects and expenses. The current study has been conducted to calculate the cost of insulin applied in patients with insulin-dependent diabetes who are younger than 19 years old in 2016 and 2017.

Methods: The current study is a descriptive and cross-sectional study
We investigated all registered prescriptions of social security and health insurance in this study. The price of each insulin was calculated through the official website of the Food and Drug Administration (FDA). Ultimately, the cost of insulin has been calculated based on gender, age group, and insurance types under the age of 19 in patients with insulin-dependent diabetes and those without insulin-dependent diabetes. Data has been analyzed using $SPSS_{24}$. The frequency command is used to obtain the percentages.

Results: In this study, 1135105 insured cases younger than 19 years old were investigated, which females consisted almost half of the insured cases (51 %), and most of them were in the age group of 2-7 years (34 %), and 50 % of the participants in this study were covered by social security insurance. The treatment of each patient with insulin-dependent diabetes included a cost of $ 1187 and $ 1309, respectively, in 2016 and 2017, and $ 1.4 and $ 1.7 respectively (1$ = 42,000 Rials), for each person under the age of 19 in the general population.

Conclusion: The results achieved by the mentioned study explained that nearly remarkable cost is spent on preparing insulin for patients with Type 1 Diabetes Mellitus every year. This amount is increasing, and it is essential to predict insulin needs for the future according to the insulin consumption changes.

Key words: Insulin, Diabetes, Type 1 diabetes, Diabetes mellitus, Cost

Citation

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Introduction

Type 1 Diabetes Mellitus (T1DM) is an autoimmune disease that is regularly diagnosed in the early ages of life (1) and is considered the most prevalent endocrine disorder in children (2). CDC findings suggest that 5 to 10 % of all diabetes cases belong to Type 1 Diabetes Mellitus (3). The frequency rate of Type 1 Diabetes Mellitus has increased in recent decades in all parts of the world, notably in children (4, 5). It is calculated that 40 million people in the world have Type 1 Diabetes Mellitus, and 78,000 people are added to this statistic annually (6). Type 1 Diabetes Mellitus has long-term complications that may increase mortality (7). Agency for Healthcare Research and Quality (AHRQ) reported that $ 34 billion spent on health cases in 2005 was related to diabetes (8). A recent study conducted by the American Diabetes Association in 2005 shows that patients with diabetes spend an average of $ 16,752 a year on medical expenses. Approximately half of this amount (57 %) is related to treatment, including the cost of diabetes medications. (9) The average health costs for diabetes patients are 2.3 times higher than for patients without diabetes in the United States (10). A study conducted in Scotland, hospitalization rates and hospitalization costs for patients with diabetes was 2.1 and 2.2 times higher than the general population, respectively (11). A study conducted in the US indicated that the whole medical cost of type 1 diabetes is $ 6.9 million (1). A study conducted in Brazil based on the National Brazilian Health Care System (NBHCS) recognized that each patient with type 1 diabetes needs $ 1319.15 annually to treat it (12).

A study conducted in Iran indicated that the whole diagnostic cost of Type 2 Diabetes Mellitus in 2009 was estimated at $ 3.78 billion, including direct costs (medical and non-medical) at $ 2.04 ± 2.08 billion and its indirect costs include $ 1.73 million. The average direct and indirect costs were $ 842.6 ± 102 and $ 864.8, respectively. Complications (48.9 %) and drugs (8.23 %) were among the main elements of direct costs (13). Another study conducted in 2009 in Iran showed that the treatment and controlling the patients with diabetes included the cost annually $ 14.5 ± 3.152 and $ 52.8 ± 5.8, respectively, which shows that the costs of diabetics are 2.92 times the costs of people without diabetes. Most direct costs have been spent on medicines and devices and hospitalization in diabetic patients (14).

Most studies conducted on diabetes include Type 1 Diabetes Mellitus and Type 2 Diabetes Mellitus (T2DM) or type 2 diabetes alone (10, 15), and little information is available about the cost of treating insulin-dependent diabetes. Insulin should be daily injected for Regular care for Type 1 Diabetes Mellitus, and they should be continually monitored, which indicates the cost of care and time needed (16). Since there is no information about the cost of insulin-dependent diabetes, principally the cost of treating Type 1 Diabetes Mellitus with insulin and its yearly changes in Iran, this study was conducted to estimate the cost of insulin-dependent diabetes in the under-19 age group in 2016 and 2017 in Iran. The under-19 age group is more likely to have type 1 diabetes.

Materials and Methods

Prescript insulin registered in insurance databases in 2016 and 2017 was used in this descriptive study. All registered prescriptions of Social Security and Health Insurances (by covering 98% of the total population) were investigated. During the year, all prescriptions of each person were collected based on the national code utilizing the KU-TOOLS tool in Excel. The type of insulin and its dose for one year were calculated for each person. The family physician database was utilized to get age and sex information for all individuals younger than 19 years old. Hence, there were 1,135,105 insured persons younger than 19 years old. We used Excel software to integrate family physician information and medicine information based on the national code. Telephone communication was held with all people who had more than two years of prescription insulin, and 200 people had no history of insulin to ensure that

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insulin-based estimates and based on prescription are reliable. Kappa agreement coefficient is high and equal to 96.2 % (95.8 % to 96.5 %). Conclusively, we have estimated all insulin and its dose used in people younger than 19 years old. $SPSS_{24}$ has been used to analyze the data. In this study, we employ the frequency command to calculate the frequency and percentage. Moreover, the split command was employed before the frequency for calculations by gender and age group. The official website of the Food and Drug Administration (FDA) was used to calculate the price of each insulin (17). The following table shows the price of each type of insulin:

At last, the cost of insulin in patients with insulin-dependent diabetes and those without insulin-dependent diabetes has been estimated based on gender, age group, and types of insurance at the age of younger 19. This design was recorded with the code of ethics IR.SUMS.REC. 1397. 982 in Shiraz University of Medical Sciences. In this study, the personal information of patients was not used, however, after contacting them, their informed consent was first asked.

Table 1. Price of insulin by type in Iranian Rail and USD PPP adjusted

Types of insulin	Price	
	Iranian Rial	USD, PPP adjusted
Novo rapid	353,700	19.9
Lantus	870,000	48.9
Regular	140,000	7.9
NPH	140,000	7.9
Novo mix	353,700	19.9
Apidra	311,600	17.5
Levemir	355,000	19.9
Biphasic	188,400	10.6

Results

In this study, 1135105 insured cases younger than 19 years old were investigated, which females consisted almost half of the insured cases (51 %), and most of them were in the age group of 2-7 years (34 %), and 50 % of the participants in this study were covered by social security insurance. Table 2 shows the details of the participants' demographic characteristics in the study.

Novo rapid insulin is the most used among all insulins used in both sexes and different age groups and insurance types. Biphasic and Levemir insulin has been used less compared to other insulins. Table 3 shows the details of consuming insulin types by gender, age groups, and types of insurance booklets.

Novo rapid insulin had been the most extensively used one among all the insulins used, but Lantus insulin had been the most expensive. Table 4 shows the dose of insulin used along with their price as well as their change percentage.

Most of the costs spent on insulin-dependent diabetes treatment had been related to females and the age group of 14-19 years old and social security insurance. Table 5 shows the cost related to treating insulin-dependent diabetes by gender, age group, type of insurance booklet, and their percentage of changes.

The cost of treating each person with insulin-dependent diabetes in 2016 and 2017 had been $ 1187 and $ 1309, respectively, and $ 1.4 and $ 1.7, respectively for each person younger than the age of 19 in the general population. Table 6 shows the costs to treat each patient with insulin-dependent diabetes and each insured person under 19 years old by gender, age groups, and types of insurance booklet.

Table 2. Demographic characteristic of participants and patients; and prevalence (per 100,000) of IDDM during 2016 – 17 in Fars province

Variable	Participants Frequency		Patients 2016		Patients 2017	
	No.	%	No.	Prevalence	No.	Prevalence
Sex						
- Male	582,122	51.3	653	112.1	747	128.3
- Female	552,983	48.7	683	123.5	806	145.7
Age group						
- < 2	135,203	11.9	1	0.7	9	6.6
- 2 - 7	395,499	34.8	173	43.7	229	57.9
- 8 - 13	351,314	30.9	537	152.9	630	179.3
- 14 - < 19	253,089	22.3	625	246.9	685	270.7
Type of Insurance						
- SSI [a]	571,939	50.4	702	122.7	826	144.4
- IHI [b](Urban)	312,509	27.5	430	137.6	482	145.2
- IHI (Rural)	250,657	22.1	204	81.4	245	97.7
Total	1.135.105	100%	1336	117.6	1553	136.8

a = Social security insurance
b = Iranians health insurance

Table 3. Insulin consumption (vials) in patients with IDDM by sex, age groups and Insurance, in 2016-17 in south of Iran

Type of Insulin	Year	sex		Age groups				Type of Insurance		
		Male	Female	< 2	2 - 7	8 - 14	15 - 19	SSI [a]	IHI [b](U)	IHI (R)
Novo rapid	2016	11787	13023	0	1451	8759	14600	14352	7781	2677
	2017	15347	17095	1	2554	12466	17421	18156	10632	3654
Lantus	2016	10152	11407	7	1326	7410	12816	12797	6483	2279
	2017	12866	14443	14	2046	10366	14883	16250	8159	2900
Regular	2016	643	748	9	279	418	685	642	474	275
	2017	514	531	27	236	310	472	436	367	242
NPH	2016	884	1069	15	385	521	1032	925	659	369
	2017	746	780	35	302	386	803	677	508	341
Novo mix	2016	264	168	0	36	95	301	422	10	0
	2017	284	163	0	22	62	363	433	14	0
Apidra	2016	81	62	0	6	76	61	123	5	15
	2017	416	322	0	52	323	363	673	45	20
Levemir	2016	53	37	0	15	18	57	44	41	5
	2017	296	291	1	205	108	273	293	230	64
Biphasic	2016	0	1	0	0	0	1	0	1	0
	2017	0	3	0	0	2	1	0	3	0
Sum	2016	23,864	26,515	31	3,498	17,297	29,553	2,9305	15,454	5,620
	2017	30,469	33,628	78	5,417	24,023	34,579	3,6918	19,958	7,221
Change rate (%)		27.7	26.8	151.6	54.9	38.9	17.0	26.0	29.1	28.5

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Table 4. Doses (vials) and cost expenditure (USD, PPP adjusted) of insulin 1n 2016-17 in south of Iran

Types of insulin	2016			2017			Change rate (%)
	Doses (vial)	Cost, USD PPP adjusted		Doses (vial)	Cost, USD PPP adjusted		Both Doses (vials) and cost
		Amounts	%		Amounts	%	
Novo rapid	24,810	493,088	31.09	32,442	644,771	31.71	30.8
Lantus	21,559	1,053,927	66.44	27,309	1,335,020	65.65	26.7
Regular	1391	10,943	0.69	1045	8,221	0.40	-24.9
NPH	1953	15,364	0.97	1526	12,005	0.59	-21.8
Novo mix	432	8,586	0.54	447	8,884	0.44	3.5
Apidra	143	2,504	0.16	738	12,922	0.64	416.1
Levemir	90	1,795	0.11	587	11,709	0.58	552.2
Biphasic	1	11	0.00	3	32	0.00	200.0
Total	50,379	1,586,217	100	64,097	2,033,563	100	27.23

Table 5. Cost expenditure (USD, PPP adjusted) of insulin by sex, age groups and type of insurance in IDDM in 2016-17 in south of Iran

Variable		2016	2017	2-year proportion (%)	Change rate (%)
Sex	male	750,284	962,723	47.3	28.3
	female	835,933	1,070,839	52.7	28.1
Age groups	< 2	531	1,212	0.05	128.2
	2- 7	100,004	160,449	7.20	60.4
	8 -13	547,289	769,044	36.37	40.5
	14 - < 19	938,393	1,102,858	56.38	17.5
Type of Insurance	SSI	934,576	1,190,225	58.70	27.4
	IHI (U)	481,598	622,734	30.51	29.3
	IHI (R)	170,043	220,603	10.79	29.7

Table 6. Average cost expenditure (USD, PPP adjusted) of insulin in population and IDDM patient in age < 19 by sex, age groups and Insurance in 2016-17 in south of Iran

Variable		Number of population	In 2016			In 2017		
			Population	Patients		Population	Patients	
			Average cost	No.	Average cost	Average cost	No.	Average cost
Sex	Male	582,122	1.28	653	1,148.98	1.65	747	1,288.79
	Female	552,983	1.51	683	1,223.91	1.93	806	1,328.59
Age groups	< 2	135,203	0.00	1	531.00	0.00	9	134.66
	2- 7	395,499	0.25	173	578.06	0.40	229	700.65
	8 -13	351,314	1.55	537	1,019.16	2.18	630	1,220.71
	14 - < 19	253,089	3.70	625	1,501.43	4.35	685	1,610.01
Type of Insurance	SSI	571,939	1.63	702	1,331.31	2.08	826	1,440.95
	IHI (U)[a]	312,509	1.54	430	1,120.00	1.99	482	1,291.98
	IHI (R)[b]	250,657	0.67	204	833.55	0.88	245	900.42

[a] *urban area*
[b] *rural area*

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Discussion

Diabetes is one of the most significant challenges facing the public health of the 21st century (18). Type 1 Diabetes Mellitus is also a chronic disease that its prevalence is increasing worldwide (19). The current study is one of the studies that has calculated the costs of treating insulin-dependent diabetes based on the follow-up of prescribed prescriptions, including insulin. The results achieved by our study show that insulin costs for patients with insulin-dependent diabetes are estimated at $ 1,586,217 and $ 2,033,563, respectively, in 2016 and 2017. We understand by comparing the results achieved by this study and a study conducted in the United States that the cost of treatment for insulin-dependent diabetes is lower in Iran, and it is due to this fact that the study conducted in the United States calculated the costs of hospitalization in addition to the cost of treatment (1). The cost of treating each patient with insulin-dependent diabetes in 2016 and 2017 was calculated at $ 1.187 and $ 1309, respectively, in our study, which is in agreement with the results of a study conducted in Brazil (12). A study that was conducted to simulate the costs related to insulin-dependent diabetes in Spain showed that the cost of caring for and treating a patient with insulin-dependent diabetes was calculated at $ 3,645 in the first year of diagnosis and $ 1,708 in consequent years, (20) which is in agreement with the results of our study, and the very small difference is because of considering other direct costs of treatment, such as hospitalization. The average cost spent on treating type 1 diabetes in Australia had been $ 570 million annually. The annual cost related to each patient with diabetes had been $ 4,699, which 13 % of the total costs is allocated to insulin costs (21).

A study conducted in England and Wales to examine the costs related to insulin-dependent diabetes determined that about 93.581 million Pound has been spent on insulin-dependent diabetes in 1991, which 23 million Pound is related to insulin. (22). Another study conducted to estimate the costs related to the disease imposed on the families of children with insulin-dependent diabetes in Sudan showed that the average annual cost of diabetes care was $ 283 for each diabetic child, which 36 % was spent on insulin and 65 %. of total family expenses have been spent for a diabetic child (23), the results of this study are not in agreement with the results achieved by our study, this disagreement may be caused because of the small sample size (147 people) and the selection of urban area in the study of Sudan. Novo Rapid Insulin has been extensively used among all types of insulin in 2016 and 2017, but Lantus insulin was the most expensive one.

Limitations: We determined to conduct this study for the age group younger than 30 years old, but we decided by advising a clinical consultant that this study to be conducted for the under-19 age group due to some cases of Type 2 Diabetes Mellitus in the age group younger than 30 years old. Additionally, we could not study the total population of children younger than 19 years old, but this study has been conducted on 98 % of children younger than 19.

Conclusion

The results achieved by the above study explained that nearly high cost is spent on preparing insulin for patients with type 1 diabetes annually. It is inevitable to predict insulin needs for the future due to the changes in insulin consumption. Also, it is concluded, according to the agreement of the results obtained in this study with the results of other studies, that the method of using insurance archives can be a satisfactory method to estimate the costs of some diseases.

We advise enthusiastic researchers to apply the method used in this study (using the insurance archive) to investigate the costs of some diseases that comply with the method's rules.

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Conflict of interests

There was no Conflict of interests.

Authors' contributions

Mirahmadizadeh A and Amiri S designed research; Mirahmadizadeh A, Amiri S and Seyfi S conducted research; Mirahmadizadeh A and Amiri S analyzed data; and Seyfi S wrote manuscript. All authors read and approved the final manuscript.

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