




## Cost-of-Illness Analysis of Diabetic Foot Ulcer: A Prevalence-Based Approach in Southwest of Iran

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### Abstract

**Background:** Diabetic foot ulcer (DFU) is a destructive complication of diabetes that imposes a significant economic burden on patients and the health system. This study was conducted to estimate and influence factors on DFU costs in Ahvaz, Iran.

**Methods:** This study was a cross-sectional study in 2017 among 213 DFU patients referred to Razi Hospital in Ahvaz, Iran. A cost of illness checklist was used to collect information. After calculating the costs, to analyze the effect of variables on the change of costs, regression analysis was used in the generalized linear method with gamma distribution. Also, based on the percentage of changes in cost items in 5 years, the costs of DFU until 2042 were estimated. Data analysis was done using descriptive and analytical tests (gamma regression) in SPSS Version 26 software.

**Results:** The total costs of each patient in the year were 319,885,040 Rials (\$7616.31). Direct medical costs were 280,539,930 Rials (\$6679.52) (87.7%), indirect medical costs were 5,670,550 Rials (\$135.01) (1.77%), and indirect costs were 3,3674,560 Rials (\$801.78) (10.53%). Based on the estimate, annual DFU cost items and total costs will increase by 32 and 258.3 times for each patient in 2042, respectively. Regression analysis showed that type of insurance, presence of infection, hospitalization, degree of wound, duration of wound, family history, and employment status are influential factors in changes in DFU costs.

**Conclusion:** DFU treatment costs are a substantial financial burden for patients, and these costs are increasing. Controlling the factors affecting the costs during the treatment process of this disease will reduce the financial burden on the patients.

**Keywords:** Diabetic Foot Ulcer, Cost Analysis, Direct Cost, Indirect Cost

**Conflicts of Interest:** None declared

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### Introduction

More than 400 million people have diabetes worldwide. The International Diabetes Federation (IDF) estimates that in 2019, 463 million people worldwide had diabetes, and in 2045, more than 700 million people will have diabetes (1). Diabetes and its complications are a global public health challenge and are an essential cause of complica-

tions and deaths (2).

Diabetic foot ulcer (DFU) is the most commonly known, complex, and costly complication of diabetes, which appears with the formation of wounds and destruction of deep tissues as a result of the interaction of factors caused by persistent and uncontrolled hyperglycemia (3,

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#### ↑What is “already known” in this topic:

Diabetic foot ulcer (DFU) is the most common complication of diabetes. The costs of this disease impose an enormous financial burden on patients and the health system. Identifying and calculating costs, factors affecting their changes, and finally reducing costs is the basic goal of health systems.

#### →What this article adds:

We concluded that the trend of DFU costs will increase in the next 20 years. Also, the type of insurance, presence of infection, hospitalization, degree and duration of the wound, family history, and employment status are the practical factors of DFU costs.

4). DFU is diagnosed in 12% to 18% of patients with type 2 diabetes and in 0.6% to 2% of patients with type 1 diabetes (5). The annual incidence of DFU in diabetic patients is about 2% to 5%. Also, according to studies, the lifetime risk of DFU in diabetic patients is between 15% and 20% and 19% and 34% (6, 7). According to a systematic review and meta-analysis study in 2017, the prevalence of DFU was 6.3% worldwide and 8.1% in Iran (8). Also, the prevalence of DFU in Ahvaz, Iran (where the study was conducted) was 6.4% (9).

DFU has high medical costs for the patient and health system, significant social and economic effects, and long periods of disability (10, 11). Due to the complex and lengthy treatment from prevention to amputation and the recurrence risk of 50% globally, DFU consumes a significant amount of healthcare budgets worldwide (1). The costs of diabetic patients with DFU are 2.7 times that of diabetic patients without DFU (12). The mean costs of DFU in the world are increasing, and about 20% to 33% of the costs related to diabetes are related to DFU treatment (6). A study in Canada showed that the admission of DFU patients was 49.6% more than that of diabetic patients without foot ulcers, and the average costs of these patients were 25.6% more than 5 expensive internal diseases (12). In Nigeria, the average total cost of DFU for each patient is more than 140,000 per year (13). In England, 0.8% to 0.9% of the National Health Service budget is allocated to the cost of health care for wounds and amputations in diabetes (14). A study in Iran showed that the cost of treating patients with DFU in 2007 was between \$5000 and \$8000 (15). Another study in Iran calculated the average direct costs of patients with DFU and neuropathy in men and women in 2014 to be \$85.6 and \$71.6, respectively (16).

DFU leads to an increase in financial costs, complications, and even death in the diabetic population. Thus, the cost of DFU is higher than that of treating many types of cancer (4, 17, 18); therefore, not paying attention to the costs of DFU and the factors affecting their amount can make this situation more critical. Given the considerable resources required to treat DFU, it seems that more studies should focus on measuring the costs of DFU in the healthcare system and payers (19). The ultimate goal of the Cost-Of-Illness (COI) study is to provide objective evidence needed for policy-making, design, and management of health programs (20). Therefore, this study was conducted to estimate and analyze the costs of DFU patients and the effect of social, economic, and clinical variables on patients' costs. The overall results of this study can be a valuable basis for future health economic studies and DFU management.

## Methods

This study was carried out in 2017 as a cross-sectional study of a COI based on prevalence. This study was conducted in the internal and infectious department of Razi Hospital in Ahvaz, Iran, which is the most important center for the treatment of infectious patients in the southwest of Iran. The sample size of the study was calculated using Cochran's formula with an error of 0.05 for at least 213

people. The inclusion criteria were foot ulcer due to diabetes, under-active follow-up, and willingness to participate in the study. Also, the exclusion criteria were missing or incomplete data, patients with other severe and chronic complications of diabetes except DFU, death due to DFU, presence of psychiatric problems or cognitive impairment, and inability to understand or complete the questionnaire.

In the prevalence-based approach, costs are measured for a given period, usually 1 year. In this method, instead of following a patient for the entire course of the disease to examine all the conditions experienced by the patient, patients from different stages (old or newly diagnosed) are included and followed for a shorter period (21, 22). In this study, information related to costs was limited to 1 year. Direct costs include 2 parts: direct medical costs and direct nonmedical costs. Direct medical expenses are divided into 2 categories: hospitalization and outpatient expenses, which are the expenses of medical care for diagnosis, treatment and rehabilitation, et cetera, during hospitalization and outpatient expenses outside or maybe inside the hospital. The data relating to the inpatient part of the direct medical costs were extracted by referring to the patient's files, and the data related to the outpatient part of the direct medical costs were collected using the cost estimation checklist and through interviews with the patients. In this instance, the expenses were gathered through interviews with individuals and a cost assessment checklist. The nonmedical direct costs include travel, food, and lodging expenses.

In this study, the indirect cost of patients was calculated based on absenteeism or days lost due to disability. To calculate the cost of days lost due to disability, the number of days of disability and disability or absence from work was multiplied by the average daily wage of the person. The amount obtained was considered as the monetary value of lost production. The lost production of nonworking people and homemakers was also calculated by determining the expected minimum wage of a working person for these people. The average daily wage rate of a person was extracted based on the approval of the Supreme Labor Council and from the rate letter approved by the government in 2016.

Due to the non-normality of disease cost distribution, for the statistical analysis of the relationship between the independent variables and the dependent variable (cost) and the effect of the variables on the cost change, generalized linear regression analysis with gamma distribution was used. Descriptive statistics—including number, frequency, mean and standard deviation, median and interquartile range, minimum and maximum for variables—and costs were used. To estimate the annual costs of DFU for each patient until 2042, according to the percentage increase of the items constituting the costs in the 5 years between 2017 and 2022, the cost of the following periods was estimated. The desired currency for estimating the costs of DFU was the Iranian Rials because the dollar rate in Iran has increased by 745% from 2017 to 2021 and by 40.8% from 2021 to 2023 and has had many fluctuations. Therefore, estimating the costs in dollars could not provide a logical result. SPSS Version 26 software was used

for data analysis.

## Results

The average age of patients was 58.03 years (12.57 years). The age of most patients (47.9%) was between 51

and 65 years. The age of the patients was between 29 and 90 years. The individual income of most patients (40.8%) (median, 35,000,000 and interquartile range [IQR], 23,400,000-80,000,000) was 30,000,000 million Rials or less. The average income of patients was 50,732,390

**Table 1.** Sociodemographic and Economic Characteristics of Patients with DFU (N = 213)

Variables		Frequency	Percentage
Age	50≤	60	28.2
	65-51	102	47.9
	≥66	51	23.9
gender	Female	119	55.9
	Man	94	44.1
Marital status	Married	175	82.2
	single	38	17.8
Level of Education	Illiterate	50	23.4
	Elementary	47	22.1
	Diploma	73	34.3
	University degree	43	20.2
Residence	Rural	36	16.9
	Urban	177	83.1
Family size	4≤	61	28.6
	7-5	98	46
	8≥	54	25.4
Type of Insurance	Social Security	138	64.8
	Healthcare Service	13	6.1
	Armed Forces	16	7.5
	Health of Iranians	26	12.2
	Rural	20	9.4
Employment Status	Unemployed	135	63.4
	Employed	78	36.6
Personal income (Rials)	30000000<	87	40.8
	40000000-30000000	79	23
	109990000-41000000	54	25.4
	110000000≥	23	10.8

**Table 2.** Clinical Characteristics of Patients With DFU (N = 213)

Variables		Frequency	Percentage
Degree of Ulcer	0	23	10.8
	1	35	16.4
	2	57	26.8
	3	56	26.3
	4	29	13.6
	5	13	6.1
Ulcers elsewhere except the leg	Yes	104	48.8
	No	109	51.2
Ulcer duration	12<	127	59.6
	24-12	47	22.1
	25≥	39	18.3
Classification of the Degree of Ulcer	0&1	58	27.2
	2&3	113	53.1
	4&5	42	19.7
Infection	Yes	173	81.2
	No	40	18.8
Hospitalization due to infection	Yes	70	32.9
	No	143	67.1
Type of diabetes	1	36	16.9
	2	177	83.1
Duration of diabetes	10≤	76	35.7
	20-11	97	45.5
	21≥	40	18.8
family history	Yes	97	45.5
	No	116	54.5
Risk factor	Yes	114	53.5
	No	99	46.5
BMI	24.9-18.5	141	66.2
	29.9-25	49	23
	34.9-30	13	6.1
	35≥	10	4.7
Smoking Status	Yes	36	16.9
	No	177	83.1

(35,048,210) million Rials. The minimum income of the patients was 10,000,000, and the maximum was 130,000,000 million Rials. The average number of family members of patients was 5.97(2.61) people, and the number of family members was between 1 and 18. Also, most homes (46%) had between 5 and 7 people living in them (Table 1).

The average duration of diabetes was 14.28 (6.8) years. The duration of diabetes in patients was at least 1 and at most 40 years. The patients suffered from DFU complications for at least 1 month and a maximum of 60 months. The average duration of DFU in patients was 14.22 (17.74) months. Also, the most extended duration of DFU in patients (59.6%) (median, 4 and IQR, 1-24) was less than 12 months. Body mass index (BMI) in patients was a minimum of 19 kg/m<sup>2</sup> and a maximum of 38 kg/m<sup>2</sup> (Table 2).

The average cost of DFU for each patient was 319,885,040(393579670) million Rials (Median, 231332680 and IQR, [133,242,440-382,953,460]). The direct costs of patients were 8.5 times their indirect costs. Also, direct medical costs were 49.48 times the direct nonmedical costs. The cost of hospitalization (79.3 %) was the highest, and the cost of medicine (0.3%) had the lowest share in the expenses of patients (Table 3).

The estimation of the costs of DFU disease until 2042 compared with 2017 shows that direct medical costs are 32 times (3100%), direct non-medical (travel) costs are

2151 times (214975%), direct costs are 74 times (7298%), indirect costs are 1825 times (182387%) and total costs are 258.3 times (25729%). Also, direct medical, direct non-medical (travel), and indirect costs increase by 100%, 364%, and 349%, respectively, every 5 years (Table 4).

The results showed that the type of insurance is related to the total costs of the patients, so the people covered by the armed forces insurance and rural insurance had more costs ( $P < 0.05$ ). The presence of infection in patients and hospitalization due to infection have also become significant factors affecting the total cost of patients ( $P < 0.05$ ). Thus, DFU patients with infection ( $P = 0.032$ ) and a history of hospitalization due to infection ( $P = 0.003$ ) incurred more total costs. The degree of the wound is another compelling factor in increasing the total costs of DFU patients, thus with the increase in the degree of the wound, the total cost also increased ( $P = 0.004$ ) (Table 5).

According to the findings, the type of insurance, infection, hospitalization due to infection, and the degree of the wound were statistically significant factors affecting the direct costs ( $P < 0.05$ ). The presence of infection, hospitalization due to infection, and the degree

of the wound have each increased the direct cost. Also, patients covered by armed forces insurance and rural insurance had more direct costs ( $P < 0.05$ ) (Table 6).

The findings showed that employed people had more indirect costs than unemployed people ( $P < 0.0001$ ). People covered by Iranian rural and health insurance had

Table 3. Costs of Patients With DFU in 2017

Cost		Mean (SD) (IRR)	Mean (\$)	Median [IQR] (IRR)	Min	Max	Percentage
Medical direct	Visit	1295560(580450)	30.85	[1200000-12000000]	400000	6480000	0.4
	Drug	943610(305260)	22.47	1200000 840000[760000-1280000]	540000	1280000	0.3
	Test	1166670(528890)	27.78	1000000[1000000-1000000]	1000000	4000000	0.37
	Outpatient	9076390(2173330)	216.11	8740000[8260000-9480000]	3960000	18960000	2.84
	Hospitalization	252813820(387565370)	6019.38	152692320[76736040-314230760]	227050	3223432000	79.03
	Equipment	15243890(17092610)	362.95	4000000[2800000-39984000]	1400000	40000000	4.76
	Total	280539930(388886620)	6679.52	175426800[104622180-3380980050]	14307050	3275896000	87.7
Non-medical direct	Travel	5670550(1971870)	135.01	5220000[5220000-6000000]	1000000	16000000	1.77
	Direct	286210480(388823200)	6814.54	181186800[110162180-340228050]	20307040	3281416000	89.47
	Indirect	33674560(29785380)	801.78	23823360[15160320-45751680]	4331520	194918400	10.53
Total	319885040(393579670)	7616.31	231332680[133242440-382953460]	45213290	3330145600	100	

Table 4. Annual Cost Estimate of DFU Disease for Each Patient Until 2042 in Iran (IRR)

Cost		2022	2027	2032	2037	2042
Medical direct	Visit	2,591,120	5,182,240	10,364,480	20,728,960	41,457,920
	Drug	1,887,220	3,774,440	7,548,880	15,097,760	30,195,520
	Test	2,333,340	4,666,680	9,333,360	18,666,720	37,333,440
	Outpatient	18,152,780	36,305,560	72,611,120	145,222,240	290,444,480
	Hospitalization	505,627,640	1,011,255,280	2,022,510,560	4,045,021,120	8,090,042,240
	Equipment	30,487,780	60,975,560	121,951,120	243,902,240	487,804,480
Non-medical direct	Travel	26,311,352	122,084,673	566,472,883	2,628,434,177	12,195,934,581
	Direct	587,391,232	1,244,244,433	2,810,792,403	7,117,073,217	21,173,212,661
Indirect		151,198,774	678,882,495	3,048,182,402	13,686,338,985	61,451,662,043
Total		738,590,006	1,923,126,928	5,858,974,805	20,803,412,202	82,624,874,704

Table 5. Factors Affecting the Total Cost of Patients with DFU

Variables		B	SE	Regression coefficient confidence interval		P-value
				Lower	Upper	
gender	Female	0.065	0.098	-0.127	0.256	0.508
	Man	---	---	---	---	---
Employment Status	Employed	0.032	0.109	-0.182	0.245	0.772
	Unemployed	---	---	---	---	---
Type of Insurance	Armed Forces	0.876	0.261	1.386	11.304	0.001
	Rural	0.545	0.258	0.04	1.05	0.034
	Health of Iranians	0.429	0.234	-0.029	0.887	0.067
	Social Security	0.357	0.204	-0.042	0.757	0.079
Risk factor	No	---	---	---	---	---
	Yes	-0.007	0.096	-0.197	0.183	0.945
family history	Yes	-0.094	0.103	-0.296	0.108	0.363
	No	---	---	---	---	---
infection	Yes	0.379	0.177	0.032	0.726	0.032
	No	---	---	---	---	---
Hospitalization due to infection	Yes	0.32	0.108	0.108	0.533	0.003
	No	---	---	---	---	---
Age		0.001	0.004	-0.008	0.01	0.811
BMI		-0.014	0.013	-0.041	0.014	0.325
Duration of diabetes		-0.015	0.008	-0.03	0.001	0.07
Degree of Ulcer		0.133	0.046	0.043	0.223	0.004
Ulcer duration		0.001	0.003	-0.005	0.008	0.704

Table 6. Factors Affecting the Direct Medical and Nonmedical Costs of Patients with DFU

Variable		B	SE	Regression coefficient confidence interval		P-value
				Lower	Upper	
Gender	Female	0.065	0.098	-0.129	0.259	0.510
	Man	---	---	---	---	---
Employment Status	Employed	0.021	0.110	-0.195	0.238	0.846
	Unemployed	---	---	---	---	---
Type of Insurance	Armed Forces	0.884	0.264	0.367	1.402	0.001
	Rural	0.533	0.261	0.021	1.044	0.041
	Health of Iranians	0.423	0.237	-0.041	0.887	0.074
	Social Security	0.358	0.206	-0.046	0.763	0.082
Risk factor	No	---	---	---	---	---
	Yes	-0.007	0.098	-0.199	0.186	0.946
family history	Yes	-0.089	0.101	-0.293	0.116	0.397
	No	---	---	---	---	---
infection	Yes	0.391	0.179	0.04	0.742	0.029
	No	---	---	---	---	---
Hospitalization due to infection	Yes	0.316	0.109	0.101	0.531	0.004
	No	---	---	---	---	---
Age		0.001	0.005	-0.008	0.01	0.816
BMI		-0.014	0.014	-0.041	0.014	0.325
Duration of diabetes		-0.015	0.008	-0.031	0.001	0.07
Degree of Ulcer		0.132	0.047	0.041	0.223	0.004
Ulcer duration		0.001	0.003	-0.006	0.007	0.796

more indirect costs than people covered by other insurance ( $P < 0.05$ ). Also, infection, degree of wound, and duration of the wound had a significant effect on the increase in indirect cost ( $P < 0.05$ ) (Table 7).

## Discussion

Examining the financial burden of DFU as the most common complication of diabetes is significant, considering that diabetes has become a global challenge due to its prevalence and costs. In addition to the high economic burden, DFU causes disability and labor loss due to amputation.

In the present study, the share of direct medical costs, nonmedical direct costs, direct costs, and indirect costs of

patients from the total costs were 87.7%, 1.77%, 89.47%, and 10.53%, respectively. In their study in Nigeria, Alfa et al (21) in Nigeria showed that the share of direct medical costs, nonmedical direct costs, direct costs, and indirect costs of DFU patients from the total costs were 77.9%, 14.1%, 92%, and 8%, respectively. The difference between the shares of nonmedical direct costs is due to the difference in the cost items of this group. In the current study, direct nonmedical expenses were made up of travel expenses, and in the mentioned study, they were made up of travel and food costs. This significant difference between the share of direct and indirect costs of DFU treatment from total costs in similar studies is because direct costs are usually the main costs in calculating the costs of

Table 7. Factors Influencing the Indirect Costs of Patients With DFU

Variables	B	SE	Regression coefficient confidence interval		P-value	
			Lower	Upper		
Gender	Female	0.096	0.097	-0.095	0.286	0.325
	Man	---	---	---	---	---
Employment Status	Employed	0.527	0.109	0.312	0.742	<0.0001
	Unemployed	---	---	---	---	---
Type of Insurance	Armed Forces	0.234	0.262	-0.280	0.748	0.373
	Rural	0.661	0.256	0.159	1.164	0.01
	Health of Iranians	0.589	0.231	0.135	1.043	0.011
	Social Security	0.22	0.203	-0.178	0.618	0.279
Risk factor	No	---	---	---	---	---
	Yes	-0.003	0.099	-0.197	0.109	0.974
family history	No	---	---	---	---	---
	Yes	-0.263	0.104	-0.468	-0.059	0.012
infection	No	---	---	---	---	---
	Yes	0.008	0.186	-0.356	0.373	0.964
Hospitalization due to infection	No	---	---	---	---	---
	Yes	0.461	0.106	0.254	0.668	<0.0001
Age	0.003	0.004	-0.005	0.012	0.430	
BMI	0.001	0.135	-0.025	0.028	0.931	
Duration of diabetes	-0.003	0.008	-0.019	0.013	0.737	
Degree of ulcer	0.122	0.051	0.023	0.221	0.016	
Ulcer duration	0.017	0.004	0.01	0.024	<0.0001	

a disease (23). One of the most essential items of direct costs is hospitalization cost, which is the highest in similar studies (24, 25) and has a significant contribution and impact on direct costs, followed by total costs.

In this study, the average direct, indirect, and total costs for DFU patients were \$6814.54, \$801.78, and \$7616.31, respectively. Also, the average direct medical costs were \$6679.31, and nonmedical costs were \$135.01. A study in Nigeria showed that the average direct medical, direct nonmedical, direct, indirect, and total costs of DFU patients were \$191.52, \$34.7, \$226.22, \$19.8, and \$246 annually, respectively (21). Su et al study (26) in Taiwan also showed that the average costs of primary DFU, DFU without infection, and DFU with infection were \$161, \$97, and \$160 per month for each patient, respectively. Also, in Taiwan, the average annual cost of each patient with DFU is \$3284.20 (27). The study by Jafari et al (25) in Iran showed that the average direct medical, indirect medical, indirect, and total costs in a 6-month course based on hospital-based care for patients were \$3001, \$413.4, \$529.9, and \$3940.3. In Spain, the average cost of DFU treatment for each patient is €7633 per year (28). Also, a study in Bahrain showed that the average annual total cost for DFU patients is €13,285 (29). In the present study, hospitalization costs for each patient were \$376.21. The results of a study in Nigeria showed that the average direct medical costs, direct non-medical costs, direct costs, indirect costs, and total costs for each patient with DFU were \$12.694, \$241.98, \$1023.27, \$209.90, and \$1381.55, respectively (13). The costs of the patients in the present study were not much different from most of the mentioned studies. Nevertheless, the difference in costs in some cases, especially compared with developed countries, can be caused by the heterogeneity of the population under study, the amount of insurance coverage, the difference in the tariff of services provided, the level of self-care of pa-

tients, the amount of education to patients, the use of new treatment methods, and change in care patterns. Also, the cost structure or the items that make up the costs in the studies are different and cause differences in the costs. The share of each cost in the present study was similar to the compared studies. In addition, to compare the treatment costs in the mentioned study with other studies, the income level of the patients and the amount of government support for the patients should also be considered. Therefore, in a developed nation, the patient's expenses are paid by the high income of the patient or his family, the government's assistance in providing services at a reasonable rate, and the reduction of the patient's part.

However, in underdeveloped and developing countries with a low share of gross domestic product for the health sector, with low levels of income of patients, and incomplete insurance coverage, the cost of patients is not covered. Despite the measures taken to control the costs of this disease by governments, the results of estimating the costs of DFU in this study showed that the total costs of this disease will increase by 258.3 times in 2042 compared with 2017, equivalent to 25,729%. A study in China showed that the costs of DFU treatment have increased, so the total costs of each patient in 2020 compared with 2014, increased by 2.71 times and equal to 170.6% (4). Therefore, to reduce and control the costs of DFU, such measures as determining health policies for prevention, checking the effectiveness of treatment interventions, financial support for patients, full insurance coverage, and reducing tariffs can be taken.

The results of regression analysis showed that the presence of infection, hospitalization due to infection, degree of the wound, type of insurance, employment status, and duration of the wound had a significant effect on the increase of patients' expenses. A study in Turkey, similar to the present study, showed that the increase in the degree

of wound in patients and hospitalization costs was a compelling factor in increasing the total costs of patients (24). In another study, similar to this study, the duration of the wound and the presence of co-morbidities were influential factors in increasing the total costs of DFU patients. Hicks et al study (30) showed that the treatment costs of DFU patients increased with the increase in the duration and stages of treatment so that the costs were 12.65 times higher than the initial stages of treatment. This was consistent with the results of the present study. The study of Lobmann et al (31) also showed that as the duration of the wound increased, the costs of the patients also increased. The study of Mairghani et al (29) showed that the male sex and age of >60 years increase costs. In the present study, no relationship was found between sex and age with the amount of expenses. Also, there was no relationship between the presence of risk factors, the duration of diabetes, the duration of the wound, the presence of infection, the degree of the wound, and the cost of DFU patients in the mentioned study. This was not consistent with the results of the present study. This difference can be due to the characteristics of the patients or the type and tariff of the services provided. In this study, the people covered by some insurances had a higher cost, which is due to their poor coverage level. In a study, it was shown that poor insurance coverage increased the cost of patients (13), which was consistent with the results of the present study. Thus, increasing the extent of insurance coverage, particularly for the services, medications, and equipment required by DFU patients, lowering infection rates through patient education and appropriate treatment measures, lowering hospitalization rates, employing preventive and appropriate treatment measures both at home and in the hospital to stop the progression of the wound degree and shorten the duration of the wound, and providing financial assistance or free services to low-income patients can all be major efforts to lower patient costs.

In this study, according to the average cost of the disease for each person (\$7616.31), the amount of poverty line in the year of conducting the study was 40,000,000 million Rials (\$952.38) and 63.8% of the patients were below the poverty line, the costs of this disease are very overwhelming and unbearable. Therefore, the first measure is primary prevention of diabetes mellitus and secondary prevention of DFU (13). More importantly, DFU should be controlled with appropriate measures so that it does not lead to amputation, as the costs of DFU patients who had amputations are between 3.22 and 3.79 times that of diabetic patients without DFU and 1.06 times that of patients with DFU (27).

This study had limitations and strengths. One of the limitations of this study is the problematic access to patients due to the physical and mental conditions of their patients and the cultural and ethnic differences of the participants. One of the strong points of this study is to conduct research in the only DFU treatment center in Ahvaz and examine many sociodemographic, economic, background, and clinical variables in patients.

## Conclusion

The high costs of DFU impose a tremendous economic burden on patients, health systems, and the government. Therefore, 3 basic actions can be taken: (1) preventing diabetic patients from developing DFU; (2) reducing the costs of patients with DFU by strengthening insurance coverage, providing free drugs prescribed for these patients in government health and treatment centers, exempting poor and low-income people from diagnosis and treatment costs, using new treatment methods, intervention in the variables influencing the cost increase; and (3) preventing limb amputation in DFU patients with follow-ups and regular care. Finally, the cost information presented in this study can be used to intervene in the influencing variables in increasing the costs of the disease.

## Authors' Contributions

Conceptualization: A.T. and A.S. Data collection: A.S., A.H., and M.D. Methodology: A.T. A.S., and A.T.G. Writing the original draft: A.T.G. Review & Editing: A.T. and A.T.G.

## Ethical Considerations

This study was approved by the Medical Ethics Committee of Ahvaz Jundishapur University of Medical Sciences with code No. IR.AJUMS.REC.1395.579.

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## Conflict of Interests

The authors declare that they have no competing interests.

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