

ORIGINAL ARTICLES

Direct non-medical cost and associated factors in treatment of type 2 diabetes with complications at several hospitals in Ho Chi Minh city

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ABSTRACT

Introduction: Type 2 diabetes mellitus (T2DM), especially those with complications, requires lifelong care and incurs substantial expenses. In order to reduce out-of-pocket costs borne by patients, understanding costs including direct non-medical cost is important. This study aims to examine direct non-medical cost and related factors among T2DM with complications.

Methods: A cross-sectional survey of 617 T2DM patients conducted at Thong Nhat and Nguyen Tri Phuong hospitals from May 2023 to July 2023 using convenience sampling method. Generalized linear regression models were used to examine the effect of having complications on direct non-medical cost and other associated factors.

Results: The average direct non-medical costs amounted to 1,351,706 VND. For individuals with complications, the average direct non-medical cost was 1,716,756 VND, nearly 1.81 times higher than those without complications. Regarding type of complications, having both complications incurred higher cost than those without complications (245631.8, 95%CI: 29952.3-461311.4, $p=0,026$), adjusted for other factors. The factors associated with direct non-medical costs included place of residence, educational attainment, having health insurance, traveling with a family member, using personal or public transport, using supplementary foods, and the patient's income ($p < 0.05$).

Conclusion: This study, among the first to analyze differences in direct non-medical costs among T2DM groups with complications in Vietnam, could contribute to understanding the economic dimensions of T2DM and provide valuable insights for future interventions aimed at alleviating the economic burden of T2DM on patients and society.

Keyword: Direct non – medical cost, type 2 diabetes, complication, associated factors.

INTRODUCTION

The World Health Organization (WHO) predicts that the 21st century will be marked by a surge in endocrine diseases and metabolic disorders, with diabetes leading as a swiftly

advancing chronic condition (1). T2DM specifically constitutes a substantial 87% to 91% of all chronic disease cases worldwide. In 2021, diabetes was accountable for 6.7 million global deaths, with more than three-quarters of adults affected residing in low-



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and middle-income countries (1). Regarding healthcare cost, the average diabetes-related costs per person (aged 20 – 79 years) with diabetes rose from US\$62 in 2009 to US\$163 in 2015 and further to US\$217 in 2017 (International Diabetes Federation). The associated healthcare costs for diabetes in 2021 were estimated to be a staggering 966 billion USD, imposing a significant economic burden on both health systems and societies as a whole. It is estimated that direct medical costs, direct non-medical costs, and indirect costs accounting for 65%, 12%, and 24% of the total costs, respectively (1).

In Vietnam, the rate of diabetes cases is rapidly escalating, surpassing that of some other countries. In 1990, the estimated prevalence of T2DM was 1.2%, which rose to 2.7%, 5.4%, and 6% in 2002, 2012 and 2017, respectively (2). By 2017, this figure had further increased to around 6%, corresponding to approximately 5.76 million individuals affected by diabetes, the majority of whom are diagnosed and treated for T2DM (2-4). Direct medical costs due to diabetes comprised 10% of total medical expenditures in Vietnam in 2017. The impact of these direct medical costs is significant on the payors, as the majority is covered by health insurance (ranging from 80% to 95%) (5). In contrast, direct non-medical costs and indirect costs are mostly borne by the patients themselves, making it a crucial aspect in estimating the economic burden on individuals with diabetes. In 2017, direct non-medical costs and indirect costs related to diabetes totaled 239 million USD, equivalent to 55% of the total direct medical costs associated with the disease.

Despite this, studies analyzing direct non-medical costs of T2DM remain limited. In a country where the share of out-of-pocket (OOP) payment has reached 45% in 2018 (6), a figure notably surpassing the thresholds

indicating catastrophic health expenditures (set at 10% or 40%) and exceeding the levels observed in neighboring countries, it is essential for Vietnam to seek a solution to reduce OOP for patients and their families. Additionally, diabetes-related complications could add another layer of cost to patients. While it was estimated that diabetes-related complications accounted for approximately 70% of the total direct medical costs in Vietnam, its impact on direct non-medical cost is unknown. This study aimed to analyze direct non-medical costs and related factors in the treatment of T2DM with a focus on diabetes-related complications at two hospitals in Ho Chi Minh City during the period of 2022–2023.

METHOD

Study design: A cross-sectional descriptive study was conducted through surveys and interviews with outpatients diagnosed with T2DM at Thong Nhat Hospital and Nguyen Tri Phuong Hospital in Ho Chi Minh City during the period of 2022-2023. The research methodology and data analysis process was illustrated in Figure 1.

Research subjects: The research subjects comprised outpatients undergoing treatment for T2DM at Thong Nhat and Nguyen Tri Phuong hospitals in Ho Chi Minh City throughout the research period.

Inclusion criteria:

- Patients aged 18 years or older.
- Patients diagnosed with T2DM for at least 1 year

Exclusion criteria:

- Patients provided insufficient research information.

- Women reported receiving maternity-related services during the study period.

Study site and time: The research was carried out at the following locations:

- Thong Nhat Hospital (01 Ly Thuong Kiet Street, Ward 7, Tan Binh District, HCMC)
- Nguyen Tri Phuong Hospital (468 Nguyen Trai, Ward 9, District 5, Ho Chi Minh City)

The research implementation spanned from September 2022 to October 2023.

Sample size and sampling method: The study aimed to achieve a sufficient sample size based on the following parameters:

$$N = Z^2_{(1-\alpha/2)} \times \frac{S^2}{d} = 384 \quad (7)$$

N: the required research sample size

α : the statistical significance level (set at $\alpha=0.05$)

S: the standard deviation, as determined by a prior study ($S=0.248$) (8)

d: the estimated deviation range (anticipated to be 2%)

$Z(1-\alpha/2)$: the reliability coefficient ($Z(0.975)=1.96$)

Data was collected from 05/2023 to 07/2023 using convenience sampling method, and the collected sample size was 617 patients.

Research variables: This cross-sectional study addressed three groups of variables:

(1) Patient's characteristics include:

- *Demographic characteristics:* gender, age; residence; marital status; education attainment; medical insurance; travel with family member; transport; supplementary food; patient's income

- *Pathological characteristics:* length of the illness; comorbidities

- *Characteristics of risk factors:* smoking; alcohol; exercises; diabetes in the family history; re-examination frequency.

(2) Direct non-medical costs of T2DM treatment are analyzed from a social perspective including cost components: Food cost; Transportation cost; Other cost. All costs were calculated for one year of treatment.

Data collection: Data were collected through surveys with outpatients diagnosed with T2DM at the Department of Endocrinology at Thong Nhat and Nguyen Tri Phuong hospitals from May 2023 to July 2023. Raw data obtained in phase 2 were examined, screened, coded, and cleaned to obtain the final analytical dataset.

Data analysis: Following data collection, entries were made, and data were screened and cleaned using Microsoft Excel 365 software. Subsequently, the data were coded and analyzed using STATA 14 software. Categorical variables were statistically described through frequencies and percentages, and statistically significant differences were tested using the Chi-square test or Fisher exact test. Quantitative variables were presented as mean, SD, median, average value, and interquartile range. Various tests, including t-test, 1-factor ANOVA, Mann-Whitney, and Kruskal-Wallis, were applied based on the distribution of quantitative data.

The study employed multivariable generalized linear regression models (GLM) to analyze the relationship between variables and direct non-medical costs in the treatment of T2DM. The dependent variable was the direct non-medical costs of individuals with T2DM, while independent variables included demographic characteristics, pathological characteristics, and risk factor characteristics of the patients. The results of the multivariate regression equation model are presented as variable analysis values after the GLM model

(margins). Demographic, pathological, and risk factor characteristics were considered related when $p < 0.05$. Variables with $p < 0.05$ in the univariate model were included in the multivariate regression model.

Ethics approval: The study received approval from the Ethics Council in Biomedical Research of Ho Chi Minh City University of Medicine and Pharmacy (No. 138/HDĐĐ - DHYD dated February 7, 2023) and the Ethics Committee in Biomedical Research of Thong Nhat Hospital (28/2023/BVTN-HDYD on April 28, 2023).

RESULTS

Patients characteristics

Table 1 presents the demographic of the 4 patient groups: those without complications, with microvascular complications (mcv), with macro vascular complications (MCV), and with both mcv and MCV. The average age of the 4 groups were 59.3, 62.9; 70.7, and 71.8, respectively. The majority of patients in all 4 patient groups were married, cared for by

their family, visited to the hospital with their family, and resided in Ho Chi Minh City. The income of the group without complications was higher than that the other 3 groups, at approximately 7,793,265 VND. Statistical tests show significant relationships between type of complications and age, residency, marital status, travelling with family member, and means of transport ($p < 0.05$).

Table 1 also presents pathological characteristics and risk factors of T2DM. The illness duration of the above 4 groups were 8.24, 10.20, 11.75, and 15.64 years, respectively. There was 87.52% of studied sample having comorbidities, and 52.84% of them having complications of T2DM. Regarding risk factors of T2DM among 04 patient groups, the most common risk factors were smoking (86.25%) and drinking alcohol (79.04%). The percentage of using alcohol among those without complications was higher than that in the other groups. Statistical tests show significant relationships between type of complications and length of illness, having comorbidities, and drinking alcohol ($p < 0.05$).

Table 1. Demographic, pathological characteristics and risk factor of T2DM of the studied sample

Characteristics		Total		Complications, n (%)			p-value	
		n (%)		No complication	mcv	MCV		2 complications
		N = 617	N = 291					
Gender	Male	243 (39.38)	126 (43.30)	59 (37.34)	20 (29.41)	38 (38.00)	0.168 ^a	
	Female	374 (60.62)	165 (56.70)	99 (62.66)	48 (70.59)	62 (62.00)		
Age	Mean (SD)	63.4 (11.8)	59.3 (11.9)	62.9 (10.7)	70.7 (7.5)	71.8 (8.0)	<0.001 ^b	
Residency	HCM city	590 (95.62)	285 (97.94)	146 (92.41)	67 (98.53)	92 (92.00)	0.006 ^c	
	Other	27 (4.38)	6 (2.06)	12 (7.59)	1 (1.47)	8 (8.00)		
Marital status	Single	79 (12.80)	30 (10.31)	21 (13.29)	11 (16.18)	17 (17.00)	0.027 ^a	
	Married	538 (87.20)	261 (89.69)	137 (86.71)	57 (83.82)	83 (83.00)		

Education attainment	Illiterate	19 (3.08)	41 (14.09)	21 (13.29)	8 (11.76)	17 (17.00)	0.912 ^a
	Primary school	87 (14.10)	67 (23.02)	35 (22.15)	16 (23.53)	18 (18.00)	
	Secondary school	136 (22.04)	72 (24.74)	42 (26.58)	17 (25.00)	32 (32.00)	
	High school	163 (26.42)	37 (12.71)	14 (8.86)	15 (22.06)	9 (9.00)	
	College/ University/Post Grad	212 (34.4)	104 (35.7)	53 (33.5)	24 (35.3)	31 (31.0)	
Medical insurance	No insurance	7 (1.13)	6 (2.06)	1 (0.63)	0 (0.00)	0 (0.00)	0.127 ^a
	80%	425 (68.88)	207 (71.13)	108 (68.35)	41 (60.29)	69 (69.00)	
	95%	103 (16.69)	47 (16.15)	25 (15.82)	18 (26.47)	13 (13.00)	
	100%	82 (13.29)	31 (10.65)	24 (15.19)	9 (13.24)	18 (18.00)	
Travel with family member	No	420 (68.07)	212 (72.85)	107 (67.72)	47 (69.12)	54 (54.00)	0.007 ^a
	Yes	197 (31.93)	79 (27.15)	51 (32.28)	21 (30.88)	46 (46.00)	
Transport	Personal's transport	418 (67.75)	218 (74.91)	99 (62.66)	44 (64.71)	57 (57.00)	0.003 ^a
	Public transport	199 (32.25)	73 (25.09)	59 (37.34)	24 (35.29)	43 (43.00)	
Supplementary food	No	511 (82.82)	246 (84.54)	132 (83.54)	56 (82.35)	77 (77.00)	0.384 ^a
	Yes	106 (17.18)	45 (15.46)	26 (16.46)	12 (17.65)	23 (23.00)	
Patient's income (VND)	Mean (SD)	6.250.511 (1.06*10 ⁷)	7.793.265 (1.03*10 ⁷)	4.679.747 (6.67*10 ⁷)	5.566.176 (1.31*10 ⁷)	4.708.250 (1.37*10 ⁷)	< 0.001 ^b
Length of the illness (Years)	Mean(SD)	10.55(7.95)	8.24 (6.65)	11.75(7.91)	10.20(6.87)	15.64 (9.39)	< 0.001 ^b
Comorbidity	No	77 (12.48)	51 (17.53)	15 (9.49)	5 (7.35)	6 (6.00)	0.004 ^a
	Yes	540 (87.52)	240 (82.47)	143 (90.51)	63 (92.65)	94 (94.00)	
Smoking	Yes	69 (11.18)	40 (13.75)	15 (9.49)	6 (8.82)	8 (8.00)	0.286 ^a
	No	548 (88.82)	251 (86.25)	143 (90.51)	62 (91.18)	92 (92.00)	
Alcohol	Yes	82 (13.29)	61 (20.96)	11 (6.96)	7 (10.29)	3 (3.00)	< 0.001 ^a
	No	535 (86.71)	230 (79.04)	147 (93.04)	61 (89.71)	97 (97.00)	
Diabetes in the family history	Yes	253 (41.00)	119 (40.89)	69 (43.67)	21 (30.88)	44 (44.00)	0.294 ^a
	No	364 (59.00)	172 (59.11)	89 (56.33)	47 (69.12)	56 (56.00)	
Re-examination frequency	1 month	596 (96.60)	283 (97.25)	150 (94.94)	67 (98.53)	96 (96.00)	0.468 ^a
	3 months	15 (2.43)	7 (2.41)	6 (3.80)	0	2 (2.00)	
	6 months	6 (0.97)	1 (0.34)	2 (1.27)	1 (1.47)	2 (2.00)	

^aChi-square test, ^bKruskal Wallis test, ^cFisher's Exact test; *mvc*: microvascular complications, *MCV*: macrovascular complications

Direct non – medical cost of patients with type 2 diabetes

Direct non-medical costs for T2DM patients were detailed in Table 3. The study documented the average annual direct non-medical costs per patient as 1,351,706 VND. Transportation costs constituted the highest percentage at

66.20% (894,769 VND), followed by food costs at 29.20% (394,645 VND), and other expenses at 4.60% (62,291 VND). Patients with complications incurred higher total direct non-medical costs compared to the group without complications (947,431 VND). For individuals with complications, the average

direct non-medical cost was 1,716,756 VND, nearly 1.81 times higher than those without complications. Specifically, the group with both macro vascular and microvascular complications had the highest costs (2,423,875 VND), followed by the group with microvascular complications (1,450,200 VND) and the group with macro vascular

complications (1,276,173 VND). Statistical tests showed significant relationships between type of complications and total direct non-medical costs, food costs for accompanying individuals, overall transportation costs, patient transportation costs, accompanying person's transportation costs, and public transport travel costs ($p < 0.05$).

Table 2. Direct non – medical cost of patients with type 2 diabetes

Type of cost	Content	Mean cost (VND) ± Standard deviation					P - value
		Total N = 617	No complication N = 291	mcv N = 158	MCV N = 68	2 complications N= 100	
Food cost	Patient	291,828 ± 360,588	280,783 ± 338,915	269,329 ± 333,016	289,058 ± 321,116	361,400 ± 469,946	0.474*
	Accopaning of patient	102,816 ± 266,536	68,384 ± 200,456	128,544 ± 313,790	111,352 ± 271,694	156,560 ± 332,737	0.012*
	General	394,645 ± 535,961	349,168 ± 452,826	397,873 ± 553,119	400,411 ± 527,209	517,960 ± 701,385	0.320*
Transportation cost	Patient	683,576 ± 1,651,993	463,854 ± 651,527	789,621 ± 2,152,047	606,090 ± 1,221,456	1,208,108 ± 2,634,634	0.021*
	Accopaning of patient	210,696 ± 1,207,561	93,110 ± 468,823	192,878 ± 778,316	183,926 ± 992,402	599,230 ± 2,570,621	0.012*
	Personal's transport	321,819 ± 1,182,209	242,269 ± 307,577	511,681 ± 2,172,254	180,934 ± 110,242	405,056 ± 1,289,433	0.63*
	Public transport	2,098,253 ± 4,025,453	1,498,245 ± 1,617,170	1,774,530 ± 3,127,610	1,906,667 ± 3,234,239	3,667,983 ± 7,025,311	0.031*
	General	894,769 ± 2,616,350	557,342 ± 1,008,745	983,251 ± 2,633,373	790,016 ± 2,070,974	1,808,115 ± 4,951,245	0.014*
	Other cost	62,291 ± 192,317	40,920 ± 147,612	69,075 ± 218,622	85,764 ± 222,839	97,800 ± 232,023	0.243*
Total cost		1,351,706 ± 2,838,206	947,431 ± 1,253,515	1,450,200 ± 2,902,013	1,276,193 ± 2,402,094	2,423,875 ± 5,157,348	< 0.001*

(*) *Kruskal – Wallis test*

mcv: microvascular complications, MCV: macrovascular complications

Factors associated with direct non-medical cost

Table 3 presents results from the GLM analysis fitted to the data by specifying a gamma distribution and using a log link function. In the unadjusted model, having both complications incurred higher cost

then those without complications (651962.3, 95%CI 244888-1059037, $p=0.002$). In the adjusted model, having both complications still incurred higher cost than those without complications (245631.8, 95%CI: 29952.3-461311.4, $p=0,026$). Other factors associated with direct non-medical costs included place

of residence (living in Ho Chi Minh City or other area), education attainment, having health insurance (80%, 95%, 100%), traveling with a family member, using personal or public transport, using supplementary foods,

and the patient's income ($p < 0.05$) (see Table 3). All related variables increased the value of direct non-medical costs, with transportation having the highest impact on direct non-medical costs compared to other factors.

Table 3. Multivariable GLM to identify factors related to direct non-medical costs in T2DM treatment

Characteristics	Unadjusted Coefficient [95% CI] (VND)	Adjusted Coefficient [95% CI] (VND)	P-value	
Complications	No complication	-	-	
	mcv	93961.8 [-141730.3; 329653.8]	-51924.7 [-194081.6; 90232.1]	0.474
	MCV	126612.2 [-207289.5; 460513.9]	40982.1 [-169355.7; 251319.9]	0.703
	Both complications	651962.3 [244888; 1059037]	245631.8 [29952.3; 461311.4]	0.026
Gender	Female	-	-	
	Male	-	51763.8 [-86530.7; 190058.2]	0.463
Age	-	-24316.1 [-91427.5; 42795.3]	0.478	
Residency	HCM city	-	-	
	Others	-	-1088033 [-1787538; -388527.7]	0.002
Education attainment	Illiterate	-	-	
	Primary school	-	362446.7 [65564.6; 659328.8]	0.017
	Secondary school	-	401423.7 [118412.8; 684434.7]	0.005
	High school	-	310234.3 [36950.1; 583518.4]	0.026
	College/University/ Post grad	-	325543.9 [46312; 604775.9]	0.022
Health insurance	No insurance	-	-	
	80%	-	440502.8 [108947.2; 772058.4]	0.009
	95%	-	526924.4 [152903; 900945.9]	0.006
	100%	-	490242.2 [97641; 882843.4]	0.014
Travel with family member	No	-	-	
	Yes	-	955373.4 [749417.1; 1161330]	<0.001
Means of transportation	Personal's transport	-	-	
	Public transport	-	1170564 [962026.1; 1379103]	<0.001
Supplementary food	No	-	-	
	Yes	-	600519.7 [370865.4; 830173.9]	<0.001
Patient's income	-	1164.2 [484.1; 1844.3]	0.001	

Note : GLM was fitted to the data by specifying a gamma distribution and using a log link function.

DISCUSSION

The survey encompassed 617 patients with T2DM at Nguyen Tri Phuong Hospital and Thong Nhat Hospital in 2023, revealing an average annual direct non-medical cost of 1,351,706 VND per patient, of which transportation costs constituted the highest percentage (66.20%). In contrast, Le et al.'s 2017 study reported direct non-medical costs for type 2 diabetes patients at 34.40 USD (approximately 825,000 VND), potentially stemming from variations in cost components such as functional foods, additional food expenses, and treatment-related loan interests (9). Global studies on T2DM patients' direct non-medical costs, including those by Zinash Alemu (2020), Ivan I. Dedov (2017), and Habib Jalilian (2023), presented diverse findings, highlighting methodological differences (10-12).

Among factors associated with direct non-medical costs, means of transportation had the highest impact on direct non-medical costs compared to other factors. In the cost components, transportation costs also constituted the highest percentage (66.20%). Although other published studies did not examine factors associated with direct non-medical cost (9,13), these both recognized transportation cost as an important component, which was similar to this study. Analysis of patient groups based on complication classification unveiled that the average direct non-medical cost for those with complications reached 1,716,756 VND, nearly 1.81 times higher than the group without complications, aligning with Kieu Thi Tuyet Mai's 2020 study (13). Additionally, various studies underscored the heightened direct medical costs associated with microvascular or macrovascular complications (14, 15). The difference between groups categorized by type of complications reduced after being

adjusted for other potential confounding. After being adjusted for other variables, having both complications still incurred higher cost than those without complications (245631.8, 95%CI: 29952.3-461311.4, $p=0,026$). To enhance treatment quality and alleviate the burden on T2DM patients, focus on complication control is crucial. Recommendations for cost-effective interventions emphasize the need to manage microvascular and macrovascular complications (16). Subsequent studies should evaluate the impact of complications on total treatment costs, encompassing direct medical, direct non-medical, and indirect costs, to devise appropriate interventions for controlling T2DM and its complications.

While contributing to the understanding of T2DM's economic burden regarding direct non-medical cost, our research has limitations. As a cross-sectional study conducted in two large hospitals in Ho Chi Minh City, although we detected factors associated with the outcome of interest using regression models, our study cannot establish causal relationships between related factors and direct non-medical costs. The study population, limited by funding, time, and resources, does not represent the entire community, especially those in rural areas. Further studies are essential to assess the medical burden of T2DM patients in Vietnam, encompassing the general population.

CONCLUSION

This study was among the first to assess differences in direct non-medical costs among various T2DM disease groups with complications in Vietnam. The findings revealed that for individuals with complications, the average direct non-medical cost was 1,716,756 VND, nearly 1.81 times higher than those without complications.

Regarding type of complications, having both complications (mcv and MCV) incurred significantly higher cost than those without complications after being adjusted for other factors. Factors associated with direct non-medical costs included place of residence, educational attainment, having health insurance, traveling with a family member, using personal or public transport, using supplementary foods, and the patient's income. By illuminating the complexity of direct non-medical costs and associated factors, the study provided insights for future interventions aimed at minimizing the economic burden of T2DM for patients and society as a whole.

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