©*Genus Homo* (ISSN 2457-0028)
Dept of Anthropology
West Bengal State University

Genus *Homo*, Vol. 9, 2025
Chaurasia *et al*, pp 25-37
Accepted on 26th December 2025
Published on 31st December 2025

Original article

ECONOMIC BURDEN OF TYPE 2 DIABETES MELLITUS AMONG THE ADULTS: A CROSS-SECTIONAL STUDY IN MADHESH PROVINCE OF NEPAL

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is an escalating global health challenge, projected to affect 783 million people by 2045. Low- and middle-income countries (LMICs) face increasing burdens due to limited healthcare resources and high out-of-pocket expenses. In Nepal, the prevalence of diabetes has reached 8.7% and continues to rise, particularly in Madhesh Province, where obesity, hypertension, and urbanization are increasing. Limited access to specialized care further exacerbates the situation.

Methodology: A cross-sectional study was conducted in Madhesh Province from June 2023 to March 2024 among adults aged 20–79 years diagnosed with T2DM. Using multistage random and snowball sampling, 492 participants were recruited. Data were collected through face-to-face interviews using a validated structured questionnaire that included socio-demographic information, treatment history, and healthcare expenditures. Glycemic control was assessed using fasting plasma glucose levels based on the American Diabetes Association (ADA) criteria.

Results: Among the 492 participants, the majority were middle-income (68.3%), married (81.9%), rural residents (68.3%), and had primary-level education (46.7%). More than three-fourths (78.5%) reported a family history of diabetes. Mean overall expenditure increased with disease duration—from 237.7 units for ≤3 years to 270.0 units for ≥8 years—with medication costs being the largest component. Females incurred significantly higher overall, hospital, and medication expenses ($p<0.05$), particularly among those with ≥8 years of disease duration. Higher education, urban residence, and dietary counseling were also associated with greater expenditures, highlighting gender and socioeconomic disparities in diabetes management.

Conclusion: The increasing economic burden of T2DM in Madhesh Province underscores the urgent need for gender-sensitive and cost-effective interventions to improve diabetes management, alleviate financial strain, and guide equitable health policy decisions.

KEY WORDS: Type 2 Diabetes Mellitus; Economic Burden; Gender Disparities; Cost-Effective Interventions; Chronic Disease Management.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) has become a major global health issue due to its significant impact on individuals, healthcare systems, and economies worldwide, as well as its rapidly increasing prevalence. The World Health Organization (WHO) reported that in 2021, 537 million people were living with diabetes, and this number is expected to rise to 783 million by 2045(Magliano et al., 2021).In low and middle-income countries (LMICs), where healthcare

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resources are often limited and dispersed, diabetes not only increases illness and death rates but also puts heavy financial pressure on healthcare systems. In these regions, patients and their families bear most of the out-of-pocket costs linked to managing the disease (Zhuo et al., 2013).

The International Diabetes Federation (IDF) estimates that 783 million people will have diabetes by 2045. It is predicted that most T2D patients (79%) will live in lower- and upper-middle-income countries, and that the majority will go untreated (IDF, 2021). Diabetes has become much more common in Nepal in recent decades, coinciding with changes in nutrition, lifestyle, and urbanization. T2D is one of the chronic illnesses that Nepal is dealing with. The prevalence of diabetes mellitus was 8.5% and 8.7%, respectively, according to a recent nationwide population-based study and IDF, and it is predicted to rise to 9.4% by 2045 (Yang et al., 2020;(Rasu et al., 2015).

This aligns with the overall trends in South Asia, where diabetes rates are rising. Due to a mix of lifestyle, environmental, and genetic factors—such as poor diet, sedentary habits, and high rates of obesity and hypertension—people in South Asia are especially at risk for diabetes (Zhuo et al., 2014; Rosella et al., 2016).

One of the most costly and challenging medical conditions, type 2 diabetes has a significant financial burden on society (Yang et al., 2020; Snorgaard et al., 2017). Diabetes cost the U.S. $966 billion in 2021, and by 2030, expenses are expected to rise to epidemic proportions, reaching over $2.1 trillion (IDF, 2021; Mattei et al., 2015).

The total health care expenditure, including out-of-pocket expenses, to manage T2D in Nepal was US $115.8 million $102(IDF, 2021).Per person per year in 2021 and is projected to nearly double (i.e., total cost US $190.5 million), with costs of US $168.1 per person by 2045(Rasu et al., 2015). More than half of the expenses for Nepalese T2D patients are out-of-pocket, a significant concern in low and middle-income countries like Nepal (WHO, 2021).

Madhesh Province in Nepal's Terai region has a dense, diverse population. Although it is the smallest province in Nepal by area, rapid urban growth and an increase in diabetes risk factors like obesity and hypertension have caused a significant rise in Type 2 diabetes cases. Access to specialized healthcare is limited here, and many rely on public health services that face resource shortages and infrastructure hurdles (Ghimire et al., 2023). Despite these growing concerns, there is a lack of comprehensive research on the economic burden of diabetes at the provincial level in Nepal, particularly in Madhesh Province.

The economic burden of diabetes includes both direct medical costs (such as hospital visits, medications, laboratory tests) and indirect costs, which involve lost productivity, absenteeism from work, and the long-term financial impact of complications like cardiovascular disease, kidney failure, blindness, and amputations (Zhang et al., 2020; Hussain et al., 2016). The total costs of managing diabetes costs can cause financial hardship for individuals and families, potentially pushing them into poverty. In countries like Nepal, where out-of-pocket expenses make up most healthcare costs, this burden can be overwhelming (Barcelo et al., 2003).

Given the rising prevalence of Type 2 diabetes and its economic impact in Nepal, this study aims to address a significant gap in the existing literature by measuring the

economic burden of T2DM in Madhesh Province. The results will be crucial for shaping health policies, allocating resources, and developing targeted strategies for diabetes prevention and management at the provincial level. Additionally, this study will provide locally relevant data to support strengthening the health system, improving access to affordable diabetes care, and promoting integrated management programs that can reduce the financial strain on patients and families.

This research seeks to evaluate the economic burden of Type 2 diabetes mellitus (T2DM) among adults aged 20–79 years in Madhesh Province, Nepal, by estimating both direct medical costs, such as hospital visits, medications, and laboratory tests. The findings will provide locally relevant information, insights, and evidence to inform health policy, resource allocation, and targeted diabetes prevention and management strategies.

OBJECTIVES

The primary objective of this study is to assess the economic burden of Type 2 diabetes mellitus (T2DM) in adults aged 20–79 years in Madhesh Province, Nepal.

Specifically, the study aims to:

1. Quantify the direct medical costs of T2DM, including hospital visits, medications, and laboratory tests.
2. Estimate the indirect costs associated with T2DM, such as loss of productivity and absenteeism.
3. Identify socio-demographic factors associated with the economic burden of T2DM in this population.

Research Questions:

1. What is the total direct medical cost of managing T2DM in Madhesh Province?
2. What are the indirect costs related to T2DM, including productivity loss and absenteeism, in the region?
3. Which socio-demographic factors (e.g., age, gender, occupation, income) are associated with higher economic burden due to T2DM?

Hypotheses:

1. H_1: There is a significant association between socio-economic factors (age, gender, income) and the economic burden of T2DM in Madhesh Province.
2. H_2: The direct medical costs of T2DM in Madhesh Province are significantly higher than the indirect costs.
3. H_3: Individuals with poor glycemic control incur higher medical and indirect costs compared to those with reasonable glycemic control**.**

METHODS

Study Design: This cross-sectional study was conducted in Madhesh Province, Nepal, which covers 6.5% of the country's total area and has a population of over 6 million people (Central Bureau of Statistics, 2021). The province has eight districts, including densely populated urban and semi-urban areas. It is culturally significant and a hub for religious tourism; however, health infrastructure is limited, especially in managing chronic conditions like diabetes.

Study Population: The study population consisted of adults aged 20–79 years diagnosed with T2DM in the Madhesh Province. A diagnosis of T2DM was confirmed based on fasting plasma glucose (FPG) levels ≥126 mg/dL (≥7.0 mmol/L) (American Diabetes Association, 2021). People who were bedridden or residing outside the province were excluded from study.

Sample Size and Sampling Technique: The sample size was calculated based on an estimated diabetes prevalence of 10% in Nepal (Shrestha et al., 2021). Using the formula: $n = \frac{z^2pq}{d^2} = \frac{1.96^2 * 0.1 * 0.9}{0.05^2} = 139$, where Z=1.96, p=0.1, q=0.9 and d=0.05, the required sample size was calculated to be 139. However, to account for a 5% absentee rate, the final sample size was increased to 492 participants. A multistage random sampling method was used to select districts and municipalities, followed by snowball sampling to identify individuals with T2DM in each selected area.

Data Collection: Data collection was carried out from June 1, 2023 to March 30, 2024, using face-to-face interviews. A structured questionnaire was administered to gather information on participants' sociodemographic characteristics, diabetes history, current treatment practices, healthcare expenditures, and the impact of diabetes on daily living. The questionnaire underwent expert review to ensure content validity and was subsequently translated into Nepali to facilitate participant understanding. Prior to the main survey, the tool was piloted to evaluate its reliability**,** yielding a Cronbach's alpha greater than 0.80, indicating strong internal consistency.

Outcome Variables: The primary outcome variable was glycemic control (GC), assessed using FPG levels. According to the American Diabetes Association, good GC was defined as an FPG level of 80–130 mg/dL, and poor GC was defined as an FPG level greater than 130 mg/dL (American Diabetes Association, 2021).

Data Analysis: Data were analyzed using SPSS (IBM Version 25.0). Descriptive statistics were used to summarize sociodemographic characteristics. Chi-square tests and binary logistic regression were applied to assess factors influencing poor glycemic control. The multicollinearity of independent variables was checked using the variance inflation factor (VIF), with values between 0–5 indicating no multicollinearity. Statistical significance was set at $p<0.05$.

Ethical Considerations: The Ethical Review Board of the Nepal Health Research Council approved the study (reference number 2925). Written informed consent was obtained from all participants, who were informed about the study's objectives, data collection procedures, and confidentiality measures.

RESULTS

General Characteristics: Table1 revealed a middle-income group (68.3%), with a significant proportion (60%) having health insurance. The majority of participants are married (81.9%) and living in rural areas (68.3%). The educational level varies, with nearly half (46.7%) having only primary education. A high proportion (78.5%) has a family history of diabetes. Lifestyle habits such as exercise are common (72.6%), but a notable percentage remains overweight (38.4%) or obese (16.1%).

Table 2 presents the expenditure breakdown for patients with Type 2 Diabetes Mellitus (T2DM) according to the duration of illness, including overall costs as well as hospital, medication, and diagnosis costs. Among the participants, 31.3% had been living with T2DM for ≤3 years, 52.8% for 4–7 years, and 15.9% for ≥8 years. The mean overall expenditure increased with the duration of illness. Patients with ≤3 years of T2DM spent an average of 237.71 ± 91.00 units (95% CI: 223.53–251.89), while those with 4–7 years and ≥8 years of disease incurred higher costs of 251.25 ± 91.06 (95% CI:

240.13–262.38) and 270.03 ± 86.35 (95% CI: 250.57–289.50), respectively. Hospital costs followed a similar trend, rising from 86.93 ± 66.27 (95% CI: 76.39–97.48) for patients with ≤3 years of illness to 93.10 ± 47.27 (95% CI: 82.44–103.76) for those with ≥8 years of illness. Medication costs were consistently the largest component of expenditure across all groups, increasing from 110.00 ± 26.88 (95% CI: 105.72–114.28) in the ≤3 years group to 119.94 ± 24.91 (95% CI: 114.32–125.55) in the ≥8 years group. Diagnosis costs also showed a progressive increase with disease duration, from 48.08 ± 23.54 (95% CI: 44.33–51.83) in the shortest duration group to 57.47 ± 27.78 (95% CI: 51.20–63.73) in the longest duration group.

Table 1: Socio-economic demographic characteristics of the study participants

Variable	Category	N (%)	Variable	Category	N (%)
Gender	Male	256 (52)	Income	Poorest	44 (8.9)
	Female	236 (48)		Middle class	336(68.3)
Marital status	Married	403(81.9)		Richest	112(22.8)
	Others	89(18.1)	Occupation	Job	101(20.5)
Residence	Rural	336 (68.3)		Business	100(20.3)
	Urban	156(31.7)		Farming	82 (16.7)
Health Insurance	Yes	295(60)		Unemployed	209 (42.5)
	No	197(40)	Visit Physician	Yes	177(36)
Education	Primary	230 (46.7)		No	315(64)
	Secondary	171 (34.8)	Family History of Diabetes	Yes	386 (78.5)
	Higher	91(18.5)		No	106(21.5)
Illness of Diabetes	≤ 3year	145(31.3)	Avoidance of food	Yes	173(35.2)
	4-7 years	260(52.8)		No	319(64.8)
	8 years and more	78(15.9)	Dietician advice	Yes	363(73.8)
Lab diagnosis	Yes	429 (87.2)		No	129(26.2)
	No	63 (12.8)	Physician follow-up	Yes	177 (36)
BMI	Normal	224 (45.5)		No	315 (64)
	Overweight	189 (38.4)	Exercise	Yes	357 (72.6)
	Obesity	79 (16.1)		No	135 (27.4)

Table 2: Duration specific medical expenses among the studied participants

Duration	N (%)	Overall	Hospital	Medicine	Diagnosis
		Mean, ±SD(95% CI of mean (LL-UL))	Mean, ±SD (95% CI of mean (LL-UL))	Mean, ±SD (95% CI of mean (LL-UL))	Mean, ±SD (95% CI of mean (LL-UL))
≤3 years	154 (31.30)	237.71, ± 91 (223.53 – 251.89)	86.93, ± 66.27 (76.39 -97.48)	110.00, ± 26.88 (105.72 -114.28)	48.08, ± 23.54 (44.33 – 51.83)
4-7 years	260 (52.84)	251.25, ± 91.06 (240.13 -262.38)	88.41, ± 52.90 (81.95 – 94.87)	111.90, ± 25.13 (108.93– 114.97)	51.69, ± 27.50 (48.33 -55.05)
≥8 years	78 (15.85)	270.03, ± 86.35 (250.57 – 289.50)	93.10, ± 47.27 (82.44 – 103.76)	119.94, ± 24.91 (114.32 -125.55)	57.47, ± 27.78 (51.20 – 63.73)

Table 3: Expenditure for Type 2 Diabetes Mellitus (T2DM) Patients by Duration of Illness and gender: Overall, Hospital, Medication, and Diagnosis Costs

Duration	N (%)	Gender N (%)	Overall expenditure	Hospital expenditure	Medication expenditure	Diagnosis expenditure
			Mean, ±SD	Mean, ±SD	Mean, ±SD	Mean, ±SD
≤3 years	154 (31.30)	Male 58 (11.79)	236.71, ± 77.83	87.31, ± 59.29	110.85, ± 24.62	110.85, ± 2305
		Female 96 (19.51)	238.31, ± 95.63	86.70, ± 70.45	109.48, ± 28.27	109.48, ± 23.95
			p-value = 0.910	p-value = 0.955	p-value = 0.753	p-value = 0.753
4-7 years	260 (52.84)	Male 144 (29.27)	254.43, ± 93.06	90.62, ± 53.46	112.79, ± 26.52	52.36, ± 28.41,
		Female 116 (23.58)	247.32, ± 88.76	85.66, ± 52.30	110.79, ± 23.35	50.86, ± 26.43
			p-value = 0.530	p-value = 0.453	p-value = 0.518	p-value = 0.662
≥8 years	78 (15.85)	Male 54 (10.98)	252.79, ± 83.02	83.29, ± 43.27	116.42, ± 27.05	53.76, ± 27.41
		Female 24(4.88)	308.85, ± 82.50	115.19, ± 49.30	127.85, ± 17.20	65.80, ± 36
			p-value = 0.007	p-value = 0.005	p-value = 0.025	p-value = 0.077

Table 3 showed that females have significantly higher overall expenditure (p = 0.007), hospital costs (p = 0.005), and medication expenses (p = 0.025) than males in the 8+ years category, reflecting the need for more intensive care and therapy. There is no significant gender difference in diagnosis expenditure, although females tend to have slightly higher costs (p = 0.077). These findings emphasize higher long-term diabetes management costs for females.

This analysis reveals gender differences in overall expenditure across various variables. Females incur higher costs than males in urban areas (277.45 ± 88.71 vs. 261.96 ± 98.15, p = 0.011), family history of diabetes (244.79 ± 95.80 vs. 233.66 ± 75.53, p = 0.017), and lab diagnostic tests (147.23 ± 56.59 vs. 222.25 ± 58.79, p = 0.037).

Males with higher BMI (Obesity) tend to have greater expenditures (303.84 ± 37.13 vs. 235.38 ± 75.31, p = 0.407). Furthermore, age groups exhibit differences, with males aged 51-60 (274.77 ± 70.37 vs. 195.06 ± 45.45, p = 0.158) and those aged ≥ 60 (297.59 ± 57.30 vs. 172.55) incurring higher costs than females (Table 4(a)).

Table 4 (a): Comparison of Overall Expenditure by Gender and Illness Duration (≤ 3 Years) Across Different Variables/Characteristics in Type 2 Diabetes Mellitus (T2DM) Patients

Variable	Group	Male Mean, ± SD	Female Mean, ± SD
Residence	Rural	230.12, ±71.45	223.00, ± 94.46
	Urban	261.96, ± 98.15	277.45, ± 88.712
		*(-1.26), p-value = 0.210	* (-2,58), p-value = 0.011
Glycemic control	Control	226.47, ±83.93	209.29, ± 94.22
	Uncontrolled	249.31, ±83.93	254.23, ± 93.35
		*(-1.11), p-value = 0.270	* (-2.24), p-value = 0.07
Marital status	Married	234.18, ± 83.16	240.77, ± 83.16
	Others	243.36, ± 63.65	240.77, ± 97.36
		*(-0.398), p-value = 0.692	*(1.07), p-value = 0.285
Health insurance	Yes	247.04, ± 80.75	224.06, ± 83.76
	No	220.99, ± 72.05	248.94, ± 103.07
		*1.25, p-value =0.215	* (-1.26), p-value = 0.209
Family history of diabetes mellitus	Yes	233.66, ± 75.53	244.79, ± 95.80
	No	292.59, ± 116.95	155.94, ± 40.85
		* (-1.28), p-value = 0.204	* 2.09, p-value = 0.017
Lab diagnostic test	Yes	239.02, ±80.71	242.27, ±95.19
	No	222.25, ±58.79	147.23, ±56.59
		*0.562, p-value =0.576	*3.17, p-value = 0.037
Visit physician	Yes	243.34, ±70.11	232.30, ±98.85
	No	232.36, ±90.01	242.80, ±93.83
		*0.522, p-value =0.604	*(-0.530), p-value = 0.597
Dietician advice	Yes	236.71, ±77.83	238.99, ±104.16
	No	0.00, ± 0.00	237.23, ± 81.56
			*0.087, p-value = 0.931
Avoid food	Yes	258.20, ±83.63	236.18, ±113.64
	No	231.10, ±76.22	239.11, ±88.94
		*1.07, p-value = 0.287	*(-0.133), p-value = 0.895
Age	18 -34	241.32, ±73.56	253.31, ± 95.63
	35-50	221.21, ± 79.19	221.83, ±123.52
	51-60	274.77, ± 70.37	195.06, ±45.45
	≥ 60	297.59, ±57.30	172.55
		** 1.79, p-value = 0.158	** 1.77, p-value = 0. 158
Education	Primary	225.95, ±72.82	247.29. ±96.05
	Secondary	237.07, ±110.89	195.76, ± 90.05
	Higher	262.58, ±59.73	228.82, ±26.52
		** 1.102, p-value = 0.339	** 1.977, p-value = 0.144

BMI	Normal	228.69, ±77.72	233.63, ±96.48
	Overweight	239.94, ±79.29	249.31, ±112.27
	Obesity	303.84, ±37.13	235.38, ±75.311
		**0.914, p-value = 0.407	** 0.234, p-value = 0.792
Occupation	Job	224.51, ±77.98	279.73, ±149.65
	Business	253.47, ±101.64	246.21, ±79.82
	Farming	240.91, ±60.65	126.29, ±48.95
	Unemployed	234.82, ±64.87	236.31, ±92.97
		** 0.379, p-value = 0.768	** 1.924, p-value = 0.131

NB: * = t-value; ** = F-value

Table 4(b) analysis reveals gender differences in overall expenditure, particularly in education and family history of diabetes. Males with higher education incur significantly higher costs (293.27 ± 102.27 vs. 248.70 ± 96.82, p = 0.022), and those without a family history of diabetes spend more (277.80 ± 93.14 vs. 224.47 ± 83.26, p = 0.147). Females tend to have lower costs without lab diagnostic tests (147.23 ± 56.59 vs. 258.38 ± 112.62, p = 0.234). Males with dietician advice spend more (256.76 ± 93.00 vs. 245.04 ± 86.12, p = 0.560), while BMI shows no significant gender differences. These results highlight the complex relationship between gender, health factors, and expenditures in managing Type 2 Diabetes Mellitus.

Table 4(b): Comparison of Overall Expenditure by Gender and Illness Duration (3 -7 Years) Across Different Variables/Characteristics in Type 2 Diabetes Mellitus (T2DM) Patients

Variable	Group	Male Mean, ± SD	Female Mean, ± SD
Residence	Rural	250.36, ±97.89	258.19, ±86.38
	Urban	261.84, ±83.96	226.66, ±90.63
		* (0.739), p-value =0.461	* 1.83, p-value = 0.069
Glycemic control	Control	236.07, ±81.44	239.22, ± 88.14
	Uncontrol	284.13, ±103.30	288.64, ± 82.12
		* (-3.10), p-value = 0.002	* (-2.36), p-value = 0.25
Marital status	Married	253.49, ± 94.99	249.41, ±86.75
	Others	263.12, ± 75.05	235.91, ±100.92
		*(-0.367), p-value = 0.714	*0.592, p-value =0.555
Health insurance	Yes	247.58, ± 90.63	248.26, ±87.69
	No	271.64, ± 97.94	246.30, ±90.67
		*(-1.359), p-value = 0.179	*0.118, p-value = 0.906
Family history of diabetes mellitus	Yes	246.92, ± 92.21	253.59, ± 89.63
	No	277.80, ± 93.14	224.47, ± 83.26
		*(-1.71), p-value = 0.088	*1.46, p-value =0.147

Lab diagnostic test	Yes	253.60, ±88.95	242.27, ±95.19
	No	258.38, ±112.62	147.23, ±56.59
		*(-0.233), p-value = 0.816	*1.19, p-value = 0.234
Visit physician	Yes	258.20, ±89.16	252.47, ±93.72
	No	252.82, ±95.01	242.51, ±84.37
		*0.312, p-value = 0.756	*0.602, p-value = 0.548
Dietician advice	Yes	256.76, ±93.00	245.04, ±86.12
	No	245.57, ±94.36	252.37, ±95.42
		*0.584, p-value = 0.560	*(-0.410), p-value = 0.683
Avoid food	Yes	265.41, ±93.72	259.72, ± 90.85
	No	246.36, ±92.31	241.28, ± 87.68
		*1.21, p-value = 0.226	*1.051, p-value = 0.296
Age (in years)	18 -34	238.31, ± 95.63	265.08, ± 82.64
	35-50	275.71, ± 67.76	260.62, ± 85.05
	51-60	260.64, ± 111.11	231.96, ± 86.59
	≥ 60	271.49, ± 85.23	284.15, ± 99.48
		**1.39, p-value = 0.246	** 0.795, p-value = 0.499
Education	Primary	241.52, ± 81.42	253.58, ± 86.46
	Secondary	245.20, ± 97.65	243.27, ± 88.63
	Higher	293.27, ± 102.27	248.70, ± 96.82
		**3.901, p = 0.022	** 0.151, p-value = 0.860
BMI	Normal	264.30, ±93.42	242.53, ±93.14
	Overweight	243.82, ±91.34	257.73, ±85.11
	Obesity	266.96, ±102.24	244.14, ±85.25
		** 0.912, p-value = 0.404	** 0.330, p-value = 0.720
Occupation	Job	244.09, ±71.39	248.65, ±73.91
	Business	273.72, ±97.53	271.69, ±82.98
	Farming	245.54, ±110.81	200.69, ±60.00
	unemployed	265.08, ±79.09	246.34, ±93.36
		**0.881, p-value = 0.453	** 0.906, p = 0.441

NB: * = t-value; ** = F-value

Table 4 (c) analysis indicates significant gender-based differences in health factors and expenditure across various categories. Females generally incur higher costs in several areas, particularly dietician advice (p = 0.002), and age (p = 0.024 for the 51-60 age group). Males tend to have lower costs for physician visits (p= 0.044) and dietician advice (p = 0.002). Education also shows that females with higher education incur significantly higher costs (p = 0.001). These findings underscore the need for gender-sensitive approaches in managing the healthcare costs of Type 2 Diabetes Mellitus, particularly in older age groups and those with higher educational backgrounds.

Table 4 (c): Comparison of Overall Expenditure by Gender and Illness Duration (8 years and more) Across Different Variables/Characteristics in Type 2 Diabetes Mellitus (T2DM) Patients

Variable	Group	Male Mean, ± SD	Female Mean, ± SD
Residence	Rural	247.68, ±73.82	303.62, ± 86.07
	Urban	262.19, ±99.29	321.53, ± 77.89
		* (-0.558), p-value = 0.581	*(-0.496), p-value = 0.629
Glycemic control	Control	259.05, ± 74.02	270.08, ±86.19
	Uncontrolled	242.14, ± 97.58	321.77, ± 79.47
		*0.670, p-value = 0.508	*(-1.29), p-value = 0.190
Marital status	Married	228.98, ± 73.38	289.67, ± 66.66
	Others	271.83, ± 86.50	366.36, ± 104.43
		*(1.933), p-value = 0.059	*(-2.11), p-value = 0.46
Health insurance	Yes	256.79, ± 86.72	349.61, ± 85.40
	No	229.76, ± 55.99	279.73, ± 69.28
		*1.114, p-value = 0.271	*2.21, p = 0.038
Family history of diabetes mellitus	Yes	255.76, ± 80.93	301.22, ± 82.62
	No	250.74, ± 85.66	346.98, ± 81.35
		*0.216, p-value = 0.830	*(-1.013), p-value = 0.322
Lab diagnostic test	Yes	252.31, ± 77.50	302.70, ± 78.54
	No	254.45, ± 104.02	450.14
		*(-0.078), p-value =0.938	*(-1.83), p-value =0.080
Visit physician	Yes	188.81, ± 88.05	285.09, ± 78.86
	No	260.78, ± 79.75	323.10, ± 83.95
		*(-2.063), p-value = 0.044	*(-1.098), p-value=0.284
Dietician advice	Yes	232.09, ± 76.77	338.76, ± 85.64
	No	306.59, ± 76.18	273.49, ± 65.69
		*(-3.20), p-value = 0.002	*2.11, p-value = 0.047
Avoid food	Yes	234.89, ±94.15	341.61, ±71.56
	No	264.17, ± 74.38	254.24, ± 72.39
		*(-1.27), p-value = 0.210	*2.88, p-value = 0.009
Age	18 -34	210.06	214.56, ± 45.82
	35-50	240.54, ± 66.11	315.10, ± 35.18
	51-60	259.23, ± 90.37	342.61, ± 15.61
	≥ 60	252.79, ± 90.37	337.60, ± 88.42
		** 0.409, p-value = 0.667	** 3.918, p-value = 0.024
Education	Primary	235.38, ± 88.03	214.56, ± 45.82
	Secondary	262.35, ± 81.00	305.34, ± 62.27
	Higher	239.21, ± 88.16	365.11, ± 70.87
		** 0.559, p-value = 0.575	**9.18, p-value = 0.001

BMI	Normal	238.98, ±77.06	342.96, ±113.67
	Overweight	254.01, ±81.67	286.75, ±69.34
	Obesity	286.75, ±100.21	303.84, ±63.02
		** 1.091, p-value = 0.344	** 0.930, p-value = 0.410
Occupation	Job	267.20, ±61.45	214.56, ±45.82
	Business	219.01, ±78.91	330.10, ±39.22,
	Farming	276.58, ±93.82	337.6
	unemployed	244.69, ±89.06	334.39, ±81.95
		** 1.324, p-value = 0.277	** 3.735, p-value = 0.028

NB: * = t-value; ** = F-value

DISCUSSION

This study aimed to assess the economic burden of Type 2 Diabetes Mellitus (T2DM) in Madhesh Province, Nepal, with a focus on the impact of illness duration and gender differences. Our results indicate that the economic burden of T2DM increases with the length of the illness, with females experiencing higher costs than males over time.

Illness Duration and Economic Burden: As the duration of diabetes lengthens so do the overall hospital, medication, and diagnostic costs. The group with 8+ years showed the highest expenses across all categories, reflecting the increasing medical costs associated with long-term diabetes management. These findings align with previous studies that have documented a significant rise in healthcare costs as the duration of diabetes increases (Zhuo et al., 2014).

Gender Differences in Expenditure: Our analysis revealed that females generally incur higher total expenses than males, particularly in the 8+ year's group. This includes increased hospital and medication costs, which may relate to the need for more intensive care and therapy over time. These findings align with other studies highlighting gender disparities in diabetes-related healthcare costs (Tsai et al., 2019).

Factors Influencing Expenditure: Several factors were found to contribute to the economic burden associated with T2DM. For example, individuals with a family history of diabetes and those without laboratory diagnostic tests exhibited higher costs. Additionally, males with higher Body Mass Index (BMI) categories tended to incur greater expenses, emphasizing the role of obesity in diabetes-related costs. These findings highlight the complex interplay between demographic, lifestyle, and clinical factors in shaping healthcare expenditure (Yang et al., 2020).

CONCLUSION:

The rising economic burden of T2DM in Madhesh Province, Nepal, emphasizes the need for targeted interventions that address both the duration of the illness and gender-specific factors. Implementing cost-effective health behaviour interventions, such as those assessed in previous studies could help reduce the financial impact of diabetes and enhance patient outcomes. Further research is necessary to examine the long-term cost-effectiveness of such interventions within the Nepalese context.

Acknowledgment: We sincerely thank the Health Coordinator, Health Post In-Charge, Administrative Officer, and community political leaders for their invaluable support and cooperation in

facilitating data collection for this study. The authors are also deeply grateful to all study participants and staff for their meaningful contributions. ChatGPT (version 4.0) was used to enhance the readability and language of the manuscript.

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