• Investigation •

Factors associated with annual eye examinations among known diabetics in Malaysia: a cross-sectional study from the National Health and Morbidity Survey 2023

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Abstract

● **AIM:** To identify factors associated with adherence to annual eye examinations among adults with diabetes mellitus (DM) in Malaysia

● **METHODS:** Data from community-dwelling adults aged ≥18y with known DM, defined as those who had previously been informed by a doctor or assistant medical officer of their diagnosis were analyzed using the National Health and Morbidity Survey 2023, a population-based cross-sectional survey conducted using a two-stage stratified random sampling design. Locally validated questionnaire on diabetic eye screening was administered through face-to-face interviews from July until September 2023. Adults with known DM were asked three key questions about eye examinations: whether their eyes had been examined using clinical tools (illustrated with images of a direct ophthalmoscope, slit lamp or fundus camera), the timing of their last eye examination (if applicable), and whether they had been referred to an ophthalmology clinic for DM-related complications, serving as a proxy for diabetic retinopathy (DR) referrals. Complex sample analysis, incorporating sample weights and the study's design, were used to describe respondents' baseline characteristics by urban or rural localities. Multivariable binary logistic regression with adjusted odds ratio (aOR) and 95% confidence interval (CI) was performed.

● **RESULTS:** Among 1554 adults with known DM in Malaysia, 58.8% had never undergone an eye examination and only 29.5% complied with the recommended annual eye check-ups. Additionally, 25.8% of DM patients were referred to an ophthalmology clinic for DR. Referral to ophthalmology clinic for DR (aOR=4.63, 95%CI: 3.27, 6.55), insulin use (aOR=1.93, 95%CI: 1.37, 2.72), secondary education (aOR=1.71, 95%CI: 1.03, 2.85) and DM duration ≥10y (aOR=1.48, 95%CI: 1.02, 2.16) were associated with higher odds of annual eye examinations. Chinese (aOR=0.50, 95%CI: 0.29, 0.87) and Indian (aOR=0.47, 95%CI: 0.29, 0.78) ethnicities had lower odds of undergoing annual eye examinations compared to Malay ethnicity. Similarly, those with a monthly household income of ≥RM10 000 (aOR=0.45, 95%CI: 0.21, 0.95) were less likely to get their eyes examined yearly.

● **CONCLUSION:** Fewer than one-third of adults with DM in Malaysia adhere to the recommended annual eye examinations, with lower compliance observed among Chinese or Indian ethnicities and those with higher household incomes. Targeted educational campaigns for Chinese, Indian, and higher-income adults with DM may encourage regular eye exams and reduce preventable vision loss from DR in Malaysia.

● **KEYWORDS:** diabetic retinopathy; insulin; diabetic eye screening

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INTRODUCTION

Diabetic retinopathy (DR), a microangiopathic complication of diabetes mellitus (DM) continues to be a major cause of avoidable blindness worldwide among individuals with DM[1]. The global prevalence of DR is

estimated at 22.27% and is projected to remain high in the next 20y, with countries in the Western Pacific region being disproportionately affected[2]. Despite its clinical manifestation through a wide spectrum of retinal signs, including microaneurysms, dot-and-blot hemorrhages, cotton-wool spots or intraretinal microvascular abnormalities, most people living with DM remain asymptomatic during the early stages of mild non-proliferative DR[3]. This lack of sight-threatening symptoms and relatively preserved visual acuity often led to delays in diagnosis of DR. By the time ocular symptoms such as floaters or blurring of vision appear in advanced stage of proliferative DR, irreversible vision loss or compromised vision-related quality of life may have already occurred[4].

Early detection of DR is therefore critical to mitigate these adverse ophthalmic outcomes. Cost-effective strategies such as regular diabetic eye screenings among adults with DM can help to prevent severe vision impairment by facilitating timely ophthalmological interventions[5]. In Malaysia, national guidelines recommend that individuals with type 2 DM (T2DM) undergo an initial fundus examination at the time of diagnosis, followed by at least an annual eye screening if no retinal abnormalities are detected[6]. When an annual eye examination identifies fundoscopic changes indicative of DR, clinical management should prioritize optimizing glycemic control to prevent the paradoxical phenomenon of early worsening of DR in some patients with DM and delay the progression of the diabetic milieu toward advanced diabetic eye disease[7]. Depending on clinical severity or classification of DR, treatment options may include laser photocoagulation, intravitreal anti-vascular endothelial growth factor therapy for coexisting diabetic macula edema, or vitrectomy.

Despite these evidence-based recommendations and the availability of DR screening services at primary healthcare facilities, the uptake of annual eye examinations among adults with DM in Malaysia remains suboptimal[8]. The National Health and Morbidity Survey (NHMS) 2006 revealed that 55% of adults with DM in Malaysia had never undergone an eye examination, and only 32.8% had done so in the preceding year. These statistics highlight gaps in adherence to yearly eye screening protocols, a local problem that exists despite governmental efforts to integrate non-mydriatic digital fundus cameras with two-dimensional non-stereoscopic photography into primary healthcare settings. However, it is noteworthy that these estimates align with a Meta-analysis finding which reported DR global screening adherence rate of 39.3% in low- and middle-income countries[9].

Similar Meta-analysis encompassing global data from 28 countries across five continents identified several factors associated with adherence to DR screening[9]. These include older age, higher education levels, marital status, urban residence, higher household income, access to health insurance, longer duration of DM, T2DM, a family history of DM, vision impairment, a history of eye diseases, insulin use, and good mental health. Nevertheless, the association with the underlying low compliance with annual eye examinations in Malaysia remains poorly understood, posing a barrier to effective public health interventions. Identifying the associated factors is crucial for designing targeted local strategies to improve diabetic eye screening uptake and reduce the disease burden of DR-related blindness. Therefore, this study aims to investigate the factors associated with adherence to annual eye examinations among adults with DM in Malaysia.

PARTICIPANTS AND METHODS

Ethical Approval Ethical approval was received from the Medical Research and Ethics Committee of the Ministry of Health Malaysia. It was registered in the National Medical Research Registry with the identification number NMRR ID-22-00545-XAC.

Study Design and Data Source The current study specifically focused on adults with known non-gestational DM sampled from NHMS 2023. In Malaysia, NHMS 2023 was a cross-sectional, nationwide population-based survey employing a two-stage stratified random sampling design to ensure national representativeness[10]. The sampling frame was derived from the Population and Housing Census conducted by the Department of Statistics Malaysia in 2020. All non-institutionalized residents of Malaysia aged 18y and above who had lived in their households for at least two weeks were invited to participate in the door-to-door survey from July until September 2023. The primary sampling units were randomly-selected enumeration blocks provided by Department of Statistics Malaysia, while the secondary units consisted of the living quarters within these blocks.

Data Collection Instruments Ground data was collected using a locally validated questionnaire. Information gathered were sociodemographic characteristics (gender, age, ethnicity, marital status, education level, employment status, household income, urbanity, smoking status), DM status and other parameters of public health interest.

DM status was determined through either self-reported prior diagnosis by a healthcare professional or biochemical confirmation using capillary blood glucose measurements. Adults who were informed of a prior diagnosis of DM by a doctor or assistant medical officer, were classified as having "known DM". Capillary blood glucose levels were measured using the Accu-Chek Guide during the face-to-face interview. "Undiagnosed DM" was defined as a respondent who was not "known DM" but had a fasting blood glucose level of ≥7.0 mmol/L or a random blood glucose level of ≥11.1 mmol/L during the field survey.

Figure 1 Fundus examination approaches using direct ophthalmoscope, slit lamp or non-mydriatic fundus camera.

Measurement of the Dependent Variable All adults with known DM were asked three questions regarding eye examinations, whereas individuals with undiagnosed DM were not required to answer these questions. The first question was "Have your eyes been checked by a doctor using one of the equipment shown in these pictures". Accompanying pictures depicted commonly used clinical tools for fundus examinations, such as a direct ophthalmoscope, slit lamp, and non-mydriatic fundus camera (Figure 1). Second, participants who answered "yes" were then asked the subsequent question about the timing of their most recent eye examination. Lastly, they were asked "Have you been referred to an eye specialist clinic for diabetes-related eye complications"—a proxy question to assess referral for DR.

Statistical Analysis Data analysis was performed using Statistical Package for the Social Sciences software (version 22.0). A complete case analysis was employed. Complex sample statistics were applied to describe the respondents' baseline characteristics based on their locality (urban or rural). All analyses accounted for sample weights and the study's complex sampling design. Crude odds ratios (OR) and adjusted odds ratios (aOR) with 95% confidence intervals (CI) were calculated. Variables with a *P*-value <0.25 in the univariable analysis were included in the multivariable analysis. A *P*-value <0.05 was considered statistically significant in the final multivariable binomial logistic regression model.

RESULTS

Among the 10 858 community-dwelling adults recruited in NHMS 2023, 1554 individuals were known to have DM, with a weighted prevalence of 9.7% (95%CI: 9.0%, 10.5%). These individuals were predominantly female (57.5%) and aged 60y or older (61.3%; Table 1).

The majority were of Malay ethnicity (62.3%). Most adults with DM were married or living with a partner (72.7%) and reported secondary education as their highest level of formal education (55.6%). Nearly one-quarter (24.0%) had a monthly household income of RM2000–RM3999.

High rates of medical comorbidities were observed, with 81.6% having hypertension and 76.8% having hypercholesterolemia. Notably, 93.6% of known DM individuals had recently undergone screening for hypertension or cholesterol for the past year. Approximately 97.4% had measured their blood sugar within the past 12mo. Among the 1385 individuals assessed for capillary blood glucose levels, 86.9% demonstrated values within the normal range whereas 13.1% exhibited hyperglycemic levels (fasting ≥7.0 mmol/L or random ≥11.1 mmol/L).

Most adults with DM received dietary, weight loss, and exercise advice, with rates exceeding 78.9% in each category. Oral hypoglycemic drugs were the most used treatment, reported by approximately 91.6% of DM adults, while only 23.1% used insulin in the past two weeks. Traditional and complementary medicine use was less common, with only 14.5% seeking such treatments. Regarding the duration of DM, nearly equal proportions of participants in NHMS 2023 had DM for less than 5y (37.3%) and 10y or more (37.6%).

About 25.8% were referred to an ophthalmology clinic for DR. Approximately 58.8% did not undergo an eye examination and only 29.5% adhered to the recommended annual eye examinations. Referral to ophthalmology clinic for DR was associated with more than 4 times the odds of annual eye examinations (aOR=4.63, 95%CI: 3.27, 6.55) whereas adults with DM who are on insulin therapy had nearly twice the odds of undergoing annual eye examinations (aOR=1.93, 95%CI: 1.37, 2.72; Table 2).

Those with secondary education were more likely to undergo annual eye examinations (aOR=1.71, 95%CI: 1.03, 2.85) compared to those with no formal education. Additionally, individuals with a DM duration of 10y or more had higher odds of undergoing annual eye examinations (aOR=1.48, 95%CI: 1.02, 2.16) than those who had DM for less than 5y. In contrast, compared to adults of Malay ethnicity with DM, Chinese (aOR=0.50, 95%CI: 0.29, 0.87) and Indian (aOR=0.47, 95%CI: 0.29, 0.78) ethnicities had lower odds of

Table 1 Baseline characteristics of community-dwelling adults with known diabetes mellitus in National Health and Morbidity Survey 2023

n=1554

Parameters	Frequency	Unweighted percentage (%)	Estimated population	Weighted percentage (%)
Gender (*n*=1554)				
Male	660	42.5	1039773	47.0
Female	894	57.5	1170683	53.0
Age group (*n*=1554)				
18–39y	65	4.2	169581	7.7
40–59y	536	34.5	988697	44.7
≥60y	953	61.3	1052179	47.6
Ethnicity (*n*=1554)				
Malay	968	62.3	1288704	58.3
Chinese	225	14.5	410934	18.6
Indian	187	12.0	275973	12.5
Bumiputra and others	174	11.2	234845	10.6
Marital status (*n*=1551)				
Never married	52	3.4	107309	4.9
Married/living with partner	1127	72.7	1632388	74.1
Separated/divorced/widowed	372	24.0	463379	21.0
Education level (*n*=1551)				
No formal education	269	17.3	335791	15.2
Primary education	331	21.3	405422	18.4
Secondary education	863	55.6	1288168	58.3
Tertiary education	88	5.7	178688	8.1
Employment status (*n*=1542)				
Government employee	76	4.9	108195	4.9
Private employee	196	12.7	386570	17.6
Self employed	188	12.2	294106	13.4
Unpaid worker/homemaker/caregiver	331	21.5	437288	19.9
Retiree	259	16.8	365085	16.7
Not working	492	31.9	601131	27.4
Household income (*n*=1549)				
<RM1000	369	23.8	480034	21.9
RM1000–1999	275	17.8	325697	14.9
RM2000–3999	371	24.0	519561	23.7
RM4000–5999	204	13.2	334666	15.3
RM6000–7999	116	7.5	182740	8.3
RM8000–9999	81	5.2	134290	6.1
≥RM10000	133	8.6	215415	9.8
Urbanity (*n*=1554)				
Urban	1190	76.6	1763723	79.8
Rural	364	23.4	446734	20.2
Hypertension (*n*=1554)				
No	286	18.4	466958	21.1
Yes	1268	81.6	1743498	78.9
Hypercholesterolemia (*n*=1554)				
No	360	23.2	555829	25.1
Yes	1194	76.8	1654628	74.9
Current tobacco users (*n*=1551)				
No	1362	87.8	1880952	85.2
Yes	189	12.2	326743	14.8
Current e-cigarette/vape users (*n*=1548)				
No	1529	98.8	2162034	98.0
Yes	19	1.2	43122	2.0
Screened for high blood pressure, cholesterol or diabetes for the past year (*n*=1553)				
No	100	6.4	155270	7.0
Yes	1453	93.6	2053874	93.0
Difficulty of seeing (*n*=1550)				
No	1172	75.6	1702131	77.1

Table 1 Baseline characteristics of community-dwelling adults with known diabetes mellitus in National Health and Morbidity Survey 2023 (continued) *n*=1554

Parameters	Frequency	Unweighted percentage (%)	Estimated population	Weighted percentage (%)
Yes	378	24.4	504526	22.9
Skin, eyes or nose allergies (*n*=1550)				
No	1354	87.4	1957838	88.7
Yes	196	12.6	248819	11.3
Measured blood sugar in the past 12mo (*n*=1553)				
No	40	2.6	70029	3.2
Yes	1513	97.4	2139295	96.8
Duration of diabetes (*n*=1538)				
<5y	574	37.3	897029	41.1
5–10y	385	25.0	548539	25.1
≥10y	579	37.6	738480	33.8
Used insulin in the past 2wk (*n*=1552)				
No	1194	76.9	1726632	78.2
Yes	358	23.1	480340	21.8
Used oral hypoglycaemic drug in the past 2wk (*n*=1554)				
No	131	8.4	245788	11.1
Yes	1423	91.6	1964669	88.9
Given dietary advice (*n*=1554)				
No	145	9.3	194833	8.8
Yes	1409	90.7	2015623	91.2
Given weight loss advice (*n*=1554)				
No	328	21.1	485004	21.9
Yes	1226	78.9	1725452	78.1
Given exercise advice (*n*=1552)				
No	250	16.1	373808	16.9
Yes	1302	83.9	1832476	83.1
Seek traditional and complementary medication (*n*=1552)				
No	1327	85.5	1875867	84.9
Yes	225	14.5	333852	15.1
Health facility to seek medical treatment (*n*=1551)				
Government public healthcare clinic	1227	79.1	1710948	77.5
Private clinic	105	6.8	183727	8.3
Government hospital	159	10.3	206414	9.3
Private hospital	34	2.2	58264	2.6
Pharmacy	11	0.7	29176	1.3
Traditional and complementary	3	0.2	3273	0.1
No treatment	12	0.8	17097	0.8
Capillary blood glucose (*n*=1385)				
Non fasting <11.1 mmol/L or fasting <7.0 mmol/L	1204	86.9	1719107	87.8
Non fasting ≥11.1 mmol/L or fasting ≥7.0 mmol/L	181	13.1	238722	12.2
Eyes checked by a doctor (*n*=1554)				
No	913	58.8	1433630	64.9
Yes	641	41.2	776826	35.1
Referral to ophthalmology clinic for diabetic retinopathy (*n*=1548)				
No	1149	74.2	1718317	78.1
Yes	399	25.8	482868	21.9
Duration of eye examination (*n*=641)				
Within 1y	458	71.5	566639	72.9
1–2y	83	12.9	95590	12.3
2–3y	32	5.0	37213	4.8
3–4y	10	1.6	8929	1.1
4–5y	22	3.4	26202	3.4
5–10y	27	4.2	28884	3.7
≥10y	9	1.4	13370	1.7
Annual eye examinations (*n*=1554)				
No	1096	70.5	1643818	74.4
Yes	458	29.5	566639	25.6

Table 2 Factors associated with annual eye examination among community-dwelling adults with known diabetes mellitus in National Health and Morbidity Survey 2023 *n*=1554

Parameters	Annual eye examination		Crude odds ratio (95%CI)	*P*	Adjusted odds ratio (95%CI)	*P*
	No (weighted row %)	Yes (weighted row %)				
Gender (*n*=1554)						
Male	490 (78.0)	170 (22.0)	Reference			
Female	606 (71.1)	288 (28.9)	1.44 (1.08, 1.92)	[a]0.01	1.16 (0.79, 1.72)	0.45
Age group (*n*=1554)						
18–39y	49 (82.1)	16 (17.9)	Reference			
40–59y	369 (74.4)	167 (25.6)	1.58 (0.77, 3.24)	[a]0.22	1.10 (0.49, 2.47)	0.81
≥60y	678 (73.1)	275 (26.9)	1.68 (0.80, 3.56)	[a]0.17	0.87 (0.37, 2.03)	0.74
Ethnicity (*n*=1554)						
Malay	656 (70.3)	312 (29.7)	Reference			
Chinese	184 (84.7)	41 (15.3)	0.43 (0.26, 0.70)	[a]<0.01	0.50 (0.29, 0.87)	[b]0.02
Indian	141 (81.4)	46 (18.6)	0.54 (0.34, 0.87)	[a]0.01	0.47 (0.29, 0.78)	[b]<0.01
Bumiputra and others	115 (70.6)	59 (29.4)	0.99 (0.63, 1.55)	0.95	0.94 (0.54, 1.63)	0.82
Marital status (*n*=1551)						
Never married	40 (85.3)	12 (14.7)	Reference			
Married/living with partner	784 (74.0)	343 (26.0)	2.04 (0.71, 5.84)	[a]0.18	1.01 (0.40, 2.52)	0.99
Separated/divorced/widowed	269 (72.8)	103 (27.2)	2.17 (0.74, 6.40)	[a]0.16	1.06 (0.42, 2.68)	0.91
Education level (*n*=1551)						
No formal education	197 (79.2)	72 (20.8)	Reference			
Primary education	239 (72.9)	92 (27.1)	1.42 (0.87, 2.31)	[a]0.16	1.55 (0.90, 2.67)	0.11
Secondary education	592 (72.5)	271 (27.5)	1.45 (0.99, 2.12)	[a]0.06	1.71 (1.03, 2.85)	[b]0.04
Tertiary education	66 (82.0)	22 (18.0)	0.84 (0.39, 1.78)	0.64	1.62 (0.70, 3.74)	0.26
Employment status (*n*=1542)						
Government employee	57 (79.2)	19 (20.8)	Reference			
Private employee	147 (82.2)	49 (17.8)	0.83 (0.37, 1.87)	0.64	1.02 (0.47, 2.24)	0.96
Self employed	135 (78.0)	53 (22.0)	1.07 (0.50, 2.31)	0.86	0.89 (0.39, 2.03)	0.79
Unpaid worker/homemaker/caregiver	217 (68.3)	114 (31.7)	1.77 (0.82, 3.80)	[a]0.14	1.25 (0.57, 2.74)	0.58
Retiree	177 (70.6)	82 (29.4)	1.59 (0.75, 3.35)	[a]0.23	1.17 (0.53, 2.57)	0.70
Not working	353 (73.6)	139 (26.4)	1.37 (0.68, 2.76)	0.38	1.13 (0.51, 2.49)	0.77
Household income (*n*=1549)						
<RM1000	271 (73.4)	98 (26.6)	Reference			
RM1000–1999	176 (69.8)	99 (30.2)	1.20 (0.75, 1.92)	0.46	1.20 (0.71, 2.04)	0.50
RM2000–3999	250 (70.2)	121 (29.8)	1.18 (0.80, 1.740	0.41	1.17 (0.75, 1.81)	0.49
RM4000–5999	151 (76.0)	53 (24.0)	0.87 (0.53, 1.44)	0.60	0.85 (0.49, 1.47)	0.56
RM6000–7999	84 (73.7)	32 (26.3)	0.99 (0.55, 1.79)	0.97	1.52 (0.75, 3.06)	0.25
RM8000–9999	54 (76.4)	27 (23.6)	0.85 (0.40, 1.81)	0.68	1.13 (0.56, 2.30)	0.84
≥RM10000	105 (88.0)	28 (12.0)	0.38 (0.21, 0.70)	[a]<0.01	0.45 (0.21, 0.95)	[b]<0.01
Urbanity (*n*=1554)						
Urban	837 (74.4)	353 (25.6)	Reference			
Rural	259 (74.1)	105 (25.9)	1.02 (0.67, 1.56)	0.94	-	-
Hypertension (*n*=1554)						
No	226 (82.0)	60 (18.0)	Reference			
Yes	870 (72.3)	398 (27.7)	1.75 (1.16, 2.63)	[a]<0.01	1.35 (0.85, 2.14)	0.20
Hypercholesterolemia (*n*=1554)						
No	265 (75.8)	95 (24.2)	Reference			
Yes	831 (73.9)	363 (26.1)	1.11 (0.76, 1.61)	0.59	-	-
Current tobacco users (*n*=1551)						
No	948 (73.4)	414 (26.6)	Reference			
Yes	146 (79.9)	43 (20.1)	0.69 (0.45, 1.08)	[a]0.11	0.81 (0.47, 1.40)	0.45
Current e-cigarette/vape users (*n*=1548)						
No	1075 (74.0)	454 (26.0)	Reference			
Yes	17 (92.1)	2 (7.9)	0.24 (0.05, 1.29)	[a]0.10	0.67 (0.18, 2.46)	0.54
Screened for high blood pressure, cholesterol or diabetes for the past year (*n*=1553)						
No	76 (81.3)	24 (18.7)	Reference			
Yes	1019 (73.8)	434 (26.2)	1.54 (0.71, 3.34)	0.27	-	-

Table 2 Factors associated with annual eye examination among community-dwelling adults with known diabetes mellitus in National Health and Morbidity Survey 2023 (continued) *n*=1554

Parameters	Annual eye examination		Crude odds ratio (95%CI)	*P*	Adjusted odds ratio (95%CI)	*P*
	No (weighted row %)	Yes (weighted row %)				
Difficulty of seeing (*n*=1550)						
No	854 (76.8)	318 (23.2)	Reference			
Yes	239 (66.0)	139 (34.0)	1.71 (1.24, 2.35)	[a]<0.01	1.05 (0.72, 1.53)	0.78
Skin, eyes or nose allergies (*n*=1550)						
No	959 (74.7)	395 (25.3)	Reference			
Yes	134 (71.8)	62 (28.2)	1.16 (0.76, 1.78)	0.49	-	-
Measured blood sugar in the past 12mo (*n*=1553)						
No	35 (94.9)	5 (5.1)	Reference			
Yes	1061 (73.7)	452 (26.3)	6.63 (2.09, 21.10)	[a]<0.01	3.14 (0.84, 11.71)	0.09
Duration of diabetes (*n*=1538)						
<5y	430 (79.8)	144 (20.2)	Reference			
5–10y	278 (77.0)	107 (23.0)	1.18 (0.79, 1.77)	0.42	0.86 (0.54, 1.37)	0.52
≥10y	372 (64.9)	207 (35.1)	2.14 (1.52, 3.02)	[a]<0.01	1.48 (1.02, 2.16)	[b]0.04
Used insulin in the past 2wk (*n*=1552)						
No	902 (79.1)	292 (20.9)	Reference			
Yes	192 (57.2)	166 (42.8)	2.82 (2.04, 3.90)	[a]<0.01	1.93 (1.37, 2.72)	[b]<0.01
Consumed oral hypoglycemia agents in the past 2wk (*n*=1554)						
No	115 (89.3)	16 (10.7)	Reference			
Yes	981 (72.5)	442 (27.5)	3.16 (1.67, 5.98)	[a]<0.01	1.85 (0.83, 4.11)	0.13
Given dietary advice (*n*=1554)						
No	116 (82.5)	29 (17.5)	Reference			
Yes	980 (73.6)	429 (26.4)	1.69 (0.99, 2.88)	[a]0.05	1.13 (0.53, 2.41)	0.76
Given weight loss advice (*n*=1554)						
No	240 (76.2)	88 (23.8)	Reference			
Yes	856 (73.8)	370 (26.2)	1.13 (0.80, 1.60)	0.48	-	-
Given exercise advice (*n*=1554)						
No	190 (80.2)	60 (19.8)	Reference			
Yes	905 (73.2)	397 (26.8)	1.49 (1.02, 2.17)	[a]0.04	1.13 (0.67, 1.90)	0.66
Seek traditional and complementary medication (*n*=1552)						
No	934 (74.1)	393 (25.9)	Reference			
Yes	160 (75.6)	65 (24.4)	0.93 (0.60, 1.44)	0.74	-	-
Health facility to seek medical treatment (*n*=1551)						
Government public healthcare clinic	851 (73.3)	376 (26.7)	Reference			
Private clinic	88 (87.8)	17 (12.2)	0.38 (0.20, 0.72)	[a]<0.01	0.67 (0.33, 1.34)	0.26
Government hospital	102 (64.0)	57 (36.0)	1.55 (0.89, 2.69)	[a]0.12	1.50 (0.81, 2.79)	0.20
Private hospital	28 (85.9)	6 (14.1)	0.45 (0.18, 1.16)	[a]0.10	0.70 (0.28, 1.73)	0.43
Pharmacy	10 (92.1)	1 (7.9)	0.24 (0.03, 2.19)	[a]0.20	0.77 (0.08, 7.34)	0.82
Traditional and complementary	3 (100)	0	-	-	-	-
No treatment	11 (83.5)	1 (16.5)	0.54 (0.07, 4.38)	0.57	2.42 (0.27, 21.64)	0.43
Capillary blood glucose (*n*=1385)						
Non fasting <11.1 mmol/L or fasting <7.0 mmol/L	849 (74.5)	355 (25.5)	Reference			
Non fasting ≥11.1 mmol/L or fasting ≥7.0 mmol/L	127 (70.0)	54 (30.0)	1.25 (0.82, 1.91)	0.30	-	-
Eyes checked by a doctor (*n*=1554)						
No	913 (100)	0	Reference			
Yes	183 (27.1)	458 (72.9)	-	-	-	-
Referral to ophthalmology clinic for diabetic retinopathy (*n*=1548)						
No	910 (82.5)	239 (17.5)	Reference			
Yes	180 (45.0)	219 (55.0)	5.74 (4.20, 7.84)	[a]<0.01	4.63 (3.27, 6.55)	[b]<0.01

[a]*P*<0.25 at univariable level; [b]*P*<0.05 at multivariable level. CI: Confidence interval. Final multivariable logistic regression model was adjusted for gender, age group, ethnicity, marital status, education level, employment status, household income, hypertension, current tobacco users, current e-cigarette/vape users, difficulty of seeing, measured blood sugar in the past 12mo, duration of diabetes, used insulin in the past 2wk, consumed oral hypoglycemia agents in the past 2wk, given dietary advice, given exercise advice, health facility to seek medical treatments, and referral to ophthalmology clinic for diabetic retinopathy.

undergoing annual eye examinations. Similarly, adults with DM whose monthly household income exceeded RM10 000 had 55.0% less odds of undergoing annual eye examinations.

DISCUSSION

This study revealed that among adults in Malaysia with known DM, only 29.5% adhered to the recommended annual eye examinations, despite the high prevalence of medical comorbidities and widespread engagement in general health screenings. Adherence to annual eye examinations was positively associated with referral to an ophthalmology clinic, insulin use, secondary education, and having DM for a longer duration. Lower odds of annual eye examinations were observed among Chinese and Indian ethnicities or those with higher household incomes.

The observed percentage of DR (25.8%) in this study was notably lower than the 36.8% reported in the 2007 Diabetic Eye Registry[11]. However, caution is warranted when interpreting these findings, as this study relied on referrals to ophthalmology clinics as a proxy for calculating DR percentage. This approach may overestimate DR proportion because DM patients can be referred to ophthalmologists for other retinal abnormalities that mimic DR[12]. Differential diagnoses such as branch retinal vein occlusion, central retinal vein occlusion or retinal arterial macroaneurysms may account for some of these referrals. Furthermore, the high prevalence of cataracts among older adults in Malaysia frequently obscures fundus visualization, necessitating referrals for comprehensive ophthalmological evaluation at tertiary hospitals, particularly when DR is suspected in patients with long-standing DM[13]. Future studies should incorporate objective clinical data, such as retinal imaging through optical coherence tomography angiography or standardized DR staging, to differentiate DR from other retinal conditions and to complement referral-based metrics.

State-level data from more recent local studies highlighted significant variations in DR prevalence among patients with T2DM, with rates of 13.5% in Sabah and 9.0% in Selangor[8,14]. These discrepancies may stem from methodological differences or recent advancements in the pharmacotherapy of DM potentially delaying or mitigating the onset of DR[15]. Interestingly, among individuals with DM who had previously undergone eye examinations, adherence to annual eye check-ups showed a marked improvement compared to the findings of NHMS 2006, which reported a compliance rate of only 32.8%[16]. In this current study, 71.5% of individuals with DM who had previously undergone eye examinations adhered to this guideline, reflecting significant progress over time. This positive trend suggests enhanced awareness and accessibility to eye screening services over the years[17].

The strongest observed association with annual eye examinations was referral to an ophthalmology clinic for DR, as individuals with DM who received the referral were over four times more likely to adhere to the recommended screenings. Referrals from primary care practitioners often act as a motivator, emphasizing the importance of regular eye assessments to prevent vision loss[18]. Once a patient with DM is being referred and placed under regular follow-up at an ophthalmology clinic, comprehensive eye examinations, including slit-lamp for anterior segment and full dilated diabetic eye assessments for posterior segment, become an integral part of every visit. Given that these follow-ups typically occur at intervals of less than a year, adherence to the recommended annual eye examination schedule is inherently facilitated. Moreover, individuals who are referred may already show early signs of ocular complications, leading to increased engagement with healthcare services. This highlights the essential role of an effective referral system in connecting patients, primary care practitioners, and ophthalmologists.

The management of DM within the framework of Chronic Care Model involves continuous collaboration between patients and multidisciplinary healthcare teams, promoting coordinated care across medical specialties over many years[19]. This may explain the higher likelihood of annual eye examinations among individuals with a DM duration exceeding 10y, as it likely reflects increased disease awareness and proactive healthcare practices by primary care practitioners. Additionally, insulin use is often a marker of more severe DM, as it has been independently associated with poorer glycosylated hemoglobin A1c (HbA1c) control[20]. This severity may lead primary healthcare providers to place greater emphasis on regular screenings to prevent microvascular complications. The failure to conduct eye screenings for early diagnosis of DR, coupled with suboptimal adherence to guidelines, reflects clinical inertia that must be addressed and prevented in the management of DM patients in Malaysia[21].

The association between secondary education and adherence to annual eye examinations highlights the positive role of education in fostering health awareness. Individuals with formal education are likely better informed about the adverse risks of DR and the benefits of early detection, which can drive higher eye screening uptake. A systematic review reported that lower education level was associated with a lack of awareness and knowledge on DR, hence a main barrier to DR screening services[22]. Thus, clinicians and diabetes program managers must improve health literacy levels, especially on diabetes-related complications to increase annual eye examinations for the prevention of DR.

Adults from Chinese and Indian ethnicities with DM were found to have significantly lower odds of undergoing annual

eye examinations compared to adults from Malay ethnicity. Although studies directly linking ethnicity to compliance to eye screening is scarce, this finding aligns with NHMS 2019 study, which reported that those of non-Malay ethnicity were less likely than those of Malay ethnicity to seek dental treatment from healthcare providers[23]. However, this contradicted another local study that found older adults of Chinese and Indian ethnicities were more likely to undergo medical check-ups than those of Malay ethnicity[24]. These inconsistent local findings highlight the lack of consensus on ethnic differences in health-seeking behaviors, which may vary depending on the type of healthcare service or age. Cultural factors or health literacy levels could also play a role, contributing to the underutilization of preventive care services among certain ethnic groups in Malaysia[25].

Interestingly, adults with DM having a household income exceeding RM10 000 were less likely to undergo annual eye examinations. This counterintuitive finding may reflect their busy lifestyles or reliance on private healthcare (instead of accessing public healthcare services[26], where many DR screening programs are implemented). Our unpublished data showed lower proportions of adults with DM seeking care at private clinics (4.0%) and hospitals (1.5%) had annual eye examinations, which could be partly due to the logistic challenge from eye referral or additional costs to be borne by patients. Indeed, the utilization of private clinics was notably higher among households with an income of ≥RM10 000 (24.4%) compared to lower-income groups. Private hospitals showed a marked increase in use among the same high-income group (34.8%), highlighting disparities in healthcare-seeking behavior across household income levels. In contrast, individuals from the lowest income category relied on public healthcare facilities, where DR screening was routinely performed in accordance with clinical practice guideline recommendations.

One of the main strengths of this study is its large, nationally representative sample. The use of a complex sample analysis method further enhanced the robustness of the findings, ensuring generalizability and accurate representation of the population in Malaysia. To the best of our knowledge, the NHMS 2023 data represents the most up-to-date evidence on ocular health among adults with DM in Malaysia, comprehensively addressing multiple social determinants of health.

However, several limitations warrant consideration. The cross-sectional design of the NHMS 2023 precludes the establishment of causal relationships, limiting the ability to firmly conclude about the factors causing a lack of screening adherence. This nationwide study also could not differentiate between type 1 and T2DM but the majority of cases were assumed to be T2DM based on the epidemiological profile of DM in this population. This study was also limited by the use of fixed variables, which were originally designed for a nationwide study on the prevalence of DM-related parameters. The primary outcome question, “Have your eyes been checked by a doctor using one of the equipment shown in these pictures” did not account for standard vision screenings performed by optometrists who in resource-limited settings, are often privileged to assist doctors in screening for fundus abnormalities *via* visual acuity examinations or portable fundus photography. Consequently, the actual number of patients with DM who were compliant with diabetic eye exams may have been underestimated. Furthermore, reliance on self-reported questionnaires introduces the potential for recall bias. Notably, the absence of diagnostic imaging studies such as fluorescein angiography or key biochemical indicators namely glycosylated HbA1c levels, restricts further analysis of clinical variables.

In conclusion, fewer than one-third of adults with DM in Malaysia undergo the recommended annual eye examinations, with lower adherence observed among Chinese and Indian ethnic groups and individuals from higher-income households. Private medical practitioners, including general practitioners in clinics and hospitals, should actively adhere to clinical practice guidelines by emphasizing the importance of annual eye examinations for individuals with DM. Educational campaigns targeting Chinese and Indian adults with DM, as well as those from higher-income households, can further promote regular eye examinations and help to reduce the burden of preventable vision loss due to DR in Malaysia.

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