National Diabetes Registry Report

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Foreword

As Malaysia continues its developmental progress as a nation both socially and economically, disease patterns and burdens are changing to reflect changes in lifestyle and dietary patterns of its population. It is well-recognized that diabetes in Malaysia has become increasingly problematic along with issues of other cardiovascular conditions such as hypertension, heart disease and stroke. Based on the latest results of the National Health and Morbidity Survey (NHMS) 2011 and projections by the Disease Control Division, Ministry of Health (MOH), the prevalence of diabetes among adults in Malaysia is projected to rise to 21.6% by the year 2020. The Ministry of Health views these changes with concern and awareness of the need to take action to both control complication rates of existing diabetics while preventing the disease among those who are currently healthy.

The National Diabetes Registry (NDR) is one of the initiatives being taken by the MOH to further strengthen Non-Communicable Disease surveillance in Malaysia, specifically for monitoring quality of care among patients living with diabetes managed in MOH healthcare facilities. While the MOH has been able to provide chronic disease management services at minimal or no cost, changes in our socio-economic circumstances have stretched our services at MOH healthcare facilities.

Research and data are critical elements that facilitate better understanding for the improvements needed. I commend the National Diabetes Registry team and all of the staff at our healthcare clinics and hospitals for having initiated and contributed to this innovative registry that leverages upon existing care and data collection processes within the MOH. It has been four good years of investment and I am happy to see this first report being published as recognition of the work as well as an opportunity to share information with all others who are interested in the care of our patients with diabetes.

Finally, it is hoped that with the existence of this useful dataset, we can better understand how to improve treatment and management of our patients to reduce complication rates, increase life span and quality of life of patients within our care.

Datuk Dr Noor Hisham Abdullah
Director-General of Health, Malaysia

Executive Summary

The National Diabetes Registry (NDR) was established to keep track of the target achievement and clinical outcomes of patients with diabetes managed at primary healthcare clinics (Klinik Kesihatan or KK) under the Ministry of Health (MOH). The NDR started in 2009, initially with manually collected data and subsequently migrated to a web-based data collection system in 2011. All patients receiving diabetes care at 644 participating KKs are required to be registered into the NDR and the status of patients is regularly updated. The combined information from patient registration and status determines the pool of 'active' patients with diabetes currently receiving care at KKs. A proportion of these active patients are audited annually to obtain clinical and treatment information including data on clinical investigation results, drug use, complications and co-morbidities. The data of audited patients are required to be completed and uploaded into the NDR database before 31st August of every year.

From 2009 to 2012 there were 657,839 patients registered in the NDR, of which 653,326 were diagnosed with T2DM. The number of registered T2DM patients ranged from 106,101 in Selangor to 524 in WP Labuan. The mean age of T2DM patients in the NDR was 59.7 years old, 41.6% were men and 58.4% were women. The mean age at diagnosis for T2DM patients was 53 years old, with a mean duration of follow-up of 6.5 years. In terms of ethnicity, 58.9% were Malay, 21.4% were Chinese and 15.3% were Indian.

The mean HbA_{1c} was 8.1% for T2DM patients audited in 2012, of which 23.8% of patients achieved the Malaysian glycaemic treatment target of HbA_{1c} <6.5%. The target achievement rate varied from 54.0% in WP Labuan and 39.1% in Sarawak to 17.6% and 14.9% in Terengganu and Kelantan, respectively. In addition, the mean systolic and diastolic BP was 135.5 and 78.4 mmHg respectively, of which 40.9% achieved BP control of ≤130/80 mmHg. Furthermore, mean total cholesterol was 5.2 mmol/l and 28.5% achieved total cholesterol of <4.5 mmol/L. The mean BMI was 27.4 kg/m^2 and only 16.6% achieved BMI<23 kg/m^2. Among T2DM patients audited in 2012, 70.1% had hypertension and 55.1% had dyslipidaemia.

Metformin was the most common OAD used in 2012 with 82.5% of T2DM patients treated with the drug, followed by 56.9% treated with sulphonylureas. Among these patients, 45.7% received ≥2 OADs while 27.0% were on OAD monotherapy. Insulin use has increased consistently since the NDR began in 2009, with 21.4% of patients treated with insulin in 2012 compared to 11.7% in 2009. Insulin use in 2012 varied across states ranging from 27.9% in Negeri Sembilan to 14.9% in Sabah.

ACE-inhibitors were the most commonly used anti-hypertensive in 2012 (49.0% of patients) whereas acetyl salicylic acid (27.1%) and statins (62.3%) were the most commonly used anti-platelet and anti-lipid drugs.

As with any registry, there are certain limitations that can be seen with regards to this dataset. The NDR relies on the quality of documentation at the KKs. Any weaknesses in documentation of medical records would be mirrored in the registry data as well. One of the possible improvements to the NDR would be a data query mechanism that would support good data collection processes and help to ensure accurate data entry. Furthermore, it would be advantageous to have a process in place to

conduct source data verification that would ensure the data entered in the registry reflects information in the medical records.

In order to limit the burden of data collection, the NDR has leveraged upon existing data collection requirements within the KK setting (Diabetes Clinical Audit and The National Diabetes Quality Assurance Programme). This approach along with limited sampling required, a web-based data entry system and automated random sampling has enabled useful data collection and tracking with relatively minimal effort.

The registry has been able to show that in the last four years there has been some progress made in terms of treatment target achievement and insulinisation among MOH patients with T2DM. There remain some questions that may not be possible to be answered with the present NDR data. It is hoped that with the publication of this report, further exploration into these questions can be pursued.

Abbreviations

2HPP	2-hour post-prandial blood glucose
ACE-I	Angiotensin converting enzyme inhibitor
ADCM	Audit of diabetes control and management
ARB	Angiotensin receptor blockers
BP	Blood pressure
CI	Confidence interval
CPG	Clinical Practice Guideline
CRF	Case Report Form
DM	Diabetes mellitus
ECG	Electrocardiogram
FBG	Fasting blood glucose
HbA_{1c}	Glycosylated haemoglobin
HDL	High density lipoprotein
IFG	Impaired fasting glucose
IGT	Impaired glucose tolerance
IQR	Inter-quartile range
JKN	State Health Department (*Jabatan Kesihatan Negeri*)
KK	Health Clinic (*Klinik Kesihatan*)
LDL	Low density lipoprotein
MOH	Ministry of Health
N/A	Not available
NDR	National Diabetes Registry
NHMS	National Health and Morbidity Survey
OAD	Oral anti-diabetes drugs
RBG	Random blood glucose
SIQ	Shortfall in quality
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
TCM	Traditional and complementary medicine
TG	Triglycerides

Definitions

Active T2DM patients	Patients with Type 2 Diabetes with at least one visit to the health clinic within one year of the date of clinical audit
Registry patients	Patients diagnosed with diabetes and registered at any of the participating health clinics
Audit patients	Active T2DM patients who were sampled in the clinical audit year

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Decisions about the content of this report rested entirely with the principal investigator and report authors. We thank Adrian Goh, Siti Haryanie, Nurul Azwani, Rozana Razali and Izmil Haikal of Azmi Burhani Consulting for their help in preparing this report.

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Introduction

Diabetes mellitus (DM) is a major public health concern in Malaysia and has been shown to be closely related to increased premature and preventable mortality, as well as macro and microvascular complications such as heart disease, stroke, end-stage renal failure, blindness and amputation. The burden of diabetes continues to increase in Malaysia. The National Health and Morbidity Survey (NHMS) 2011 has shown that the prevalence of diabetes in Malaysia has increased by 31.0% in the space of just 5 years, from 11.6% in 2006 to 15.2% in 2011 **(Figure 1)**. This means that there are currently about 2.6 million adults age 18 years and above living with diabetes.

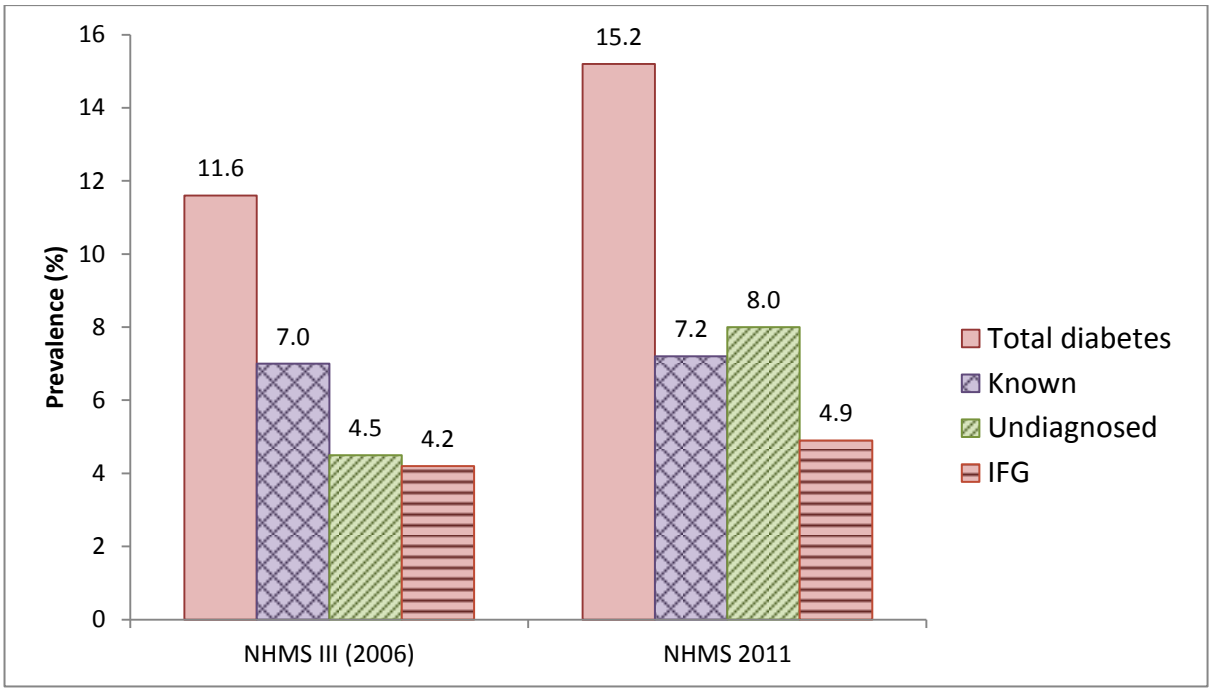

Figure 1. Prevalence of diabetes in adults aged 18 years and above (NHMS III 2006 and NHMS 2011)

Data from NHMS 2011 also shows that about 80% of patients diagnosed with diabetes seek treatment at public health care facilities **(Figure 2)**, while the rest are treated by private general practitioners, or take complementary and alternative medicines.

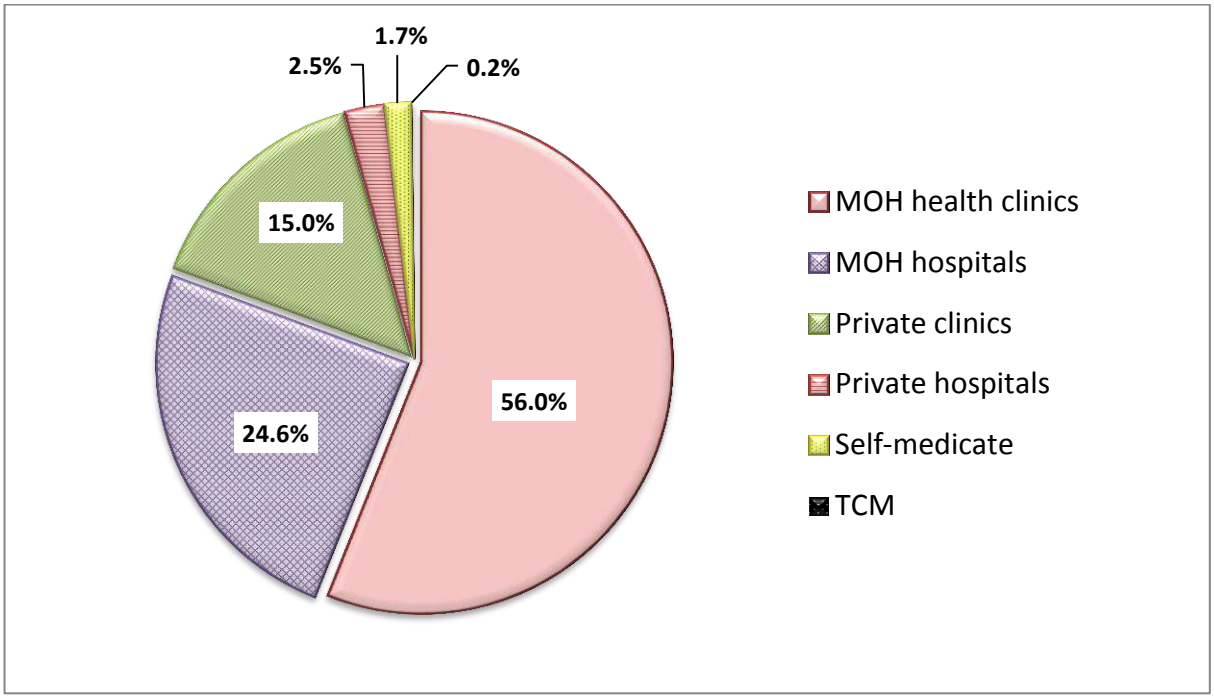

Figure 2. Usual place of treatment of patients diagnosed with diabetes (NHMS 2011)

Health clinics in the public sector provide more comprehensive diabetes services as compared to the private sector, but bear a much higher patient load. Various programmes and activities have been initiated in late 1990s and early 2000s to improve diabetes management at the primary healthcare level, including the publication of the Clinical Practice Guidelines (CPG) on the Management of Type 2 Diabetes Mellitus (T2DM), the latest being the 4th edition, published in late 2009. The MOH centres had also performed routine data collection in the past with paper-based "returns". However, these "returns" consisted mostly of process indicators, with very minimal clinical outcome data, and the paper-based system suffered from expected inherent issues of reliability and timely data. Thus, there was no reliable mechanism in place to monitor the achievement of patients' targets and clinical outcomes.

Rationale

In order to address the lack of information on the status of clinical target achievement of patients with diabetes, a National Diabetes Clinical Audit was developed and implemented in 2008 to provide data on the quality of care provided to T2DM patients managed in MOH health clinics. The clinical audit was initially conducted manually using paper CRFs supported with an Excel-based stand-alone application, but this process was gradually migrated on to a web-based application system. The NDR was developed based on the platform of the Diabetes Clinical Audit as a mechanism to routinely collect data for the audit, as well as to provide a more systematic and timely method of data collection.

In order to limit the burden of data collection on clinic staff, the Diabetes Clinical Audit was conducted on randomly sampled active T2DM on follow-up at MOH health clinics. Universal data entry for clinical variables is not currently feasible as the medical records in the majority of MOH health clinics are still paper-based.

With its establishment, the NDR has collected basic socio-demographic information, clinical and outcome data of patients with diabetes managed in MOH health clinics and selected hospitals. In addition, it has allowed greater efficiency to conduct the annual clinical audit. The NDR has been a collaborative effort among MOH clinics and hospitals that leverages upon existing data collection requirements and processes. The registry is a useful tool to better understand patterns of disease and clinical management of patients managed within the MOH in order to reduce complications and improve patient management and future outcomes.

NDR components

The NDR contains information on patients with diabetes managed at participating KKs and consists of two related components: (i) patient registry and (ii) clinical audit datasets. The audit dataset is a subset of the patient registry. On an annual basis, patients from the registry are randomly selected for auditing of clinical variables as well as clinical outcomes, with these data subsequently added to their registry record.

At the end of December 2012, the patient registry contained 657,839 patient records of which 653,326 were diagnosed with T2DM. Basic information required in the registry dataset includes socio-demographic and certain specified medical history variables from all new patients enrolled into the registry. The clinical audit dataset has more complete patient clinical information with 353,017 patient records at the end of December 2012. It captures clinical variables, drug use and outcomes data for audited patients. The clinical audit has been performed on data of active patients in the NDR since 2009.

National Diabetes Registry objectives:

- Leverage upon existing audit processes to collect useful clinical data
- Enable tracking of glucose control and clinical outcomes of patients with diabetes managed at MOH health clinics
- Enable comparisons over time and across geographical locations
- Enable research in order to improve the quality of care provided to patients

This publication is the first NDR report since the establishment of the registry. It is intended to share the data contained within the registry with clinicians, public health specialists, researchers and all those who are interested in the clinical management of diabetes.

Methodology

Site selection criteria

All MOH KKs managing patients with diabetes from 2009 onwards were eligible for inclusion into the NDR. From 2009 to 2012, 644 KKs throughout the country have provided data to the NDR as shown in **Appendix 1**.

Patient selection criteria

The NDR includes all patients with diabetes managed at KKs which submit data to the NDR. These included patients with T2DM, Type 1 Diabetes Mellitus (T1DM) and other types of DM diagnoses. Other types of DM included congenital diabetes, cystic fibrosis-related diabetes, steroid-related diabetes which is induced by high doses of glucocorticoids and several forms of monogenic diabetes. The registry excludes IGT, IFG or gestational diabetes. Since the diabetes clinical audit is only conducted for T2DM, this report focuses only on the results for patients with T2DM in the NDR.

Data collection

The NDR database contains information about patients with diabetes receiving care at participating KKs. Prior to 2011, data collection was conducted using an Excel-based application. However, since 1st January 2011, an electronic, web-based data-entry system has been used for this purpose.

Data collection is performed by the clinic staff, using 3 main CRFs:

i. **Patient Registration CRF** - for newly diagnosed patients with diabetes (Form NDR/Register/version_1.0/2010)
ii. **Outcome Update CRF** - for all registered patients with diabetes (Form NDR/Update/version_1.0/2010)
iii. **Clinical Audit CRF** - used to obtain data for clinical audit purposes (Form NDR/Audit/version_1.0/2010)

The Patient Registration CRF: (Appendix 2)

- Date of diagnosis and type of diabetes
- Demographic data (state, sex, age, ethnicity, duration of diabetes)
- Complications (retinopathy, ischaemic heart disease, cerebrovascular disease, nephropathy, diabetic foot ulcer, amputation)
- Co-morbidities (hypertension, dyslipidaemia, smoking status)

The Outcome Update CRF: (Appendix 3)

- Complications (retinopathy, ischaemic heart disease, cerebrovascular disease, nephropathy, diabetic foot ulcer, amputation)
- Co-morbidities (hypertension, dyslipidaemia, smoking status)
- Current patient status (still on active follow-up, loss to follow-up, died)

The Clinical Audit CRF: (Appendix 4)

- Complications (retinopathy, ischaemic heart disease, cerebrovascular disease, nephropathy, diabetic foot ulcer, amputation)
- Co-morbidities (hypertension, dyslipidaemia)
- Glycaemic control (HbA_{1c})

- Clinical investigation results (BP, HbA_{1c}, FBG, RBG, 2HPP, creatinine, total cholesterol, LDL, HDL, triglycerides, proteinuria, microalbuminuria)
- Diabetic treatments (monotherapy, OADs, insulin, diet)
- Anti-diabetic drug use (metformin, sulphonylurea, alpha-glucosidase inhibitor, meglitinide, glitazones, insulin, other agents)
- Drug treatments for concomitant conditions (anti-hypertensive, anti-platelet and anti-lipid drugs)

The status of registered patients is continuously updated throughout the year with updates for occurrence of any new complication(s), co-morbidities, loss of follow-up and death. The active patients with T2DM are the population pool from which patients are selected for the annual clinical audit.

Data collection for audited patients is conducted from January each year while data entry into the NDR database must be completed before 31st August of the same year.

Sampling methodology for Diabetes Clinical Audit

Random sampling is conducted to select the patients that need to be included in the annual Diabetes Clinical Audit. The sampled population comes from active patients with T2DM in the registry dataset. Since January 2011, the sampling has been automatically performed by the web-based application. Different samples of patients are drawn every year. Patients sampled in the previous year have an equal chance of being selected in the subsequent years. Prior to 2011, random sampling was performed manually by the staff at the clinics.

The sample size is determined by the number of active patients with T2DM within a particular district. This was done to minimise the number of patients audited, yet remain useful for inter-district comparability. However, some states have opted for sampling at the clinic level, thus enabling comparability between health clinics. Unfortunately, this causes an inflated number of sampled patients to be audited. Once sampling is automatically performed for each KK, the clinic staff is required to complete the audit details for all of the selected patients.

Sample size estimation

The sample size is calculated to estimate the proportion of patients with T2DM-related complications managed at MOH KKs. The number of patients expected to have complications (shown in **Box 1**) was estimated by consensus by a group of MOH clinicians.

Box 1. Consensus estimate of DM complications

Macroangiopathy	Microangiopathy
IHD (50%)	Retinopathy (30%)
Stroke (10%)	Nephropathy (40%)
PVD (12-16%) Foot ulcer (5-15%)	Neuropathy (70%) • Autonomic neuropathy (ED & GI) • Peripheral neuropathy (foot)

The largest sample size was calculated from the prevalence of stroke (10%) with acceptable difference in stroke prevalence of 20%, at power 80% and 95% confidence interval.

The sample of patients with T2DM required for the clinical audit from each district is based on the number of active patients registered in each district, and ranges from 162 to 850 patients, as shown in **Appendix 5**.

Statistical methods

Results below present descriptive statistical analysis as generated by the NDR web-based application with supplementary analyses conducted using STATA SE version 11.2. Results are presented as categorical variables (n, %) or continuous variables (mean, 95% CI and/ or median, inter-quartile range).

Results below were generated using data from the NDR extracted between 13th to 28th May 2013. The data included patient records from 1st January 2009 to 31st December 2012.

Clinical setting

A total of 644 government health clinics from all states in Malaysia were enrolled in the NDR between 2009 and 2012. In the reporting period ending December 2012, 625 KKs had submitted data to the NDR. The distribution of KKs providing data to the NDR by state is shown in **Table 1** below. A complete list of KKs enrolled in the NDR is listed in **Appendix 1**.

Table 1. Distribution of KKs enrolled in the NDR registry by state

State	Number of KKs
Johor	88
Kedah	52
Kelantan	53
Melaka	26
Negeri Sembilan	45
Pahang	67
Perak	73
Perlis	9
Pulau Pinang	27
Sabah	36
Sarawak	54
Selangor	59
Terengganu	39
WP Kuala Lumpur	13
WP Labuan	1
WP Putrajaya	2
Malaysia	**644**

Findings

Patient population

From 2009 to end of 2012, there were a total of 657,839 patients enrolled in the registry. Nearly all the patients enrolled, 653,326, were diagnosed with T2DM. As of end 2012, patients diagnosed with T1DM or other forms of DM comprised only 0.6% and 0.1%, respectively.

The characteristics of T2DM patients are shown in **Table 2**. The mean age of T2DM patients registered in the NDR was 59.7 years (95% CI: 59.7-59.7). Men represented 41.6% of the patients registered. Thus, women were in the majority representing 58.4% of patients. Comparing by states, the largest number of patients were registered from Selangor (106,101), followed by Johor (92,750) and Perak (74,492). The ethnic distribution was as follows: Malay 58.9%, Chinese 21.4%, Indian 15.3%, Other Malaysian 4.2% and Foreigner/Unknown 0.2% as shown in **Figure 3**.

Table 2. Characteristics of T2DM patients enrolled from 2009 to 2012 [Registry Dataset]

State	No. of patients, n(%)	Male, n(%)	Mean age (95% CI)	Ethnicity, n(%)				
				Malay	Chinese	Indian	Other Malaysian	Foreigner/ Unknown
Johor	92,750(14.2)	38,386(41.4)	59.8 (59.7-59.9)	58,306(62.9)	22,724(24.5)	11,219(12.1)	397(0.4)	104(0.1)
Kedah	42,344(6.5)	16,482(38.9)	59.1 (59.0-59.2)	31,515(74.4)	5,059(11.9)	5,274(12.5)	453(1.1)	43(0.1)
Kelantan	27,002(4.1)	9,692(35.9)	59.3 (59.2-59.4)	25,497(94.4)	1,066(3.9)	145(0.5)	278(1.0)	16(0.1)
Melaka	42,974(6.6)	18,640(43.4)	61.0 (60.9-61.1)	28479(66.3)	9,883(23.0)	4,264(9.9)	292(0.7)	56(0.1)
Negeri Sembilan	57,869(8.9)	25,288(43.7)	60.4 (60.3-60.5)	33,317(57.6)	10,810(18.7)	13,347(23.1)	314(0.5)	81(0.1)
Pahang	38,119(5.8)	15,972(41.9)	58.9 (58.8-59.1)	29,700(77.9)	5,450(14.3)	2,664(7)	201(0.5)	104(0.3)
Perak	74,492(11.4)	31,604(42.4)	61.1 (61.1-61.2)	38,867(52.2)	18,869(25.3)	16,113(21.6)	588(0.8)	55(0.1)
Perlis	13,388(2.1)	5,311(39.7)	58.9 (58.7-59.1)	11,521(86.1)	1,217(9.1)	326(2.4)	314(2.3)	10(0.1)
Pulau Pinang	40,439(6.2)	17,271(42.7)	60.6 (60.5-60.7)	17,758(43.9)	14,534(35.9)	7,876(19.5)	210(0.5)	61(0.2)
Sabah	11,302(1.7)	4,933(43.6)	58.8 (58.6-59.0)	560(5.0)	3,594(31.8)	104(0.9)	6,888(60.9)	156(1.4)
Sarawak	43,333(6.6)	17,046(39.3)	59.3 (59.2-59.4)	12,030(27.8)	14,850(34.3)	254(0.6)	16,088(37.1)	111(0.3)
Selangor	106,101(16.2)	45,019(42.4)	58.5 (58.4-58.6)	55,245(52.1)	19,664(18.5)	29,603(27.9)	1067(1.0)	522(0.5)
Terengganu	22,272(3.4)	8,275(37.2)	58.3 (58.2-58.5)	21,786(97.8)	427(1.9)	21(0.1)	23(0.1)	15(0.1)
WP Kuala Lumpur	37,713(5.8)	16,261(43.1)	60.5 (60.4-60.7)	17,258(45.8)	11,587(30.7)	8,448(22.4)	317(0.8)	103(0.3)
WP Labuan	524(0.1)	202(38.5)	55.8 (54.8-56.8)	363(69.3)	72(13.7)	4(0.8)	77(14.7)	8(1.5)
WP Putrajaya	2,704(0.4)	1,408(52.1)	54.5 (54.1-54.9)	2,494(92.2)	62(2.3)	128(4.7)	12(0.4)	8(0.3)
Total patients, n (%)	**653,326(100)**	**271,790 (41.6)**	**59.7 (59.7-59.7)**	**384,696(58.9)**	**139,868(21.4)**	**99,790(15.3)**	**27,519(4.2)**	**1,453(0.2)**

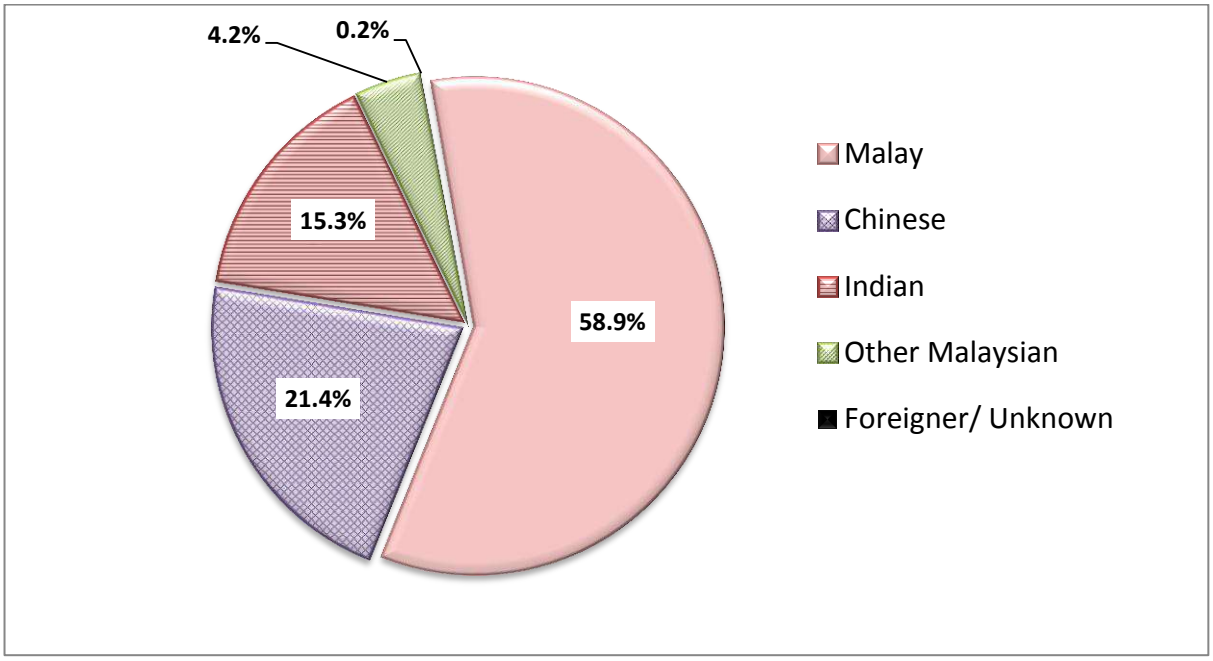

Figure 3. Distribution of T2DM patients at diagnosis by ethnicity [Registry Dataset]

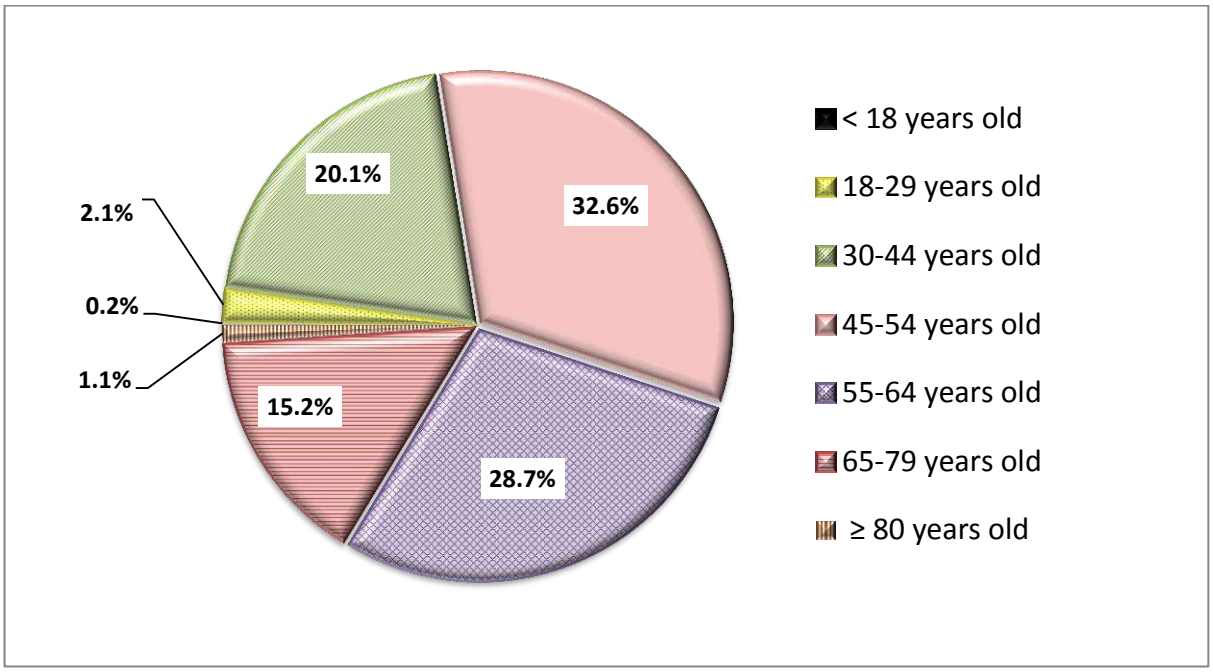

Figure 4. Distribution of T2DM patients by age at diagnosis [Registry Dataset]

The mean age of T2DM patients in the NDR was 59.7 years (95% CI: 59.7-59.7). On the other hand, the mean age at diagnosis was 53 years old (data not shown). As shown in **Figure 4** above, categorised by age at diagnosis, the largest proportion represented those who were diagnosed at age 45 to 54 years old (32.6%), followed by 55 to 64 years old (28.7%) and next at age 30 to 44 years old (20.1%).

The mean duration of follow up for the patients with T2DM was 6.5 years (95% CI: 6.5 - 6.5), with a median duration of 5.0 years (IQR: 6.0 years) as observed in **Table 3**. The differences between the mean and median are indicative that the data is not normally distributed and skewed to the right by a greater number of older patients. Overall, 43.0% of patients were diagnosed with diabetes for less

than 5 years, another 40.1% were diagnosed between 5-10 years and 17.0% were diagnosed more than 10 years. However, it is interesting to note that in 2012 the majority of patients had diabetes for a duration of 5 years or less, whereas in earlier years, the majority of patients had diabetes for 5-10 years. This may be due to a more generalized process of selecting patients for inclusion into the registry after the web-based application was implemented.

Table 3. Duration of diabetes of registered T2DM patients [Registry Dataset]

Diabetes duration	2009-2012	2009	2010	2011	2012
Mean %, (95% CI)	6.5 (6.5 - 6.5)	8.7 (8.7 - 8.8)	7.7 (7.7 - 7.7)	6.7 (6.7 - 6.7)	6.0 (6.0 - 6.0)
Median %, (IQR)	5.0 (6.0)	7.0 (6.0)	7.0 (6.0)	5.0 (6.0)	5.0 (6.0)
Duration by group, n (%)					
< 5 years	281,301 (43.0)	1,1005 (17.8)	21,032 (27.0)	155,754 (40.8)	161,224 (48.5)
5 – 10 years	262,301 (40.1)	34,720 (56.1)	41,031 (52.6)	161,171 (42.2)	118,268 (35.6)
> 10 years	111,260 (17.0)	16,148 (26.1)	15,901 (20.4)	64,696 (17.0)	52,778 (15.9)
Total patients	**654,862**	**61,873**	**77,964**	**381,621**	**332,270**

Comorbidities

Table 4 below shows the presence of co-morbidities and complications among patients with T2DM in the clinical audit dataset. Hypertension was the most common co-morbidity in 70.1% of audited patients in 2012 followed by dyslipidaemia in 55.1% of audited patients. Meanwhile, smokers comprised 4.9% of patients registered in the NDR as of December 2012. Among patients audited in 2012, the most common DM related complications were nephropathy (7.8%), retinopathy (6.7%), and ischaemic heart disease (5.3%).

Table 4. Complications and co-morbidities in 2011 and 2012 [Audit Dataset]

Co-morbidities	2011, n (%)	2012, n (%)
Hypertension		
Yes	49,038 (68.4)	86,975 (70.1)
No	15,935 (22.2)	30,251 (24.4)
Unknown	6,656 (9.3)	6,752 (5.4)
Dyslipidaemia		
Yes	37,893 (52.9)	68,283 (55.1)
No	24,111 (33.7)	45,960 (37.1)
Unknown	9,625 (13.4)	9,735 (7.9)
Smoking status*		
Smoker	19,362 (5.1)	16,361 (4.9)
Non-smoker	274,880 (72.0)	237,769 (71.6)
Unknown	86,903 (22.8)	78,089 (23.5)
Complications	**2011, n (%)**	**2012, n (%)**
Nephropathy		
Present	5,429 (7.6)	9,707 (7.8)
Absent	51,350 (71.7)	99,016 (79.8)
Unknown	14850 (20.7)	15,256 (12.3)
Retinopathy		
Present	4,627 (6.5)	8,255 (6.7)
Absent	50,455 (70.4)	96,872 (78.1)
Unknown	16,547 (23.1)	18,853 (15.2)
Ischaemic Heart Disease		
Present	3,467 (4.8)	6,508 (5.3)
Absent	53,387 (74.5)	101,630 (81.9)
Unknown	14,775 (20.6)	15,842 (12.8)
Cerebrovascular Disease		
Present	788 (1.1)	1,550 (1.3)
Absent	56,966 (79.5)	106,953 (86.2)
Unknown	13,875 (19.4)	15,476 (12.5)
Diabetic Foot Ulcer		
Present	841 (1.2)	1,527 (1.2)
Absent	58,044 (81.0)	10,8726 (87.7)
Unknown	12,744 (17.8)	13,725 (11.1)
Amputation		
Present	387 (0.5)	721 (0.9)
Absent	58,487 (81.6)	109,652 (88.4)
Unknown	12,755 (17.8)	13,605 (11.0)

Note: *Smoking status was obtained from the registry dataset. All other complications and co-morbidities were obtained from the audit dataset.

Clinical investigations

Table 5 shows the proportion of patients who had routine clinical tests performed including BP measurement, HbA_{1c}, FBG, RBG, 2HPP, creatinine, total cholesterol, LDL, HDL, TG, urine protein and urine microalbumin tests, as well as had foot examination, funduscopy and ECGs performed. Among the 124,023 patients selected for audit in 2012, 93.7% of patients had their BP taken and 78% or more of patients had total cholesterol levels and TG tested, although LDL and HDL tests were performed for only 59.1% and 59.5% of patients, respectively. Urine protein and urine microalbumin were measured in 64.7% and 56.7% of patients respectively. Meanwhile, foot examination, fundus examination and ECG were performed in 73.0%, 44.0% and 54.1% of patients, respectively.

Table 5. Proportion of patients receiving clinical investigations [Audit Dataset]

Investigation	2009, n (%)	2010, n (%)	2011, n (%)	2012, n (%)
BP	79,202 (98.8)	63,138 (81.8)	66,940 (93.4)	116,265 (93.7)
HbA_{1c}	54,431 (67.9)	48,765 (63.2)	51,018 (71.2)	96,694 (78.0)
FBG	48,019 (59.9)	46,217 (59.9)	44,565 (62.2)	71,386 (57.6)
RBG	50,744 (63.3)	43,281 (56.1)	39,169 (54.7)	74,801 (60.3)
2HPP	9,719 (12.1)	6,150 (8.0)	4,200 (5.9)	5,862 (4.7)
Creatinine	65,875 (82.2)	53,067 (68.8)	51,940 (72.5)	96,248 (77.6)
Total cholesterol	66,203 (82.6)	52,724 (68.3)	53,091 (74.1)	97,362 (78.5)
LDL	51,421 (64.2)	34,220 (44.3)	35,950 (50.2)	73,332 (59.1)
HDL	52,306 (65.3)	34,461 (44.7)	36,508 (51.0)	73,772 (59.5)
TG	65,648 (81.9)	52,360 (67.8)	52,506 (73.3)	97,045 (78.3)
Urine protein	45,794 (57.2)	44,802 (58.1)	41,830 (58.4)	80,224(64.7)
Urine microalbumin	36,300 (45.3)	35,859 (46.5)	36,842 (51.4)	70,273 (56.7)
Foot examination	58,001 (72.4)	59,643 (77.3)	50,115 (69.9)	90,558 (73.0)
Fundus	29,263 (36.5)	29,642 (38.4)	27,806 (38.8)	54,590 (44.0)
ECG	35,926 (44.8)	35,975 (46.6)	35,848 (50.0)	67,068 (54.1)
Patients audited	**80,134**	**77,179**	**71,655**	**124,023**

Clinical target achievement

Table 6 below shows the mean HbA_{1c} and the percentage of patients reaching clinical targets for HbA_{1c}. Mean HbA_{1c} has decreased slightly over 4 years, from 8.3% in 2009 to 8.1% in 2012 with most audited patients recording HbA_{1c} between 8.0% to 10.0%. In 2012, 23.8% of patients achieved the Malaysian glycaemic target of HbA_{1c} <6.5% compared to 19.4% in 2009. Assessed against the international treatment target of HbA_{1c} <7.0%, 37.9% of patients in 2012 would be considered to have achieved glycaemic control.

Table 6. Mean HbA_{1c} and patients achieving glycaemic targets* [Audit Dataset]

HbA_{1c}	2009	2010	2011	2012
Mean %, (95% CI)	8.3 (8.3 - 8.3)	8.0 (8.0 - 8.0)	8.2 (8.2 - 8.2)	8.1 (8.1 - 8.1)
Distribution, n (%)				
<6.5%**	10,559 (19.4)	12,079 (24.8)	11550 (22.6)	22,992 (23. 8)
<7.0%	17,266 (31.3)	18,948 (38.9)	18002 (35.3)	36,620 (37.9)
<8.0%	28,822 (52.9)	28,584 (58.6)	28169 (55.2)	55,635(57.5)
≥10.0%	11,480 (21.1)	8,803 (18.1)	10327 (20.2)	18,764 (19.4)
No. of patients with HbA_{1c} test results*	54,440	48,774	51,026	96,694

Note:
*The denominator for the percentage achieving target was the number of patients with HbA_{1c} test results
**Good glycaemic control as defined by the Malaysian CPG on T2DM (2009)

Table 7 below shows that the achievement of HbA_{1c} treatment target (<6.5%) varied across the states. The national HbA_{1c} treatment achievement rate was 23.8% in 2012. The achievement rate by states ranged from 54.0% in Labuan and 39.1% in Sarawak to 17.6% and 14.9% in Terengganu and Kelantan, respectively. In line with the overall increasing proportion of patients achieving treatment target at the national level over the past four years, most states have recorded stable or an increase in the target achievement rate. The exceptions were in Terengganu where the rate declined from 23.0% in 2009 to 17.6% in 2012 and in Sabah where the rate declined from 38.4% to 33.4%. It is important to note that these target achievement rates are based on the number of patients with HbA_{1c} test results.

Table 7. Proportion of patients achieving HbA_{1c} treatment target (HbA_{1c} <6.5%) and mean HbA_{1c} by state [Audit Dataset]

State	2009		2010		2011		2012	
	% achieved target	Mean HbA_{1c} (95% CI)	% achieved target	Mean HbA_{1c} (95% CI)	% achieved target	Mean HbA_{1c} (95% CI)	% achieved target	Mean HbA_{1c} (95% CI)
Johor	18.7	8.3 (8.3-8.4)	20.6	8.2 (8.2-8.3)	18.5	8.4 (8.4-8.5)	21.9	8.1 (8.1-8.2)
Kedah	15.9	8.6 (8.5-8.7)	N/A	N/A	25.0	8.4 (7.1-9.6)	22.4	8.3 (8.2-8.3)
Kelantan	14.7	8.9 (8.8-8.9)	N/A	N/A	19.9	8.6 (8.5-8.7)	14.9	8.8 (8.7-8.9)
Melaka	19.5	8.2 (8.1-8.3)	20.7	8.1 (8.0-8.2)	24.5	7.9 (7.9-8.0)	25.2	7.8 (7.8-7.8)
N.Sembilan	18.7	8.2 (8.2-8.3)	22.7	8.0 (8.0-8.1)	24.2	8.1 (8.1-8.2)	24.4	8.0 (7.9-8.0)
Pahang	18.8	8.6 (8.5-8.7)	25.2	8.2 (8.2-8.3)	20.1	8.4 (8.4-8.5)	22.4	8.3 (8.3-8.4)
Perak	18.3	8.3 (8.2-8.3)	26.1	8.0 (7.9-8.1)	24.6	8.1 (8.0-8.2)	24.3	8.2 (8.2-8.3)
Perlis	29.1	7.8 (7.6-7.9)	27.9	8.1 (8.0-8.3)	27.7	8.1 (7.9-8.2)	29.2	8.1 (8.0-8.2)
Pulau Pinang	18.2	8.3 (8.2-8.4)	21.9	8.0 (8.0-8.1)	22.0	8.1 (8.0-8.1)	21.0	8.0 (7.9-8.0)
Sabah	38.4	7.4 (7.2-7.6)	36.1	7.2 (7.1-7.3)	31.3	7.5 (7.4-7.6)	33.4	7.4 (7.4-7.5)
Sarawak	34.4	7.5(7.4-7.7)	26.3	7.8 (7.6-8.0)	30.0	7.7 (7.5-7.9)	39.1	7.4 (7.3-7.6)
Selangor	22.3	8.2 (8.1-8.3)	30.5	7.8 (7.7-7.8)	22.3	8.2 (8.2-8.3)	23.0	8.3 (8.3-8.4)
Terengganu	23.0	8.6 (8.5-8.7)	22.2	8.4 (8.3-8.5)	18.2	8.7 (8.6-8.8)	17.6	8.8 (8.7-8.9)
WP Kuala Lumpur	19.0	8.1 (8.1-8.2)	30.4	7.7 (7.6-7.7)	25.3	8.0 (7.9-8.0)	30.5	7.7 (7.7-7.8)
WP Labuan	N/A	N/A	39.4	7.3 (7.1-7.5)	32.1	7.4 (7.0-7.8)	54.0	6.9 (6.7-7.1)
WP Putrajaya	16.1	7.8 (7.6-8.1)	26.2	7.7 (7.5-7.8)	17.2	8.0 (7.9-8.2)	31.1	7.9 (7.8-8.1)
Malaysia	**19.4**	**8.3 (8.3-8.3)**	**24.8**	**8.0 (8.0-8.0)**	**22.6**	**8.2 (8.2-8.2)**	**23.8**	**8.1 (8.1-8.1)**

Table 8 below reports the mean clinical test values and proportions of audited patients achieving treatment targets for concomitant conditions. Among patients audited in 2012, more than 70% of patients tested negative for proteinuria and microalbuminuria, while 65.7% recorded HDL ≥1.1 mmol/l and 60.8% had TG ≤1.7 mmol/l. However, fewer patients achieved target total cholesterol (28.5%), LDL cholesterol (37.8%), BMI (16.6%), as well as waist circumference for both males (33.8%) and females (14.4%).

Comparing between 2009 and 2012, the achievement of treatment targets have improved for total cholesterol (from 24.1% to 28.5%), TG (53.2% to 60.8%) and LDL (30.6% to 37.8%).

Table 8. Target achievement based on clinical investigations [Audit Dataset]

Clinical test	Treatment targets	2009		2010		2011		2012	
		% achieved target	Mean test result (95% CI)	% achieved target	Mean test result (95% CI)	% achieved target	Mean test result (95% CI)	% achieved target	Mean test result (95% CI)
Urine protein	Negative	N/A	N/A	64.3	N/A	74.6	N/A	77	N/A
Urine microalbumin	Negative	N/A	N/A	64.3	N/A	71.1	N/A	71.9	N/A
Systolic BP	≤130 mmHg	48.7	136 (135.8-136.1)	52.6	134.4 (134.3-134.6)	49	135.4 (135.3-135.6)	47.6	135.5 (135.4-135.6)
Diastolic BP	≤80 mmHg	64.5	79.5 (79.5-79.6)	67.1	79.5 (79.4-79.5)	66.2	79.1 (79.0-79.1)	67.1	78.4 (78.3-78.5)
BP	≤130/80 mmHg	41.2	N/A	45	N/A	42	N/A	40.9	N/A
Total cholesterol	<4.5 mmol/l	24. 1	5.3 (5.3-5.3)	25.8	5.3 (5.2-5.3)	26.3	5.2 (5.2-5.2)	28.5	5.2 (5.2-5.2)
TG	≤1.7 mmol/l	53.2	2.0 (2.0-2.0)	54.7	1.9 (1.9-1.9)	58.7	1.9 (1.9-1.9)	60.8	1.8 (1.8-1.8)
HDL	≥1.1 mmol/l	68	1.3 (1.3-1.3)	67.1	1.3 (1.3-1.3)	66.2	1.3 (1.3-1.3)	65.7	1.3 (1.3-1.3)
LDL	≤2.6 mmol/l	30.6	3.2 (3.2-3.2)	33.6	3.2 (3.2-3.2)	34.5	3.2 (3.1-3.2)	37.8	3.1 (3.1-3.1)
BMI	<23 kg/m^2	17.2	28.0 (27.7-28.3)	15.9	30.0 (28.1-31.9)	16.3	27.4 (27.4-27.5)	16.6	27.4 (27.3-27.4)
Waist circumference	<90 cm (Male)	35.3	93.4 (93.2-93.5)	34.2	94.0 (93.8-94.1)	35.1	93.6 (93.5-93.8)	33.8	94.0 (93.9-94.1)
	<80 cm (Female)	15.6	90.1 (89.9-90.2)	14.8	90.2 (90.1-90.4)	15.2	90.4 (90.3-90.6)	14.4	90.7 (90.6-90.8)

Drug treatment

The use of anti-diabetic drugs is shown in **Table 9** below. In 2012, 27.0% of patients were on monotherapy compared to 33.7% in 2009, while 45.7% were on 2 or more OADs compared to 51.3% in 2009. The changes are reflected in patients who were on insulin-OAD combination treatment which increased from 8.8% in 2009 to 16.5% in 2012. Rather unexpectedly, the number of patients on diet management only also increased from 3.3% to 5.9%.

Among the various classes of OADs, metformin was the most commonly prescribed with 82.5% of patients on this treatment. Second to metformin are the sulphonylureas, which are used by 56.9% of patients. These are followed by alpha-glucosidase (4.7%) and glitazones (1.1%). One percent or fewer were also on meglitinides and other OADs. On the other hand, the use of insulin has increased over the last 4 years, from 11.7% of patients in 2009, increasing to 21.4% in 2012.

Table 9. Anti-diabetic drugs used [Audit Dataset]

Therapy	2009, n (%)	2010, n (%)	2011, n (%)	2012, n (%)
Monotherapy (OAD)	27,037 (33.7)	26,121 (33.8)	19,793 (27.6)	33,505 (27.0)
≥2 OAD	41,094 (51.3)	40,239 (52.1)	35,153 (49.1)	56,658 (45.7)
OAD + Insulin	7,068 (8.8)	6,851 (8.9)	9,579 (13.4)	20,434 (16.5)
Diet only	2,664 (3.3)	17,53 (2.3)	4,451 (6.2)	7,307 (5.9)
Type of anti-diabetic drug				
Metformin	65,703 (82.0)	66,268 (85.9)	59,221 (82.6)	10,2315 (82.5)
Sulphonylureas	52,394 (65.4)	48,816 (63.2)	42,932 (59.9)	70,579 (56.9)
Alpha-Glucosidase Inhibitors	3,824 (4.8)	4,534 (5.9)	4,649 (6.5)	5,801 (4.7)
Meglitinides	201 (0.3)	274 (0.4)	131 (0.2)	119 (0.1)
Glitazones	134 (0.2)	261 (0.3)	477 (0.7)	1,330 (1.1)
Other OADs	601 (0.8)	502 (0.7)	645 (0.9)	1,135 (0.9)
Insulin	9,348 (11.7)	9,075 (11.8)	12,275 (17.1)	26,553 (21.4)
Total patients audited	**80,143**	**77,188**	**71,672**	**124,023**

The use of insulin as a mode of treatment from 2009 to 2012 by state is illustrated in **Table 10** below. Generally, there was a steady growth in percentage of patients receiving insulin treatment in all states except for Perlis, Sarawak and WP Putrajaya. The highest percentage of T2DM patients receiving insulin in 2012 was in Negeri Sembilan with 27.9% followed by Selangor and WP Putrajaya with 24.2% and 23.9%, respectively.

Table 10. Use of insulin by state [Audit Dataset]

State	2009		2010		2011		2012	
	Audited patients	Patients on insulin (%)	Audited patients	Patients on insulin (%)	Audited patients	Patients on insulin (%)	Audited patients	Patients on insulin (%)
Johor	6,191	710 (11.5)	5,555	563 (10.1)	8,480	1,333 (15.7)	6,483	1,096 (16.9)
Kedah	4,033	359 (8.9)	6,629	726 (11.0)	N/A	N/A	5,920	902 (15.2)
Kelantan	7,461	482 (6.5)	6,951	572 (8.2)	4,603	579 (12.6)	9,805	1,565 (16.0)
Melaka	2,231	156 (7.0)	5,946	514 (8.6)	8,942	1,142 (12.8)	14,728	3,006 (20.4)
N.Sembilan	17,211	2,359 (13.7)	13,916	1,985 (14.3)	15,197	2,993 (19.7)	32,402	9,050 (27.9)
Pahang	5,766	708 (12.3)	6,220	855 (13.8)	5,786	1,003 (17.3)	16,844	3,369 (20.0)
Perak	5,044	448 (8.9)	6,154	658 (10.7)	5,716	878 (15.4)	7,342	1,221 (16.6)
Perlis	760	74 (9.7)	761	134 (17.6)	754	116 (15.4)	1,168	194 (16.6)
Pulau Pinang	3,293	388 (11.8)	3,632	446 (12.3)	3,850	513 (13.3)	3,690	641 (17.4)
Sabah	987	18 (1.8)	3,045	162 (5.3)	2,042	238 (11.7)	3,014	448 (14.9)
Sarawak	4,447	576 (13.0)	3,989	441 (11.1)	2,283	390 (17.1)	3,116	482 (15.5)
Selangor	6,691	822 (12.3)	6,776	1,047 (15.5)	6,188	1,493 (24.1)	6,038	1,461 (24.2)
Terengganu	2,182	124 (5.7)	3,846	388 (10.1)	3,590	600 (16.7)	4,014	892 (22.2)
WP Kuala Lumpur	13,670	2,097 (15.3)	2,948	476 (16.2)	3,577	833 (23.3)	8,716	2,071 (23.8)
WP Labuan	N/A	N/A	314	2 (0.6)	78	0	101	0
WP Putrajaya	167	26 (15.6)	496	105 (21.2)	558	163 (29.2)	631	151 (23.9)
Malaysia	**80,134**	**9,348 (11.7)**	**77,188**	**9,075 (11.8)**	**71,672**	**12,275 (17.1)**	**124,023**	**26,553 (21.4)**

The use of other concomitant drugs is shown in **Table 11** below. In 2012, ACE inhibitors were the most commonly used anti-hypertensives (49.0%) followed by calcium channel blockers (38.0%) and beta blockers (24.2%). Acetyl salicylic acid was the most commonly used anti-platelet (27.1%) and statins were the most commonly used anti-lipids (62.3%).

Table 11. Use of concomitant drugs [Audit Dataset]

Drug	2009, n (%)	2010, n (%)	2011, n (%)	2012, n (%)
Patients audited	**80,134**	**77,179**	**71,655**	**124,023**
Anti-Hypertensives				
ACE inhibitors	37,294 (46.5)	37,293 (48.3)	34,238 (47.8)	60,743 (49.0)
Angiotensin receptor blockers	2,138 (2.7)	2,752 (3.6)	2,837 (4.0)	5,165 (4.2)
Beta blockers	21,267 (26.5)	20,249 (26.2)	18,428 (25.7)	29,986 (24.2)
Calcium channel blockers	21,050 (26.3)	21,513 (27.9)	23,735 (33.1)	47,077 (38.0)
Diuretics	13,269 (16.6)	13,525 (17.5)	14,019 (19.6)	25,258 (20.4)
Alpha blockers	3,396 (4.2)	2,739 (3.6)	2,766 (3.9)	4,708 (3.8)
Central-acting agents	3,52 (0.4)	371 (0.5)	279 (0.4)	283 (0.2)
Others	568 (0.7)	269 (0.4)	367 (0.5)	801 (0.7)
Anti-Platelets				
Acetyl salicylic acid	23,543 (29.38)	24,446 (31.7)	20,813 (29.1)	33,665 (27.1)
Ticlopidine	862 (1.08)	850 (1.1)	838 (1.2)	1,628 (1.3)
Others	281 (0.35)	194 (0.3)	307 (0.4)	672 (0.5)
Anti-Lipids				
Statins	37,128 (46.3)	39,476 (51.2)	42,153 (58.8)	77,239 (62.3)
Fibrates	3,254 (4.1)	2,689 (3.3)	2,332 (3.3)	4,787 (3.9)
Others	203 (0.3)	141 (0.2)	182 (0.3)	146 (0.1)

Discussion

There are several key features that we wish to highlight in this first report. We discuss findings from the NDR data, and additionally, some comparisons are made against results of the NHMS since it also contains information about Malaysians with diabetes. Differences between the NDR and the NHMS are to be expected, bearing in mind that the NHMS data is derived from a large population-based survey whereas the NDR collects the data of patients with diabetes who are on follow up in KKs. We also note that the comparisons between the two datasets are based on trends and patterns and intended to provide a broad understanding of the differences. Statistical testing of differences was not performed.

Demographic features

Patient registration at KKs

Based on NHMS 2011 results, it was estimated that approximately 698,500 patients with diabetes are on follow-up at MOH KKs[1]. Therefore, although this registry is relatively new, it is reassuring that most of the KKs have already registered most of their patients with diabetes who are on active follow-up at their respective clinics.

Age at diagnosis

Although anecdotally many medical doctors are reporting that they are diagnosing diabetes more frequently in younger Malaysians, the fact remains that many more older adult Malaysians are being diagnosed. Again, with reference to NHMS results, **Figure 5** below demonstrates a gradual shift of the curve upwards over time, indicating that the increasing prevalence of diabetes is occurring amongst all age groups, however, more so in the older age groups. This is consistent with our results from the NDR showing the mean age of diagnosis as being 53 years old.

[1]Estimated number of diagnosed individuals with diabetes: 1,247,366 x 56% (proportion attending MOH KKs)

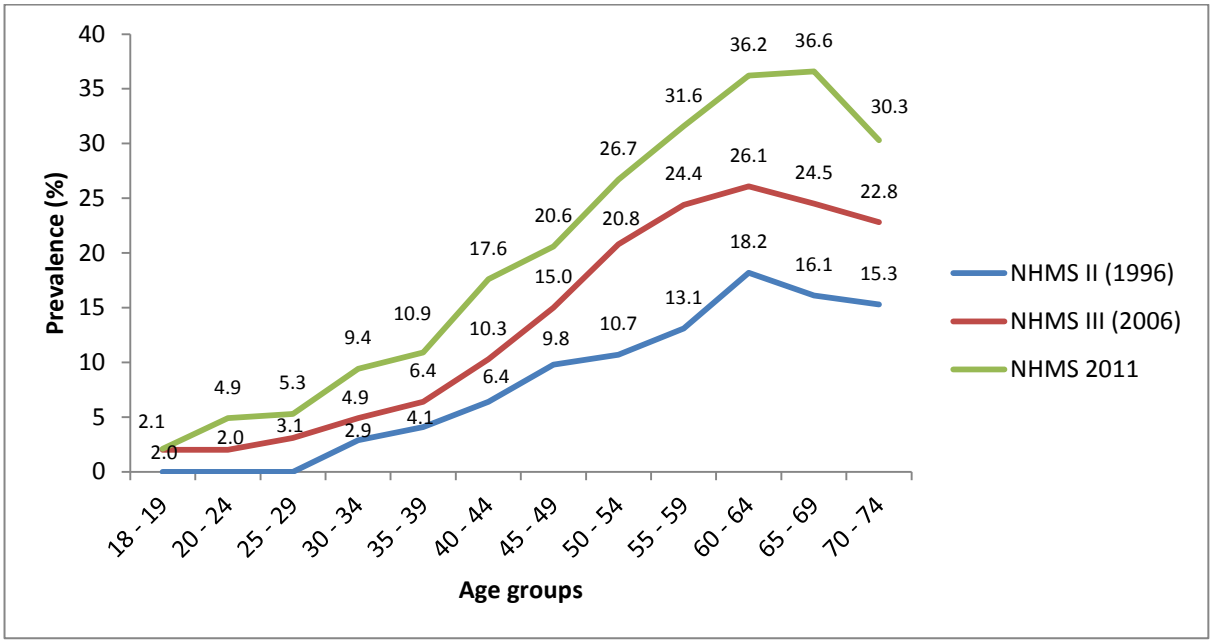

Figure 5: Prevalence of Diabetes ≥18 years, by age groups (1996, 2006 and 2011)

Age influence on follow up attendance in KKs

From the age distribution of known diabetics in the NHMS and those registered in the NDR, as shown in **Figure 6**, it appears that older patients tend to seek treatment within the KK system and are registered in the NDR. This is possibly explained by the fact that younger patients would be more inclined to seek treatment elsewhere (e.g. in private clinics) due to convenience to their location, time constraints and ability to pay for service fees.

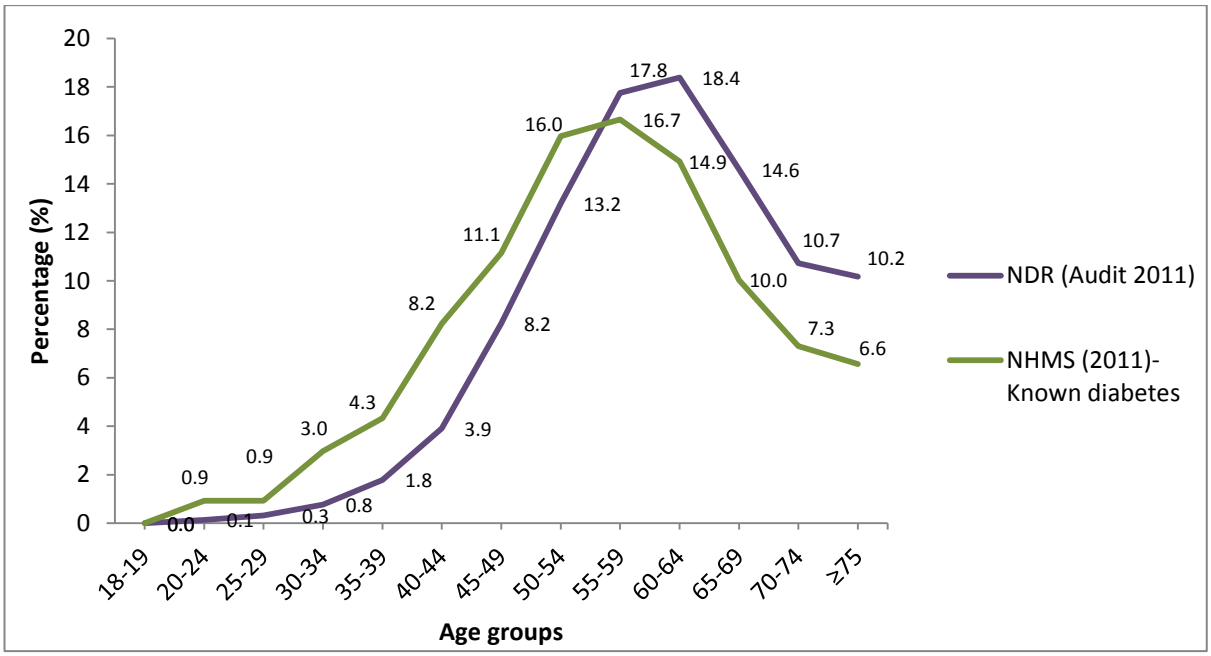

Figure 6: Age distribution of patients with known diabetes (2011)

Gender influence on follow up attendance in KKs

Another interesting observation to note from NHMS 2011 is that the distribution by sex among the patients with known diabetes was not statistically different, for males 7.0% (95%CI: 6.3-7.8) versus females 7.5% (95%CI: 6.9-8.1)[2]. However, from the NDR, there is a preponderance of women registered in KKs, with women making 58.4% of registered patients. Unfortunately, corroborative information from the NHMS is unavailable since the NHMS 2011 report doesn't provide the detailed information on sex distribution by "usual place of treatment". Thus, we are unable to provide further explanation for this difference. We can only speculate that men may be less likely to seek conventional treatment, or only seek treatment when severe complications arise.[3]

Ethnicity and diabetes

In terms of distribution by ethnicity (**Table 2**), at 15.3% Indian patients are over-represented in the registry compared to overall national demographics. This was expected since patients of Indian ethnicity tend to have a higher risk of developing diabetes as compared to patients of Malay or Chinese descent.

Complications and co-morbidities

The accuracy of data on diabetes-related complications in the NDR still needs further work. In particular, the prevalence of diabetic foot ulcer is unexpectedly low in the dataset. Considering that this is a microvascular complication, it should at least match or exceed the prevalence of retinopathy and nephropathy. This could be explained by the high proportion of patients with "unknown" complications status in **Table 4**, i.e. the rates of unknown complications in 2012 were 12.3% for nephropathy, 15.2% for retinopathy, 12.8% for IHD, 12.5% for cerebrovascular disease, 11.1% for diabetic foot ulcer and 11.0% for amputation.

Since the methodology of the Diabetes Clinical Audit is heavily dependent on the quality of documentation of the patients' case notes, more emphasis should be placed on continually improving documentation by all healthcare providers providing care to patients with diabetes, regardless of level of care. This may also explain the lower than anticipated 4.9% prevalence of smoking among patients registered in the NDR (**Table 4**).

Clinical investigations

It was reassuring to see that the coverage of HbA_{1c} testing has slowly improved over the years. For 2012, about 78.0% of patients with T2DM had a HbA_{1c} test at least once annually, compared to 67.9% in 2009 (**Table 5**); however, there were variations between states (data not shown in this report).

In addition to HbA_{1c} testing, the Malaysian CPG for the Management of T2DM (2009) has clearly laid out the various clinical examination and investigations that needs to be carried out routinely to monitor the status of control and early detection of complications, including the frequency of testing. Most of these tests only need to be performed annually. The NDR dataset showed some issues which should be of concern because of the low coverage (**Table 5**). For example:

[2] Institute for Public Health (IPH) 2011. National Health and Morbidity Survey 2011 (NHMS 2011). Vol. II: Non-Communicable Diseases.

[3] Tong SF, Low WY, Ismail SB, Trevena L, Willcock S. Malaysian primary care doctors' views on men's health: an unresolved jigsaw puzzle. BMC Fam Pract. 2011 May 12;12:29. doi: 10.1186/1471-2296-12-2

(i) Proteinuria can easily be screened using a urine dipstick, a cheap item, and available even in the remotest KKs; however, in 2012, only 64.7% of patients were tested at least once annually.

(ii) Foot examination, as defined in the NDR, is a visual inspection of the feet, which can easily be done at least once a year by the healthcare provider. In 2012, only 73.0% of patients had their foot examined at least once annually.

(iii) Fundus examination can be done by using a funduscope and not necessarily by using a fundus camera. All medical officers should have the necessary skills to use a funduscope as a basic clinical skill and with most of KKs now staffed with permanent medical officers, we should expect the rates of fundus examination to be higher than 44% in 2012. However, there is an increasing trend as compared to 36.5% in 2009.

Treatment to Target

HbA_{1c} target achievement

In terms of glycaemic control, based on the Malaysian CPG on T2DM (2009) HbA_{1c} target of less than 6.5%, 23.8% of patients with T2DM achieved good control[4], as compared to 19.4% in 2009 (**Table 6**). In addition, the mean HbA_{1c} value, although still high, has been improving from 8.3% in 2009, to 8.1% in 2012 (**Table 7**). However, we should take note that the analysis of target achievement excludes patients who did not undergo HbA_{1c} testing, or have no HbA_{1c} results documented in their case notes. If we were to assume that patients who were not tested are more likely among those with poor glycaemic control, then the percentage achieving glycaemic target would be much lower.

There was much variation between states over the years in terms of HbA_{1c} achievement (**Table 7**); however this has to be interpreted with care since the coverage of HbA_{1c} testing also greatly differs between states (data not shown in this report). Since the allocation of resources to each individual state is in proportion to its disease burden, further study would be required to explain why such discrepancies are occurring. Despite this caveat, the dataset is still useful for each individual state to monitor the changing trends of HbA_{1c} achievements over time.

Cardiovascular target achievement

Compared to glycaemic control, BP control fared much better, with 40.9% of patients with T2DM achieving BP of 130/80 or fewer in 2012, with a mean systolic BP of 135.5 mmHg and diastolic BP of 78.4 mmHg (**Table 8**). Total cholesterol control, however was poorer, with only 28.5% of patients with T2DM achieving <4.5 mmol/L in 2012, with a mean total cholesterol of 5.2 mmol/L. The mean LDL and TG for 2012 were also high, at 3.1 mmol/L and 1.8 mmol/L respectively. BMI was the worse, with only 16.6% of patients with T2DM having a BMI <23 kg/m^2 in 2012, with a mean BMI of 27.4 kg/m^2. For waist circumference, few men and women achieved target. Among men 33.8% achieved waist circumference target compared to only 14.4% in women. A greater understanding of factors influencing cardiovascular target achievement rates is needed.

[4] Based on the numerator of T2DM patients with HbA_{1c} results. Patients who are not tested for HbA_{1c} or with no results are excluded from the analysis.

Treatment

Guidelines and treatment patterns

It is heartening to observe that insulin use has increased quite substantially between year 2010 to 2011, and increased further in 2012, in line with the recommendations of the Malaysian CPG on T2DM (4th edition) which was published in late 2009. Following the publication of this CPG, the CPG Task Force had undertaken extensive train-the-trainer sessions throughout the country in a concerted effort to disseminate the information as widely as possible, in a systematic manner. This was also aided by the publication of a Training Manual, complete with its set of presentation slides, to ensure consistency of the training content. In addition, a "Practical Guide to Insulin Therapy in Type 2 Diabetes Mellitus" (PGIT) was published in 2010, developed by a group of endocrinologists, and again, nation-wide training sessions followed suit.

Insulinisation

The 3rd Edition of the CPG on Management of T2DM recommended that insulin should only be considered in patients with poor glycaemic control after lifestyle modifications and maximum oral glucose-lowering therapy. In the 4th Edition of the CPG, the recommendation was changed and healthcare providers are now advised to start insulin early, especially for patients who have poor glycaemic control at diagnosis.

In terms of distribution of insulin use by states, although there is much variation between states, there is an overall increasing trend in all states (**Table 10**). Further and more detail studies would need to be conducted to explain these variations, and to determine the exact factor(s) contributing to the low insulin usage in several states, which could be due to patient barriers, healthcare provider barriers, health system barriers or other factors.

Diet management

It is also interesting to note that 5.9% of T2DM patients in 2012 appear to be on diet control only, an increase compared to 2009 and 2010 (**Table 9**). This is contradictory to the recommendation of the current CPG, which recommends early initiation of OADs, together with insulin where applicable. Again, further studies need to be conducted to ascertain the factors contributing to this situation.

Oral medications

In 2012, 27.0% of patients were on monotherapy. Changes over time reflected a decreasing trend on this point (**Table 9**). Metformin and sulphonylureas are the obvious OADs of choice as they are the most easily available drugs in the KKs. The anti-hypertensive drug of choice in patients with T2DM was ACE-I, which continues to be recommended in the current CPG. ARBs are used less as these drugs can only be prescribed by Family Medicine Specialists or physicians in the hospitals.

Limitations

As with any registry, there are certain limitations that can be seen with regards to this dataset. It must be noted that the registry is based on data collection in KKs and further reliant on records that are kept by the doctor or medical assistant who sees the patients. To the extent that the documentation in medical records is weak, there would be a related weakness in the registry dataset as well. The dataset tends not to contain information about hospital admissions which occur elsewhere in the MOH healthcare system. Hospital admissions and diagnoses related to in-patient treatment would tend to be missing unless the information is recorded in the patients' notes at the KKs.

One of the possible improvements needed for the NDR is a data query mechanism that would support good data collection processes and help to ensure accurate data entry. Furthermore, it would be advantageous to have in place a process to conduct source data verification that would ensure the data entered in the registry reflects that which is captured in the medical records.

Characteristics of a good registry have been described as (i) being able to support the condition of interest and track desired outcomes, (ii) an application that fits with technical and financial constraints, (iii) ensures up-to-date, complete and accurate patient information and (iv) integrates its use into the workflow of the setting.[5,6] It would seem that the registry is able to do well on several of the items mentioned above, with some improvements needed on point number (iii). On this point, improvement in medical record practices would be needed to ensure that corresponding improvements can be made in the NDR. Furthermore, the suggested data query mechanism would assist in this process. Data quality standards and errors within the system can also be improved. These are limitations that are not insurmountable, and would be further explored and can be improved, resource permitting.

[5] Metzger J. Using Computerized Registries in Chronic Disease Care, 2004.
[6] Arts DG et al. Defining and Improving Data Quality in Medical Registries: A Literature Review, Case Study, and Generic Framework, J Am Med Inform Assoc.2002;9:600–611.

Conclusions

Despite some limitations in the dataset, the NDR dataset is a useful tool for tracking the status of patients with diabetes being managed at MOH KKs. Furthermore, in order to limit the burden of data collection, the NDR has leveraged upon exisiting data collection requirements within the KK setting (Diabetes Clinical Audit and The National Diabetes Quality Assurance Programme). This approach along with limited sampling required, a web-based data entry system and automated random sampling has enabled useful data collection and tracking with relatively minimal effort.

The registry has been able to show that in the last four years there has been some progress made in terms of treatment target achievement and insulinisation among MOH patients with T2DM. There remain questions that may not be possible to be answered with the present NDR data. It is hoped that with the publication of this information, further exploration into these questions can be pursued.

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APPENDICES

Appendix 1: Participating KKs

No.	Facility
Johor	
Batu Pahat	
1	Klinik Kesihatan Ayer Hitam
2	Klinik Kesihatan Bagan
3	Klinik Kesihatan Batu Pahat
4	Klinik Kesihatan Parit Raja
5	Klinik Kesihatan Parit Sri Merlong
6	Klinik Kesihatan Parit Sulong
7	Klinik Kesihatan Parit Yaani
8	Klinik Kesihatan Rengit
9	Klinik Kesihatan Semerah
10	Klinik Kesihatan Senggarang
11	Klinik Kesihatan Sri Gading
12	Klinik Kesihatan Sri Medan
13	Klinik Kesihatan Tongkang Pecah
14	Klinik Kesihatan Yong Peng
Johor Bahru	
15	Klinik Kesihatan Gelang Patah
16	Klinik Kesihatan Kampung Majidee
17	Klinik Kesihatan Kempas
18	Klinik Kesihatan Larkin
19	Klinik Kesihatan Mahmoodiah
20	Klinik Kesihatan Masai
21	Klinik Kesihatan Pasir Gudang
22	Klinik Kesihatan Sultan Ismail
23	Klinik Kesihatan Taman Ungku Tun Aminah
24	Klinik Kesihatan Taman Universiti
25	Klinik Kesihatan Tampoi
26	Klinik Kesihatan Tebrau
27	Klinik Kesihatan Ulu Tiram
Kluang	
28	Klinik Kesihatan Felda Kahang Timur
29	Klinik Kesihatan Kahang Batu 22
30	Klinik Kesihatan Layang-Layang
31	Klinik Kesihatan Mengkibol
32	Klinik Kesihatan Paloh
33	Klinik Kesihatan Renggam
34	Klinik Kesihatan Simpang Renggam
35	Klinik Kesihatan Ulu Belitong

No.	Facility
Johor (cont.)	
Kota Tinggi	
36	Klinik Kesihatan Air Tawar 2
37	Klinik Kesihatan Bandar Mas
38	Klinik Kesihatan Bandar Penawar
39	Klinik Kesihatan Bandar Tenggara
40	Klinik Kesihatan Bukit Besar
41	Klinik Kesihatan Bukit Waha
42	Klinik Kesihatan Kuala Sedili Besar
43	Klinik Kesihatan Lok Heng
44	Klinik Kesihatan Pengerang
45	Klinik Kesihatan Sening
46	Klinik Kesihatan Sungai Rengit
47	Klinik Kesihatan Tanjong Sedili
Kulaijaya	
48	Klinik Kesihatan Kulai
49	Klinik Kesihatan Kulai Besar
Ledang	
50	Klinik Kesihatan Bukit Gambir
51	Klinik Kesihatan Bukit Serampang
52	Klinik Kesihatan Gersik
53	Klinik Kesihatan Paya Mas
54	Klinik Kesihatan Sagil
55	Klinik Kesihatan Sungai Mati
Mersing	
56	Klinik Kesihatan Endau
57	Klinik Kesihatan Jemaluang
58	Klinik Kesihatan Tenggaroh II (Felda)
59	Klinik Kesihatan Tenglu
Muar	
60	Klinik Kesihatan Bakri
61	Klinik Kesihatan Bandar Maharani
62	Klinik Kesihatan Batu 15 Air Hitam
63	Klinik Kesihatan Bukit Pasir
64	Klinik Kesihatan Kampung Kenangan Tun Dr.Ismail
65	Klinik Kesihatan Lenga
66	Klinik Kesihatan Pagoh
67	Klinik Kesihatan Parit Bakar
68	Klinik Kesihatan Parit Jawa

No.	Facility
Johor (cont.)	
69	Klinik Kesihatan Parit Yusof
70	Klinik Kesihatan Sri Menanti
Pontian	
71	Klinik Kesihatan Ayer Baloi
72	Klinik Kesihatan Benut
73	Klinik Kesihatan Kayu Ara Pasong
74	Klinik Kesihatan Parit Ismail
75	Klinik Kesihatan Pekan Nanas
76	Klinik Kesihatan Penerok
77	Klinik Kesihatan Pontian
78	Klinik Kesihatan Serkat
Segamat	
79	Klinik Kesihatan Bandar Putra
80	Klinik Kesihatan Batu Anam
81	Klinik Kesihatan Bekok
82	Klinik Kesihatan Buloh Kasap
83	Klinik Kesihatan Chaah
84	Klinik Kesihatan Jementah
85	Klinik Kesihatan Labis
86	Klinik Kesihatan Pekan Air Panas
87	Klinik Kesihatan Pemanis (Felda)
88	Klinik Kesihatan Segamat
Kedah	
Baling	
89	Klinik Kesihatan Kampung Lalang
90	Klinik Kesihatan Kuala Ketil
91	Klinik Kesihatan Kupang
92	Klinik Kesihatan Malau
93	Klinik Kesihatan Parit Panjang
94	Klinik Kesihatan Tawar
Bandar Baharu	
95	Klinik Kesihatan Bandar Bharu
96	Klinik Kesihatan Lubuk Buntar
97	Klinik Kesihatan Serdang
Kota Setar	
98	Klinik Kesihatan Alor Janggus
99	Klinik Kesihatan Bandar Alor Setar
100	Klinik Kesihatan Datuk Kumbar
101	Klinik Kesihatan Jalan Putra
102	Klinik Kesihatan Kota Sarang Semut
103	Klinik Kesihatan Kuala Kedah
104	Klinik Kesihatan Langgar
105	Klinik Kesihatan Pokok Sena

No.	Facility
Kedah (cont.)	
106	Klinik Kesihatan Simpang Empat
107	Klinik Kesihatan Simpang Kuala
Kuala Muda	
108	Klinik Kesihatan Bakar Arang
109	Klinik Kesihatan Bandar Sg.Petani
110	Klinik Kesihatan Bedong
111	Klinik Kesihatan Bukit Selambau
112	Klinik Kesihatan Kota Kuala Muda
113	Klinik Kesihatan Merbok
114	Klinik Kesihatan Sungai Lalang
Kubang Pasu	
115	Klinik Kesihatan Ayer Hitam
116	Klinik Kesihatan Banai
117	Klinik Kesihatan Changloon
118	Klinik Kesihatan Kepala Batas
119	Klinik Kesihatan Kodiang
120	Klinik Kesihatan Laka Temin
121	Klinik Kesihatan Tunjang
Kulim	
122	Klinik Kesihatan Karangan
123	Klinik Kesihatan Kulim
124	Klinik Kesihatan Lunas
125	Klinik Kesihatan Mahang
126	Klinik Kesihatan Merbau Pulas
127	Klinik Kesihatan Padang Serai
128	Klinik Kesihatan Taman Selasih
Langkawi	
129	Klinik Kesihatan Air Hangat
130	Klinik Kesihatan Kuah
131	Klinik Kesihatan Padang Matsirat
Padang Terap	
132	Klinik Kesihatan Lubuk Merbau
133	Klinik Kesihatan Naka
Pendang	
134	Klinik Kesihatan Kubur Panjang
135	Klinik Kesihatan Pendang
136	Klinik Kesihatan Sungai Tiang
Sik	
137	Klinik Kesihatan Gulau
138	Klinik Kesihatan Jeniang
Yan	
139	Klinik Kesihatan Guar Chempedak
140	Klinik Kesihatan Sungai Limau Dalam

No.	Facility
Kelantan	
Bachok	
141	Klinik Kesihatan Bachok
142	Klinik Kesihatan Balai
143	Klinik Kesihatan Beris
144	Klinik Kesihatan Beris Panchor
145	Klinik Kesihatan Gunong
146	Klinik Kesihatan Mahligai
Gua Musang	
147	Klinik Kesihatan Aring 2
148	Klinik Kesihatan Bertam Baru
149	Klinik Kesihatan Chiku 3
150	Klinik Kesihatan Gua Musang
151	Klinik Kesihatan Jeram Tekoh
Jeli	
152	Klinik Kesihatan Ayer Lanas
153	Klinik Kesihatan Jeli
154	Klinik Kesihatan Kuala Balah
Kota Bharu	
155	Klinik Kesihatan Badang
156	Klinik Kesihatan Bandar
157	Klinik Kesihatan Cabang 3 Perol
158	Klinik Kesihatan Kedai Lalat
159	Klinik Kesihatan Ketereh
160	Klinik Kesihatan Kok Lanas
161	Klinik Kesihatan Kubang Kerian
162	Klinik Kesihatan Lundang Paku
163	Klinik Kesihatan Penambang
164	Klinik Kesihatan Pengkalan Chepa
165	Klinik Kesihatan Peringat
166	Klinik Kesihatan Wakaf Che Yeh
Kuala Krai	
167	Klinik Kesihatan Bandar
168	Klinik Kesihatan Dabong
169	Klinik Kesihatan Manik Urai
170	Klinik Kesihatan Pahi
Machang	
171	Klinik Kesihatan Batu 30
172	Klinik Kesihatan Labok
173	Klinik Kesihatan Pulai Chondong
174	Klinik Kesihatan Temangan
Pasir Mas	
175	Klinik Kesihatan Bandar
176	Klinik Kesihatan Chekok

No.	Facility
Kelantan (cont.)	
177	Klinik Kesihatan Kangkong
178	Klinik Kesihatan Meranti
179	Klinik Kesihatan Rantau Panjang
180	Klinik Kesihatan Tendong
181	Klinik Kesihatan Tok Uban
Pasir Puteh	
182	Klinik Kesihatan Cherang Ruku
183	Klinik Kesihatan Gaal
184	Klinik Kesihatan Jeram
185	Klinik Kesihatan Selising
Tanah Merah	
186	Klinik Kesihatan Batu Gajah
187	Klinik Kesihatan Gual Ipoh
188	Klinik Kesihatan Kemahang
Tumpat	
189	Klinik Kesihatan Bandar
190	Klinik Kesihatan Bunohan
191	Klinik Kesihatan Pengkalan Kubor
192	Klinik Kesihatan Sungai Pinang
193	Klinik Kesihatan Wakaf Bharu
Melaka	
Alor Gajah	
194	Klinik Kesihatan Durian Tunggal
195	Klinik Kesihatan Hutan Percha
196	Klinik Kesihatan Kuala Sungai Baru
197	Klinik Kesihatan Lubok China
198	Klinik Kesihatan Macap Baru
199	Klinik Kesihatan Masjid Tanah
200	Klinik Kesihatan Padang Sebang
201	Klinik Kesihatan Simpang Ampat
Jasin	
202	Klinik Kesihatan Jasin
203	Klinik Kesihatan Kemendor
204	Klinik Kesihatan Merlimau
205	Klinik Kesihatan Selandar
206	Klinik Kesihatan Simpang Bekoh
207	Klinik Kesihatan Sungai Rambai
208	Klinik Kesihatan Umbai
Melaka Tengah	
209	Klinik Kesihatan Ayer Keroh
210	Klinik Kesihatan Ayer Molek
211	Klinik Kesihatan Bukit Rambai
212	Klinik Kesihatan Cheng

No.	Facility
Melaka (cont.)	
213	Klinik Kesihatan Jalan Gereja
214	Klinik Kesihatan Klebang Besar
215	Klinik Kesihatan Peringgit
216	Klinik Kesihatan Sungai Udang
217	Klinik Kesihatan Tanjung Kling
218	Klinik Kesihatan Tengkera
219	Klinik Kesihatan Ujong Pasir
Negeri Sembilan	
Jelebu	
220	Klinik Kesihatan Jelebu
221	Klinik Kesihatan Pasoh 1
222	Klinik Kesihatan Pertang
223	Klinik Kesihatan Simpang Durian
224	Klinik Kesihatan Titi
Jempol	
225	Klinik Kesihatan Bahau
226	Klinik Kesihatan Bandar Seri Jempol
227	Klinik Kesihatan Lui Muda
228	Klinik Kesihatan Palong 4,5,6
229	Klinik Kesihatan Palong 7&8(Felda)
230	Klinik Kesihatan Palong 9,10,11
231	Klinik Kesihatan Serting Hilir
Kuala Pilah	
232	Klinik Kesihatan Gunung Pasir
233	Klinik Kesihatan Johol
234	Klinik Kesihatan Juasseh
235	Klinik Kesihatan Kuala Pilah
236	Klinik Kesihatan Padang Lebar
237	Klinik Kesihatan Senaling
238	Klinik Kesihatan Sri Menanti
239	Klinik Kesihatan Terachi
Port Dickson	
240	Klinik Kesihatan Bukit Pelanduk
241	Klinik Kesihatan Linggi
242	Klinik Kesihatan Lukut
243	Klinik Kesihatan Pasir Panjang
244	Klinik Kesihatan Port Dickson
Rembau	
245	Klinik Kesihatan Astana Raja
246	Klinik Kesihatan Kota
247	Klinik Kesihatan Pedas
248	Klinik Kesihatan Rembau
Seremban	

No.	Facility
Negeri Sembilan (cont.)	
249	Klinik Kesihatan Ampangan
250	Klinik Kesihatan Desa Rhu
251	Klinik Kesihatan Lenggeng
252	Klinik Kesihatan Mantin
253	Klinik Kesihatan Nilai
254	Klinik Kesihatan Qrts KLIA
255	Klinik Kesihatan Rantau
256	Klinik Kesihatan Senawang
257	Klinik Kesihatan Sendayan (Felda)
258	Klinik Kesihatan Seremban
259	Klinik Kesihatan Seremban 2
Tampin	
260	Klinik Kesihatan Air Kuning
261	Klinik Kesihatan Gemas
262	Klinik Kesihatan Gemenchih
263	Klinik Kesihatan Jelai
264	Klinik Kesihatan Tampin (JPL)
Pahang	
Bentong	
265	Klinik Kesihatan Bentong
266	Klinik Kesihatan Karak
267	Klinik Kesihatan Lurah Bilut (Felda)
268	Klinik Kesihatan Mempaga
269	Klinik Kesihatan Simpang Pelangai
Bera	
270	Klinik Kesihatan Bandar Bera 32
271	Klinik Kesihatan Bukit Mendi
272	Klinik Kesihatan Kemayan
273	Klinik Kesihatan Padang Luas
274	Klinik Kesihatan Purun
275	Klinik Kesihatan Triang
Cameron Highlands	
276	Klinik Kesihatan Tanah Rata
Jerantut	
277	Klinik Kesihatan Damak
278	Klinik Kesihatan Jengka 8
279	Klinik Kesihatan Kampung Bantal
280	Klinik Kesihatan Kuala Tahan
281	Klinik Kesihatan Kuala Tembeling
282	Klinik Kesihatan Lepar Utara 4
283	Klinik Kesihatan Sungai Tekam Utara
Kuantan	
284	Klinik Kesihatan Balok

No.	Facility
Pahang (cont.)	
285	Klinik Kesihatan Bandar Kuantan
286	Klinik Kesihatan Beserah
287	Klinik Kesihatan Bukit Goh (Felda)
288	Klinik Kesihatan Gambang
289	Klinik Kesihatan Jaya Gading
290	Klinik Kesihatan Kurnia
291	Klinik Kesihatan Paya Besar
292	Klinik Kesihatan Sungai Lembing
Lipis	
293	Klinik Kesihatan Benta
294	Klinik Kesihatan Bukit Betong
295	Klinik Kesihatan Mela
296	Klinik Kesihatan Merapoh (Fasa 1)
297	Klinik Kesihatan Padang Tengku
298	Klinik Kesihatan Sungai Koyan
Maran	
299	Klinik Kesihatan Bandar Jengka
300	Klinik Kesihatan Chenor
301	Klinik Kesihatan Jengka 2
302	Klinik Kesihatan Jengka 22
303	Klinik Kesihatan Maran
304	Klinik Kesihatan Pekan Awah
305	Klinik Kesihatan Pekan Tajau
Pekan	
306	Klinik Kesihatan Cini
307	Klinik Kesihatan Nenasi
308	Klinik Kesihatan Padang Rumbia
309	Klinik Kesihatan Pekan
310	Klinik Kesihatan Peramu Jaya
Raub	
311	Klinik Kesihatan Bukit Fraser
312	Klinik Kesihatan Cheroh
313	Klinik Kesihatan Dong
314	Klinik Kesihatan Jeruas
315	Klinik Kesihatan Lembah Klau
316	Klinik Kesihatan Tersang
317	Klinik Kesihatan Ulu Gali
Rompin	
318	Klinik Kesihatan Bandar Tun Abdul Razak
319	Klinik Kesihatan Bukit Ibam
320	Klinik Kesihatan Chanis
321	Klinik Kesihatan Perantau Damai

No.	Facility
Pahang (cont.)	
322	Klinik Kesihatan Perwira Jaya
323	Klinik Kesihatan Rompin
324	Klinik Kesihatan Tanjung Gemok
325	Klinik Kesihatan Tekek
Temerloh	
326	Klinik Kesihatan Bandar Mentakab
327	Klinik Kesihatan Kuala Krau
328	Klinik Kesihatan Lanchang
329	Klinik Kesihatan Sanggang
330	Klinik Kesihatan Simpang Songsang
331	Klinik Kesihatan Temerloh
Perak	
Batang Padang	
332	Klinik Kesihatan Bidor
333	Klinik Kesihatan Gunung Besout
334	Klinik Kesihatan Slim River
335	Klinik Kesihatan Sungkai
336	Klinik Kesihatan Tanjung Malim
337	Klinik Kesihatan Tapah
338	Klinik Kesihatan Trolak (Felda)
Hilir Perak	
339	Klinik Kesihatan Bagan Datoh
340	Klinik Kesihatan Chenderong Balai
341	Klinik Kesihatan Hutan Melintang
342	Klinik Kesihatan Langkap
343	Klinik Kesihatan Selekoh
344	Klinik Kesihatan Sungai Sumun
345	Klinik Kesihatan Teluk Intan
Hulu Perak	
346	Klinik Kesihatan Lawin
347	Klinik Kesihatan Lenggong
348	Klinik Kesihatan Pengkalan Hulu
349	Klinik Kesihatan Plang
Kerian	
350	Klinik Kesihatan Alor Pongsu
351	Klinik Kesihatan Bagan Serai
352	Klinik Kesihatan Gunung Semanggol
353	Klinik Kesihatan Jalan Baru
354	Klinik Kesihatan Kedai Empat
355	Klinik Kesihatan Kuala Gula
356	Klinik Kesihatan Kuala Kurau
357	Klinik Kesihatan Teluk Medan 1
358	Klinik Kesihatan Tg. Piandang

No.	Facility
Perak (cont.)	
Kinta	
359	Klinik Kesihatan Bijih Timah
360	Klinik Kesihatan Buntong
361	Klinik Kesihatan Chemor
362	Klinik Kesihatan Gopeng
363	Klinik Kesihatan Greentown
364	Klinik Kesihatan Gunung Rapat
365	Klinik Kesihatan Jelapang
366	Klinik Kesihatan Kampar
367	Klinik Kesihatan Kampung Simee
368	Klinik Kesihatan Kota Bharu
369	Klinik Kesihatan Malim Nawar
370	Klinik Kesihatan Manjoi
371	Klinik Kesihatan Menglembu
372	Klinik Kesihatan Pasir Pinji
373	Klinik Kesihatan Tanjung Rambutan
374	Klinik Kesihatan Tanjung Tualang
375	Klinik Kesihatan Tronoh
Kuala Kangsar	
376	Klinik Kesihatan Karai
377	Klinik Kesihatan Lintang
378	Klinik Kesihatan Manong
379	Klinik Kesihatan Padang Rengas
380	Klinik Kesihatan Sauk
Larut Matang	
381	Klinik Kesihatan Batu Kurau
382	Klinik Kesihatan Changkat Jering
383	Klinik Kesihatan Kamunting
384	Klinik Kesihatan Kuala Sepetang
385	Klinik Kesihatan Pokok Assam
386	Klinik Kesihatan Redang Panjang
387	Klinik Kesihatan Selama
388	Klinik Kesihatan Sungai Bayor
389	Klinik Kesihatan Sungai Kerang
390	Klinik Kesihatan Taiping
391	Klinik Kesihatan Trong
Manjung	
392	Klinik Kesihatan Ayer Tawar
393	Klinik Kesihatan Bruas
394	Klinik Kesihatan Changkat Kruing
395	Klinik Kesihatan Lekir
396	Klinik Kesihatan Pantai Remis
397	Klinik Kesihatan Pulau Pangkor

No.	Facility
Perak (cont.)	
398	Klinik Kesihatan Sitiawan
Perak Tengah	
399	Klinik Kesihatan Bota Kiri
400	Klinik Kesihatan Changkat Lada
401	Klinik Kesihatan Kampung Gajah
402	Klinik Kesihatan Lambor Kiri
403	Klinik Kesihatan Parit
404	Klinik Kesihatan Ulu Dedap
Perlis	
Perlis	
405	Klinik Kesihatan Arau
406	Klinik Kesihatan Beseri
407	Klinik Kesihatan Kaki Bukit
408	Klinik Kesihatan Kampung Gial
409	Klinik Kesihatan Kangar
410	Klinik Kesihatan Kuala Perlis
411	Klinik Kesihatan Kuala Sanglang
412	Klinik Kesihatan Padang Besar
413	Klinik Kesihatan Simpang Empat
Pulau Pinang	
Barat Daya	
414	Klinik Kesihatan Bayan Baru
415	Klinik Kesihatan Bayan Lepas
416	Klinik Kesihatan Teluk Bahang
Seberang Perai Selatan	
417	Klinik Kesihatan Bandar Tasek Mutiara
418	Klinik Kesihatan Bukit Panchor
419	Klinik Kesihatan Nibong Tebal
420	Klinik Kesihatan Sungai Acheh
Seberang Perai Tengah	
421	Klinik Kesihatan Berapit
422	Klinik Kesihatan Bukit Minyak
423	Klinik Kesihatan Kubang Semang
424	Klinik Kesihatan Prai
425	Klinik Kesihatan Seberang Jaya
Seberang Perai Utara	
426	Klinik Kesihatan Butterworth
427	Klinik Kesihatan Kepala Batas
428	Klinik Kesihatan Mak Mandin
429	Klinik Kesihatan Penaga
430	Klinik Kesihatan Sungai Dua
431	Klinik Kesihatan Tasek Gelugor
Timur Laut	

No.	Facility
Perak (cont.)	
432	Klinik Kesihatan Air Itam
433	Klinik Kesihatan Bandar Baru Air Itam
434	Klinik Kesihatan Bukit Bendera
435	Klinik Kesihatan Bukit Jambul
436	Klinik Kesihatan Jalan Macalister
437	Klinik Kesihatan Jalan Perak
438	Klinik Kesihatan Lebuh Muntri
439	Klinik Kesihatan Sungai Dua
440	Klinik Kesihatan Tanjung Bungah
Sabah	
Beaufort	
441	Klinik Kesihatan Membakut, Beaufort
442	Klinik Kesihatan Menumbok, Kuala Penyu
Beluran	
443	Klinik Kesihatan Telupid, Beluran
Keningau	
444	Klinik Kesihatan Sook, Keningau
Kinabatangan	
445	Klinik Kesihatan Sukau, Kinabatangan
Kota Belud	
446	Klinik Kesihatan Jawi-Jawi, Kota Belud
447	Klinik Kesihatan Taginambur, Kota Belud
Kota Kinabalu	
448	Klinik Kesihatan Inanam
449	Klinik Kesihatan Luyang
450	Klinik Kesihatan Menggatal
451	Klinik Kesihatan Telipok
Kudat	
452	Klinik Kesihatan Karakit, Kudat
Lahad Datu	
453	Klinik Kesihatan Lahad Datu, Lahad Datu
Nabawan	
454	Klinik Kesihatan Nabawan
455	Klinik Kesihatan Sepulot, Nabawan
Papar	
456	Klinik Kesihatan Bongawan
457	Klinik Kesihatan Kinarut
Penampang	
458	Klinik Kesihatan Penampang
459	Klinik Kesihatan Putatan, Penampang
Ranau	

No.	Facility
Sabah (cont.)	
460	Klinik Kesihatan Bundu Tuhan, Ranau
461	Klinik Kesihatan Kaingaran, Ranau
462	Klinik Kesihatan Kundasang, Ranau
463	Klinik Kesihatan Perancangan, Ranau
464	Klinik Kesihatan Timbua, Ranau
Sandakan	
465	Klinik Kesihatan Sandakan
466	Klinik Kesihatan Suan Lamba, Sandakan
467	Klinik Kesihatan Sungai Manila, Sandakan
468	Klinik Kesihatan Ulu Dusun, Sandakan
Semporna	
469	Klinik Kesihatan Semporna
Tawau	
470	Klinik Kesihatan Apas Balung
471	Klinik Kesihatan Felda Umas-Umas, Tawau
472	Klinik Kesihatan Merotai Besar
Tongod	
473	Klinik Kesihatan Tongod
Tuaran	
474	Klinik Kesihatan Kiulu, Tuaran
475	Klinik Kesihatan Tamparuli, Tuaran
476	Klinik Kesihatan Tenghilan, Tuaran
Sarawak	
Asajaya	
477	Klinik Kesihatan Asajaya
478	Klinik Kesihatan Jemukan
Belaga	
479	Klinik Kesihatan Belaga
480	Klinik Kesihatan Sungai Koyan
Betong	
481	Klinik Kesihatan Debak
482	Klinik Kesihatan Pusa
483	Klinik Kesihatan Tuie
Bintulu	
484	Klinik Kesihatan Bintulu
Dalat	
485	Klinik Kesihatan Kuala Oya
Daro	
486	Klinik Kesihatan Daro
Kanowit	
487	Klinik Kesihatan Machan

No.	Facility
Sarawak (cont.)	
Kapit	
488	Klinik Kesihatan Kapit
489	Klinik Kesihatan Tunoh Scheme
Kuching	
490	Klinik Kesihatan Batu Kawa
491	Klinik Kesihatan Biawak
492	Klinik Kesihatan Jalan Masjid
493	Klinik Kesihatan Kota Sentosa
494	Klinik Kesihatan Padawan
495	Klinik Kesihatan Sampadi
496	Klinik Kesihatan Sematan
497	Klinik Kesihatan Serasot
498	Klinik Kesihatan Tanah Puteh
Lawas	
499	Klinik Kesihatan Lawas
Limbang	
500	Klinik Kesihatan Nanga Medamit
Lubuk Antu	
501	Klinik Kesihatan Nanga Kesit
Marudi	
502	Klinik Kesihatan Long Lama
503	Klinik Kesihatan Long Naah
504	Klinik Kesihatan Long San
Matu	
505	Klinik Kesihatan Nanga Passin
Meradong	
506	Klinik Kesihatan Bintangor
Miri	
507	Klinik Kesihatan Bandar Miri
508	Klinik Kesihatan Batu Niah
509	Klinik Kesihatan Bekenu
510	Klinik Kesihatan Tudan
Mukah	
511	Klinik Kesihatan Balingian
Samarahan	
512	Klinik Kesihatan Kota Samarahan
Saratok	
513	Klinik Kesihatan Kabong
514	Klinik Kesihatan Roban
Sarikei	
515	Klinik Kesihatan Jalan Hospital, Sarikei
Selangau	
516	Klinik Kesihatan Selangau

No.	Facility
Sarawak (cont.)	
517	Klinik Kesihatan Sungai Arip
Serian	
518	Klinik Kesihatan Balai Ringin
519	Klinik Kesihatan Bunan Gega
520	Klinik Kesihatan Pangkalan Amo
521	Klinik Kesihatan Tebedu
Sibu	
522	Klinik Kesihatan Jalan Lanang
523	Klinik Kesihatan Jalan Oya
524	Klinik Kesihatan Passai Siong
Simunjan	
525	Klinik Kesihatan Munggu Lallang
Song	
526	Klinik Kesihatan Nanga Tekalit
527	Klinik Kesihatan Song
Sri Aman	
528	Klinik Kesihatan Sri Aman
Tatau	
529	Klinik Kesihatan Sangan
530	Klinik Kesihatan Tatau
Selangor	
Gombak	
531	Klinik Kesihatan AU2
532	Klinik Kesihatan Batu Arang
533	Klinik Kesihatan Kuang
534	Klinik Kesihatan Rawang
535	Klinik Kesihatan Selayang Baru
536	Klinik Kesihatan Sungai Buloh
537	Klinik Kesihatan Taman Ehsan
538	Klinik Kesihatan Taman Kenangan
Hulu Langat	
539	Klinik Kesihatan Ampang
540	Klinik Kesihatan Bandar Baru Bangi
541	Klinik Kesihatan Bandar Seri Putra
542	Klinik Kesihatan Batu 9
543	Klinik Kesihatan Beranang
544	Klinik Kesihatan Hulu Langat
545	Klinik Kesihatan Kajang
546	Klinik Kesihatan Semenyih
547	Klinik Kesihatan Sg Chua
Hulu Selangor	
548	Klinik Kesihatan Kalumpang
549	Klinik Kesihatan Rasa

No.	Facility
Selangor (cont.)	
550	Klinik Kesihatan Serendah
551	Klinik Kesihatan Soeharto
552	Klinik Kesihatan Sungai Selisek
553	Klinik Kesihatan Ulu Yam Bharu
Klang	
554	Klinik Kesihatan Bandar Botanik
555	Klinik Kesihatan Bukit Kuda
556	Klinik Kesihatan Kapar
557	Klinik Kesihatan Klang
558	Klinik Kesihatan Meru
559	Klinik Kesihatan Pandamaran
560	Klinik Kesihatan Pelabuhan Klang
561	Klinik Kesihatan Pulau Indah
562	Klinik Kesihatan Pulau Ketam
Kuala Langat	
563	Klinik Kesihatan Bukit Changgang
564	Klinik Kesihatan Jenjarom
565	Klinik Kesihatan Kampung Bandar
566	Klinik Kesihatan Sijangkang
567	Klinik Kesihatan Tanjung Sepat
568	Klinik Kesihatan Telok Datok
569	Klinik Kesihatan Telok Panglima Garang
Kuala Selangor	
570	Klinik Kesihatan Bestari Jaya
571	Klinik Kesihatan Ijok
572	Klinik Kesihatan Jeram
573	Klinik Kesihatan Kuala Selangor
574	Klinik Kesihatan Tanjung Karang
Petaling	
575	Klinik Kesihatan Kelana Jaya
576	Klinik Kesihatan Medan Maju Jaya
577	Klinik Kesihatan Puchong
578	Klinik Kesihatan Seksyen 19
579	Klinik Kesihatan Seri Kembangan
580	Klinik Kesihatan Shah Alam
Sabak Bernam	
581	Klinik Kesihatan Bagan Terap
582	Klinik Kesihatan Parit Baru
583	Klinik Kesihatan Sabak Bernam
584	Klinik Kesihatan Sekinchan
585	Klinik Kesihatan Sungai Air Tawar
586	Klinik Kesihatan Sungai Besar

No.	Facility
Selangor (cont.)	
Sepang	
587	Klinik Kesihatan Dengkil
588	Klinik Kesihatan Salak
589	Klinik Kesihatan Sungai Pelek
Terengganu	
Besut	
590	Klinik Kesihatan Jabi
591	Klinik Kesihatan Kg. Raja Besut
592	Klinik Kesihatan Kuala Besut
593	Klinik Kesihatan Pasir Akar
594	Klinik Kesihatan Sri Medang
Dungun	
595	Klinik Kesihatan Almuktafi Billah Shah
596	Klinik Kesihatan Bukit Besi
597	Klinik Kesihatan Jerangau
598	Klinik Kesihatan Ketengah Jaya
599	Klinik Kesihatan Kuala Abang
600	Klinik Kesihatan Kuala Dungun
601	Klinik Kesihatan Paka
Hulu Terengganu	
602	Klinik Kesihatan Ajil
603	Klinik Kesihatan Kuala Berang
604	Klinik Kesihatan Telemong
605	Klinik Kesihatan Tengkawang
Kemaman	
606	Klinik Kesihatan Air Puteh
607	Klinik Kesihatan Batu 2 1/2
608	Klinik Kesihatan Cheneh
609	Klinik Kesihatan Chukai
610	Klinik Kesihatan Kemasik
611	Klinik Kesihatan Kerteh
612	Klinik Kesihatan Kijal
613	Klinik Kesihatan Kuala Kemaman
614	Klinik Kesihatan Sri Bandi
Kuala Terengganu	
615	Klinik Kesihatan Batu Rakit
616	Klinik Kesihatan Bukit Tunggal
617	Klinik Kesihatan Hiliran
618	Klinik Kesihatan Manir
619	Klinik Kesihatan Seberang Takir
Marang	
620	Klinik Kesihatan Bukit Payong
621	Klinik Kesihatan Marang

No.	Facility
Terengganu (cont.)	
622	Klinik Kesihatan Merchang
623	Klinik Kesihatan Pengkalan Berangan
624	Klinik Kesihatan Wakaf Tapai
Setiu	
625	Klinik Kesihatan Bandar Permaisuri
626	Klinik Kesihatan Kampung Rahmat
627	Klinik Kesihatan Sri Langkap
628	Klinik Kesihatan Sungai Tong
WP Kuala Lumpur	
Kuala Lumpur	
629	Klinik Kesihatan Bandar Tun Razak
630	Klinik Kesihatan Batu
631	Klinik Kesihatan Cheras
632	Klinik Kesihatan Cheras Baru

No.	Facility
WP Kuala Lumpur (cont.)	
633	Klinik Kesihatan Datok Keramat
634	Klinik Kesihatan Jinjang
635	Klinik Kesihatan Kampung Pandan
636	Klinik Kesihatan Pantai
637	Klinik Kesihatan Petaling Bahagia
638	Klinik Kesihatan Sentul
639	Klinik Kesihatan Setapak
640	Klinik Kesihatan Sungai Besi
641	Klinik Kesihatan Tanglin
WP Labuan	
Labuan	
642	Klinik Kesihatan Jenis III
WP Putrajaya	
Putrajaya	
643	Klinik Kesihatan Presint 11
644	Klinik Kesihatan Putrajaya

Appendix 2: Patient Registration CRF

NDR/Register/version_1.0/2010

DIABETES PATIENT REGISTRATION FORM

Health Facility: _____

Name of Patient: _____ IC No.: _____

Date of Birth: _____ Sex: Male / Female

Date Diabetes Diagnosed: _____ Ethnicity: _____

estimate/presumed* ☐

Type of Diabetes: Type 2 / Type 1 / Others: (please specify _____)

Status of Complications at Diagnosis

Complication	Present	Absent	Not Known	If Present, date of diagnosis	Estimate/ presumed
Retinopathy	☐	☐	☐	/ /	☐
Ischaemic heart disease	☐	☐	☐	/ /	☐
Cerebrovascular disease	☐	☐	☐	/ /	☐
Nephropathy	☐	☐	☐	/ /	☐
Diabetic foot ulcer	☐	☐	☐	/ /	☐
Amputation	☐	☐	☐	/ /	☐

Concomitant Co-morbidity	Yes	No	Not Known	If Yes, date of diagnosis	Estimate/ presumed
Hypertension	☐	☐	☐	/ /	☐
Dyslipidaemia	☐	☐	☐	/ /	☐
Smoking status	☐	☐	☐		

Signature:

Name: _____ Date: _____

* **Estimate/presumed**: If exact date not known and only the year is known, please fill date as 30/06/yyyy and tick the adjacent box

Appendix 3: Outcome Update CRF

NDR/Update/version_1.0/2010

DIABETES OUTCOME UPDATE FORM

Health Facility : _____

Name of patient : _____ IC No. : _____

Complication	Present	Absent	Not known	If Present, date of diagnosis	Estimate/ presumed
Retinopathy	☐	☐	☐	/ /	☐
Ischaemic heart disease	☐	☐	☐	/ /	☐
Cerebrovascular disease	☐	☐	☐	/ /	☐
Nephropathy	☐	☐	☐	/ /	☐
Diabetic foot ulcer	☐	☐	☐	/ /	☐
Amputation	☐	☐	☐	/ /	☐
Concomitant Co-Morbidity	**Yes**	**No**	**Not known**	**If Yes, date of diagnosis**	**Estimate/ presumed**
Hypertension	☐	☐	☐	/ /	☐
Dyslipidaemia	☐	☐	☐	/ /	☐
Smoking status	☐	☐	☐		

Follow-up Status		
On active follow-up ☐		
Loss to follow-up ☐	Transferred care (government)	☐
Date of last visit: _____	Transferred care (private)	☐
	Self-treatment	☐
	Others	☐
	Reason not known	☐
Died ☐	Related to Diabetes	☐
Date of death: _____	Not related to Diabetes	☐
	Not known	☐

Signature:

Name: _____ Date: _____

* **Estimate/presumed**: If exact date not known and only the year is known, please fill date as 30/06/yyyy and tick the adjacent box

Appendix 4: Clinical Audit CRF

Audit Form No._____

NDR/Audit/version_1.0/2010

DIABETES CLINICAL AUDIT

Health Facility: _____ Clinic Type: FMS / MO / AMO

Name of Patient: _____ IC No.: _____

Date of Birth: _____ Sex: Male / Female

Date Diabetes Diagnosed: _____ Ethnicity: _____

*estimate/presumed ☐

Criteria		Latest results	Date of latest results (past 1 year)	Not done
Height		cm		☐
Weight		kg	/ /	☐
Waist circumference		cm	/ /	☐
Body Mass Index (BMI)		kg/m²	/ /	☐
Blood pressure		mmHg	/ /	☐
Random Blood Sugar (RBS)		mmol/L	/ /	☐
Fasting Blood Sugar (FBS)		mmol/L	/ /	☐
2-hour Post Prandial (2HPP)		mmol/L	/ /	☐
HbA_{1c}		%	/ /	☐
Serum cholesterol	Total:	mmol/L	/ /	☐
	TG:	mmol/L	/ /	☐
	HDL:	mmol/L	/ /	☐
	LDL:	mmol/L	/ /	☐
Creatinine		µmol/l	/ /	☐
Microalbuminuria		Positive / negative	/ /	☐
Proteinuria		Positive / negative	/ /	☐
Fundus examination		Normal / abnormal	/ /	☐
Foot examination		Normal / abnormal	/ /	☐
ECG test		Normal / abnormal	/ /	☐
Screening for Erectile Dysfuntion		Normal / abnormal	/ /	☐

Patient examined by MO at least once within 1 year of audit	☐ Yes ☐ No

* **Estimate/presumed**: If exact date not known and only the year is known, please fill date as 30/06/yyyy and tick the adjacent box

Note: For Diabetes-related complications, date of diagnosis can be at any point in time after diagnosis of diabetes.

Complication	Present	Absent	Not known	If PRESENT, date of diagnosis	*Estimate/ presumed
Retinopathy	☐	☐	☐	/ /	☐
Ischaemic heart disease	☐	☐	☐	/ /	☐
Cerebrovascular disease	☐	☐	☐	/ /	☐
Nephropathy	☐	☐	☐	/ /	☐
Diabetic foot ulcer	☐	☐	☐	/ /	☐
Amputation	☐	☐	☐	/ /	☐

Concomitant Co-morbidity	Yes	No	Not known	If YES, date of diagnosis	*Estimate/ presumed
Hypertension	☐	☐	☐	/ /	☐
Dyslipidaemia	☐	☐	☐	/ /	☐

Diabetes medications	Yes
Biguanides (e.g. metformin)	☐
Sulphonylureas (e.g. glibenclamide)	☐
α-glucosidase inhibitors (acarbose)	☐
Meglitinides (e.g. repaglinide)	☐
Glitazones (e.g. rosiglitazones)	☐
Others:_____	☐
Insulin	☐
Anti-platelets	**Yes**
Acetyl salicylate acid (aspirin)	☐
Ticlopidine	☐
Others:_____	☐

Anti-hypertensives	Yes
ACE-Inhibitor	☐
ARB	☐
Beta-blockers	☐
Calcium channel blockers	☐
Diuretics	☐
Alpha-blockers	☐
Centrally acting	☐
Others:_____	☐
Lipid-lowering agents	**Yes**
Statin	☐
Fibrate	☐
Others:_____	☐

Signature :

Name :_____ Date of audit :_____

* **Estimate/presumed**: If exact date not known and only the year is known, please fill date as 30/06/yyyy and tick the adjacent box

Appendix 5: Sample size determination for Clinical Audit

No. of active patients in a district	Sample size for district	%
200	162	81.0
300	223	74.3
400	273	68.3
500	317	63.4
600	354	59.0
700	387	55.3
800	415	51.9
900	441	49.0
1,000	464	46.4
1,500	548	36.5
2,000	604	30.2
3,000	671	22.4
4,000	711	17.8
5,000	737	14.7
6,000	755	12.6
7,000	769	11.0
8,000	780	9.8
9,000	789	8.8
10,000	796	8.0
15,000	817	5.4
20,000	829	4.1
25,000	835	3.3
30,000	840	2.8
35,000	843	2.4
40,000	846	2.1
45,000	848	1.9
50,000	850	1.7

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