FASTING PLASMA GLUCOSE AS A SCREENING TEST FOR GESTATIONAL DIABETES MELLITUS

A HOSPITAL-BASED, CROSS SECTIONAL STUDY OF 370 ANTENATAL PATIENTS IN HOSPITAL UNIVERSITI SAINS MALAYSIA, KUBANG KERIAN, KELANTAN, MALAYSIA, 1999-2000

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List of abbreviations.

100-g	100 gram
1-h	1 hour
2-h	2 hour
2hPG	2-hour post glucose
50-g	50 gram
75-g	75 gram
ACOG	American College of Obstetricians and Gynaecologists
ADA	American Diabetes Association
BMI	Body mass index
CTG	Cardiotocograph
DM	Diabetes Mellitus
ECG	Electrocardiograph
GDM	Gestational Diabetes Mellitus
GIGT	Gestational Impaired Glucose Tolerance
HUSM	Hospital Universiti Sains Malaysia
IFG	Impaired Fasting Glucose
IGT	Impaired Glucose Tolerance
IUD	Intrauterine death
KB	Kota Bharu
LSCS	Lower segment Caesarean section
MMR	Maternal Mortality Rate
NDDG	National Diabetes Data Group
NHANES III	Third National Health and Nutrition Examination Survey
OGTT/GTT	Oral Glucose Tolerance Test/ Glucose Tolerance Test
PMR	Perinatal Mortality Rate
ROC	Receiver operator characteristic
U.S.	United States of America

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KELANTAN AND MATERNAL HEALTH CARE

1 KELANTAN AND MATERNAL HEALTH CARE

1.1 INTRODUCTION

1.1.1 Background

Kelantan is one of thirteen states in Malaysia, and located in the northeastern corner of Peninsular Malaysia. Kelantan was blessed in a flash of lightning. According to popular belief, the name of Kelantan was derived from "kilatan", the Malay word for lightning, a cosmic phenomenon frequently lighting the way for early seafarers sailing into the mouth of the Kelantan River.

The Land of Lightning, an intriguing potpourri of multi-cultural, multi-religious influences that gives it what the locals call the Kelate' flavour. The Kelate' dialect in itself is interesting as many words in the dialect are not found in the Malay language.

Kelantan is by far the most unique state in Peninsular Malaysia. It is often referred to as the "Cradle of the Malay Culture" as the culture and age-old traditions are still very much alive till this day. Here, colourful kites or well known as 'wau bulan' soar upwards defying gravity and giant drums reverberate. Shadow puppets or 'wayang kulit' mesmerise audiences and giant tops provide hours of endless fun. Dubbed as "The Home of the Cottage Industries", traditional crafts such as Batik, Songket, Silver craft, Wood Carving, Kris Making are some of the many types of Cottage Industries you will find here as you journey through the Land of Lightning.

It has an area of 14,931 square kilometres. Rustic settings of picturesque villages and amidst padi-fields give insights into a way of life that endured the passing of time. It is also the most fascinating part of Peninsular Malaysia encompassing picturesque beaches, padi fields, rubber estates, palm oil plantations and fishing villages.

Kelantan has a population of about 1.4 million; 95% is Malay with Chinese, Indians, Thais and Orang Asli making up the rest. Kelantanese are renowned for their warmth and friendliness. Kelantan Darul Naim is a world of gracious beauty, retaining old-world charm that few can resist.

1.1.2 History

Kelantan's earliest known history dates back to the Middle Stone Age between 3,000 and 8,000 B.C.Chinese historical chronicles speaks of existence of city-states or kingdoms in the east coast of the Malay Peninsula which maintained contacts with the Chinese court. Kelantan was subsequently referred to as 'Ho-lo-tan', 'Chih-Tu' and 'Tan-Tan' in these records. According to a Chinese record it was said that in 1225, Kelantan was part of the Srivijaya Empire, while an old Javanese poem 'Nagarakretagama' tells us that in 1345, Kelantan was a dependency of the kingdom of Majapahit.

When Islam came to Malay world, Kelantan became one of the earliest Muslim states in the region. At the turn of the 19th century, following a brief war between Kelantan and Terengganu, the eldest son of Late Long Yunus named Long Muhammad managed to drive the Terengganu forces out of Kelantan and became Sultan Muhammad I in 1800. His descendants presently make up the Royal house of Kelantan. Kelantan came under Thai and British influence before becoming part of the Federation of Malaya in 1957 and Malaysia in 1963.

1.1.3 Economy

Kota Bharu (KB) is the administrative capital and major urban centre of Malaysia's northern Kelantan province. There are plans to open the southern portion of the state under an ambitious multi-million dollar development.

Kelantan's industry is heavily based on agriculture. Palm Oil plantations abound here, as do large and small rubber estates. Rice (padi) is grown in great quantities here as are vegetables. One only needs to visit the Central Market in Kota Bharu to begin to get a sense of how important agriculture is in the Kelantan peoples' lives. Padi (or rice growing) is the major economic activity in Kelantan. Utilising both traditional and modern methods, Kelantan has many hectares devoted to padi growing. Kelantan annual rice output: 200,000 metric tonnes (14% of Malaysia's total output).

Tobacco is a major cash crop in Kelantan. Many fields can be seen just outside of Tumpat and are also being grown in many of the coastal areas.

Rubber plantations occupy the countryside in Kelantan, whether large estates or small plots of trees. Rubber workers can be seen working the trees, collecting the raw rubber latex and drying rubber mats in the sun, and preparing for processing. Kelantan rubber-based annual output: 60,000 metric tonnes.

With 100 kilometres of coastline, Kelantan supports a fishing industry that is known throughout Peninsular Malaysia. Scenic fishing villages such as Kampung Sabak also draw tourists from all over the world. Kelantan fisheries industry contributes over 25 % of Malaysia's output wholesale value of marine fish exceeding RM 1.79 billion.

Palm oil covers about 70,000 hectares in Kelantan. Products of Palm oil include, vegetable ghee, margarine, glycerine, fatty acids, palm kernel oil and cake, amongst others. Malaysia is also planning to manufacture cars that run on palm oil. Kelantan palm oil annual output: 138,000 metric tonnes (crude oil).

Coconut trees are widely found throughout Kelantan especially in coastal areas. There are at present 18,000 hectares of land under cultivation. Products of coconuts include coconut 'milk', juice, oil, copra and coconut candy.

In addition to the primary role of agriculture and its related businesses, there is a continuous contribution from the Kelantan cottage industries. Most are based on handicraft items such as batik, silver craft, basket weaving and songket weaving, that cannot be overlooked.

As Malaysia has become recognised worldwide as an upcoming economic power, with economic growth far in advance of most of the world; Kelantan's own economic growth has been nothing short of phenomenal. This can be attributed to proper planning and commitment in both the public and private sectors. Key economic areas have been identified and expanded with proper planning and supervision. The high growth rate can in part be attributed to the diversification of the Kelantan economy and it continues to point toward an above average growth rate.

Agriculture is the mainstay of Kelantan's economy with approximately 32% of the Gross Domestic Product. Rubber and Padi (rice) are the main crops. Tobacco is fast

developing as an important cash crop as well. Other important crops are coconut, cocoa, corn and vegetables.

Forestry in the past, has played and important part in the economy. Remote areas of Kelantan have been opened for development. With the growing concern over the harvest of tropical hardwoods, logging is on a decline. This has created a paradoxical problem, in that the price of various tropical hardwoods has steadily risen making it more and more profitable to harvest this timber, benefiting the state and economy as well as those businesses that harvest the timber.

Tourism is rapidly developing as an established part of the Kelantan economy as more people throughout the world become aware of the unique opportunities Kelantan offers. For travel, variety, culture, and excellent value per dollar spent, Kelantan offers what few areas anywhere can; a wonderful experience at a reasonable price.

1.2 MATERNAL HEALTH CARE

The events pertinent to maternal health care started in Kelantan in 1930, when the first General Hospital was built. Training programs for midwives was initiated and this was upgraded in1946. In 1956, the National Rural Health Development program started with an extensive development of health infrastructures in the form of Rural Health Units organized on a 3 tiers and now 2-tier system of referral for Maternal and Child Health care.

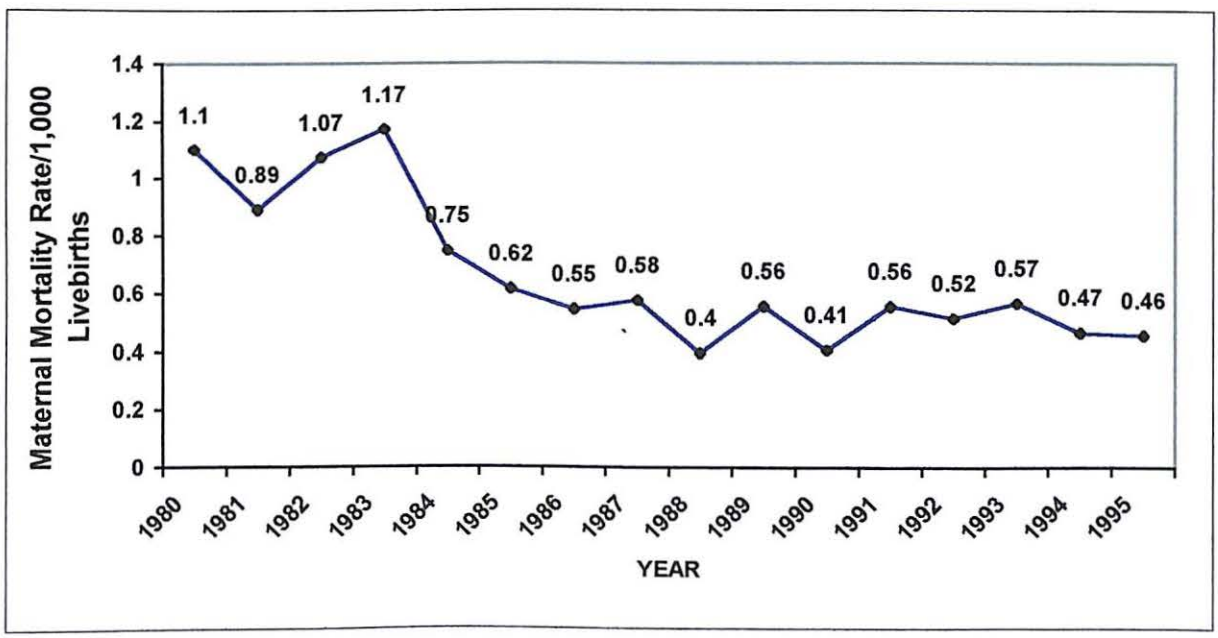
The various maternal health care services provided included antenatal care, postnatal care and family planning. Over the years, the state medical and health services have improved tremendously with the opening of district hospitals and health centers. There are altogether nine hospitals in the state – 2 in Kota Bharu and one each in each of districts except Bachok and Jeli. Previously, specialist services were provided only at Kota Bharu Hospital and Hospital Universiti Sains Malaysia. Obstetric operations are only carried out at these two tertiary care hospitals. Recently starting from 1998, Kuala Krai Hospital was upgraded and at present Obstetrician and Gynaecologist, Anaesthesiologist and Pathologist are giving their specialist services to improve health status at that area.

The improvement was also reflected the increasing numbers of hospitals deliveries. The hospital delivery was only 12.7% of all deliveries in1980 and 15.0% in 1987. In 1992, there were tremendous improvement, with 60.1% delivered in hospital and this was also accompanied by reduction in maternal mortality rate and perinatal mortality rate.

1.2.1 MATERNAL MORTALITY RATE

The Maternal Mortality Rate (MMR) in Kelantan has declined from 1.1 per 1,000 live births in 1980 to 0.55 per 1,000 live births in 1986. Since then, the rate has dropped further to 0.46 per 1,000 live births in 1995 (Figure 1.1)

Figure 1.1 Maternal Mortality Rate in Kelantan, 1980 - 1995



There were 24 maternal deaths in 1993, 19 in 1994 and 18 in 1995. The districts with relatively high maternal mortality rates were Kuala Krai district, Pasir Mas district and Machang district. The rate were also high in Pasir Puteh district and Gua Musang district in 1993 but in 1995 the rates in both districts had dropped to zero (Table 1.1)

Table 1.1 Numbers of Maternal Deaths and Maternal Mortality Rate in Kelantan by Districts, 1993 - 1995

District	No. Of Maternal Deaths			Maternal Mortality Rate*		
	1993	1994	1995	1993	1994	1995
Kota Bharu	7	5	3	0.54	0.40	0.23
Tumpat	1	0	2	0.26	0.00	0.57
Bachok	1	2	2	0.26	0.55	0.56
Pasir Puteh	4	1	0	1.09	0.28	0.00
Pasir Mas	2	4	4	0.39	0.82	0.91
Machang	2	3	2	0.76	1.16	0.80
Kuala Krai	3	2	4	0.94	0.63	1.37
Tanah Merah & Jeli	2	1	1	0.41	0.21	0.3
Gua Musang	2	1	0	1.07	0.55	0.00
Total	**24**	**19**	**18**	**0.57**	**0.47**	**0.46**

* Per 1,000 live births

Table 1.2 Maternal Mortality Rate In 1980, 1985, 1990 and 1994 by State

State	Maternal Mortality Rate (per 1,000 Live births)			
	1980	1985	1990	1994
Perlis	60.0	79.9	41.8	19.6
Kedah	80.0	54.6	25.6	20.3
Penang	40.0	30.7	16.5	27.3
Perak	70.0	44.7	22.4	28.5
Selangor	30.0	13.8	19.5	13.0
Kuala Lumpur	10.0	12.5	3.3	21.5
Negeri Sembilan	50.0	40.8	10.6	10.9
Malacca	40.0	6.4	21.0	6.7
Johore	150.0	24.0	26.9	26.8
Pahang	110.0	59.5	31.6	30.4
Terengganu	70.0	57.4	15.2	11.4
Kelantan	50.0	60.6	16.6	16.2
Sabah	10.0	20.2	19.3	15.4
Sarawak	60.0	10.0	6.7	14.5
Malaysia	**10.0**	**37.1**	**20.2**	**19.1**

Source: Department of Statistics, Malaysia.

1.2.2 PERINATAL MORTALITY RATE

The perinatal mortality rate per 1,000 live births in Kelantan has dropped from 22.76 in 1985 to 12.92 in 1994. In comparison to the state average, district of Gua Musang, Kuala Krai, Tanah Merah, Jeli, Pasir Mas and Tumpat had higher perinatal mortality rate in 1994 (Table 1.4)

Table 1.3 Perinatal Mortality Rate In 1985, 1990 and 1994 by State

State	Perinatal Mortality Rate (per 1,000 Live births and Stillbirths)		
	1985	1990	1994
Perlis	24.9	13.9	7.4
Kedah	24.5	17.7	15.8
Penang	18.6	15.0	13.8
Perak	21.5	12.6	12.1
Selangor	12.9	11.1	9.7
Kuala Lumpur	8.7	10.4	9.7
Negeri Sembilan	19.2	15.2	9.2
Malacca	20.3	16.2	13.1
Johore	20.1	12.4	10.3
Pahang	21.2	20.4	10.5
Terengganu	23.6	16.0	16.6
Kelantan	22.7	12.4	12.6
Sabah	15.0	14.0	12.2
Labuan	N.A	N.A	19.6
Sarawak	8.4	8.2	7.3
Malaysia	**18.0**	**13.4**	**11.4**

* including Federal Territory of Labuan in 1985 and 1990
N.A = Not Available
Source: Department of Statistic, Malaysia.

Table 1.4 Perinatal Mortality Rate in Kelantan, 1985, 1990 and 1994

District	1985	1990	1994
Kota Bharu	20.78	12.12	8.11
Bachok	18.53	9.12	10.55
Tumpat	25.02	13.45	14.06
Pasir Mas	25.11	13.32	17.64
Machang	17.03	12.33	10.00
Pasir Puteh	19.31	10.68	12.10
Kuala Krai	26.52	11.83	17.93
Gua Musang	27.21	17.62	18.00
Jeli	*	*	17.00
Tanah Merah	29.40	13.58	19.29
Kelantan	**22.76**	**12.45**	**12.92**

Source: Vital Statistics of Malaysia, 1985, 1990 and 1994

* Jeli and Tanah Merah was single district until 1994.

THE SCHOOL OF MEDICAL SCIENCES
UNIVERSITI SAINS MALAYSIA

2 THE SCHOOL OF MEDICAL SCIENCES – UNIVERSITI SAINS MALAYSIA

The school of Medical Sciences, Universiti Sains Malaysia is one of the medical schools in Malaysia and was set up in mid 1979. The uniqueness of this school lies in the fact that it is the first medical school in the country to adopt an innovative, community-orientated curriculum for its medical students.

Its philosophy is to stress the relevance of its curriculum to the needs of the country and the profession and to work towards producing competent practitioners who would be able to identify themselves as part and parcel of health care system of the country.

It is the first medical school to be set up in the less developed eastern coast of West Malaysia, the other medical school being located in Kuala Lumpur, the capital city i.e. University of Malaya and National University of Malaysia.

2.1 HOSPITAL UNIVERSITI SAINS MALAYSIA (HUSM)

Hospital University Science Malaysia (HUSM) is the teaching hospital for the School of Medical Sciences, University Science Malaysia. It was built in 1976 under the Third Malaysia Plan and is located at Kubang Kerian town about 6.4 km from the state capital Kota Bharu. The construction was completed in 1984 and was officially opened by the Royal Highness Al-Sultan Kelantan on 26th August 1984. The first patient was admitted on 21st January 1984 and first baby was born in April 1984.

Besides teaching and research, the University Hospital also provides adequate medical services for the population. It also serves as the referral center for the state and the neighbouring states in the East Coast.

The hospital has a total of 675 beds for medical and surgical disciplines. All the departments are adequately staffed and the hospital has backup services by the blood bank, laboratory and radiological units.

2.2 THE DEPARTMENT OF OBSTETRICS AND GYNAECOLOGY (HUSM)

In 2001, the department of Obstetrics and Gynaecology is staffed by eleven consultants/lecturers, nine registrars (the final year master students), thirty medical officers and / or trainee lecturers (five third year masters, ten second year masters and two first year masters) and twelve house officers. The postgraduate program was started in 1991 and the first Master of Medicines candidates in Obstetrics and Gynaecology graduated in June 1995.

The department of Obstetrics and Gynaecology occupies the first floor of the new hospital building above the Obstetrics and Gynaecology clinic. There is one gynaecology ward in the first floor of the hospital main building, with total of 31 beds, and two obstetric wards in the second floor of the new hospital building with a total of 80 beds (40 beds antenatal and 40 beds postnatal).

The Labour ward is situated on the first floor of the new hospital building, adjacent to neonatal intensive care unit. It is equipped with ten one-bedded delivery rooms, two-bedded admission room, two-bedded eclampsia or intensive care room and one-bedded premature room. There are no special induction rooms, patient were induced either in the obstetric wards or in labour room (if high risk). The labour ward is equipped with two ultrasound machines, five tococardiography (CTG) machines, dynamaps, ECG monitors, infusion pumps, two resuscitation trolleys and blood warmer.

There is an operation theatre in the labour ward, which is opened during the office hours for providing epidural services and anaesthesia for emergency and elective operative procedures.

The Special Care Nursery is housed next to labour room and is equipped with facilities for the care of the problem newborns. The total deliveries, mode of deliveries, perinatal and maternal mortality rate for Hospital Universiti Sains Malaysia since 1990 till 2000 were as in Table 2.1.

Table 2.1 Basic Statistics for Department of Obstetrics and Gynaecology, Hospital Universiti Sains Malaysia, 1990 - 2000

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Total deliveries	5996	6874	8184	8844	9478	8804	7669	7712	6930	7778	7487
Mode of deliveries (%)											
SVD	74.8	74.3	78.7	79.3	79.8	80.1	79.3	79.3	81.1	82.6	82.7
Vacuum	3.0	3.3	2.2	2.2	2.9	2.9	3.4	2.9	2.2	2.4	1.2
Forceps	3.2	2.6	2.6	2.0	2.3	1.2	1.5	1.0	1.1	1.0	1.1
LSCS	13.4	15.2	11.8	12.3	10.5	11.3	10.7	12.4	13.6	11.8	11.6
Breech	4.0	3.1	3.4	3.0	2.4	2.7	2.8	2.6	2.1	2.0	2.4
Twins	1.6	1.5	1.3	1.2	1.1	1.0	1.0	1.0	0.9	1.2	1.0
Still Birth*	26.2	20.0	18.2	16.8	14.6	13.3	14.5	13.0	15.2	11.6	10.6
PMR*	33.2	26.6	15.7	20.7	18.8	19.1	23.1	21.9	23.9		
MMR#	33.4	72.7	61.0	67.8	10.5	35.2	52.2	13.0			

* Per 1000

Per 100,000

The Obstetrics and Gynaecology clinic is situated at the ground floor of the new hospital building and it is equipped with two ultrasound machines and a colposcope machine. The clinics run as follows in Table 2.2.

Table 2.2 Obstetrics and Gynaecology Clinic Schedule in HUSM

DAY	MORNING	AFTERNOON
Saturday (second and fourth week)	Booking Antenatal Clinic	Booking Antenatal Clinic
Sunday	Antenatal Outpatient Clinic	Gynaecology Outpatient Clinic
Monday	Menopause Clinic Outpatient Ultrasound	Molar and Oncology Clinic
Tuesday	Antenatal Outpatient Clinic	Gynaecology Outpatient Clinic
Wednesday	Fertility Augmentation Clinic	Family Planning and Postnatal clinic

The number of outpatient seen from 1990 till 2000 were as shown in Table 2.3

Table 2.3 The number of Outpatients Seen from 1990 till 2000

YEAR	GYNAECOLOGY OUTPATIENT	OBSTETRICS OUTPATIENT
1990	3439	10049
1991	3587	11881
1992	3763	12279
1993	4315	12674
1994	4331	12321
1995	4174	10296
1996	4725	10146
1997	5319	11741
1998	5664	11826
1999	6026	9854
2000	5945	9144

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3 ABSTRACT OF DISSERTATION

3.1 BAHASA MALAYSIA VERSION

Objektif:

Mengkaji glukos plasma berpuasa (fasting plasma glucose) sebagai ujian penyaringan bagi penyakit kencing manis ketika mengandung (gestational diabetes mellitus). Objektif selanjutnya adalah untuk menentukan taburan demografi bagi penyakit kencing manis ketika mengandung dan menilai pecahan penyakit ini yang dapat dikesan melalui saringan selektif menggunakan faktor sejarah.

Metodologi:

Kajian bersilang telah dijalankan di Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan dari bulan Julai 1999 hingga bulan Oktober 2000. Data asas diambil daripada 461 pesakit yang bersetuju mengambil bahagian di dalam kajian ini, yang mana umur kandungannya tidak melebihi 28 minggu dan tidak mempunyai penyakit kencing manis sebelum ini. Ujian glukos piawai 2-jam 75-g telah dijalankan ke atas 370 pesakit. Penyakit kencing manis semasa mengandung dan subkategorinya iaitu kencing manis dan gangguan toleransi terhadap glukos semasa mengandung telah didefinasikan oleh mengikut 'Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Part 1:Diagnosis and Classification of Diabetes Mellitus Provisional Report of a WHO Consultation'. Ciri-ciri saringan glukos plasma berpuasa dikaji melalui kiraan sensitiviti dan spesifisiti dengan 'receiver operator characteristic curves'.

Keputusan:

Melalui kajian ini didapati plasma glukos berpuasa ≥7.0 mmol/l mempunyai sensitiviti (17.8%) yang amat rendah dalam mengesan kencing manis semasa mengandung secara keseluruhan. Sensitiviti (62.5%) meningkat sekiranya ia digunakan bagi mengesan subkategori kencing manis semasa mengandung. Walau bagaimanapun, plasma glukos berpuasa ≥7.0 mmol/l adalah amat spesifik (>98%) dalam mengesan kedua-dua keadaan ini. Gangguan glukos berpuasa (Impaired Fasting Glucose) didapati mempunyai sensitiviti sebanyak 1.8% sahaja dan spesifisiti sebanyak 97.1% dalam mengesan subcategori gangguan toleransi glukos semasa mengandung (gestational impaired glucose tolerance).

Mengikut kajian ini, plasma glukos berpuasa melebihi atau bersamaan 4.4 mmol/l berkebolehan mencapai sensitiviti sebanyak 75.3% dan spesifisiti sebanyak 66.3% dalam mengesan kencing manis semasa mengandung secara keseluruhan. Sekiranya 4.3 mmol/l diambil sebagai had atas bagi normal dan 7.0 mmol/l atau lebih sebagai penyakit kencing manis semasa mengandung, ujian glukos ke atas 61.9% pesakit dapat dikurangkan. Dengan menggunakan cara ini, 19 atau 5.1% pesakit termasuk ke dalam klasifikasi yang salah dengan 18 atau 4.9% daripadanya adalah keputusan negatif palsu (false negative).

Umur yang meningkat didapati mempunyai kaitan dengan peningkatan kejadian penyakit kencing manis semasa mengandung. Walaupun pecahan pesakit yang mempunyai pariti yang banyak adalah tinggi (25.1%), ia tidak berkaitan dengan peningkatan kejadian kencing manis semasa mengandung. Kebanyakan pesakit yang disahkan menghidapi kencing manis semasa mengandung adalah Melayu kerana

kebanyakan pesakit yang menyertai kajian ini adalah Melayu. Walaupun terdapat sedikit peningkatan di dalam kejadian penyakit kencing manis semasa mengandung dengan meningkatnya nilai indeks jisim badan (Body Mass Index), ia didapati tidak signifikan.Tiada terdapat perbezaan dalam kejadian penyakit kencing manis semasa mengandung yang signifikan jika dibandingkan antara pesakit daripada kumpulan pendapatan yang berbeza.

Didapati 45.3% pesakit normal mempunyai satu atau lebih faktor risiko untuk mendapat kencing manis semasa mengandung jika faktor sejarah digunakan sebagai saringan. Ini bermakna hampir separuh pesakit yang normal atau 36.4% daripada semua pesakit terpaksa menjalani ujian glukos sedangkan ia mungkin tidak diperlukan. Selain daripada itu, didapati 30.1% daripada pesakit yang menghidap kencing manis semasa mengandung tidak dapat dikesan melalui saringan secara ini.

Kesimpulan:

Melaui kajian ini didapati plasma glukos berpuasa yang dahulunya telah diabaikan sebagai alat saringan bagi mengesan penyakit kencing manis semasa mengandung adalah berpotensi kerana mudah, murah, praktikal dan mesra pengguna.

3.2 ENGLISH VERSION

Objective:

To evaluate fasting plasma glucose as a screening test for gestational diabetes mellitus. Further objectives were to determine demographic distribution of gestational diabetes mellitus and to assess the proportions of gestational diabetes mellitus picked up by selective screening using historical risk factors alone.

Methods:

A hospital-based, cross-sectional study was carried out at University Hospital, Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan, from July 1999 till October 2000. Baseline data from 461 women who agreed to participate in the study with gestational ages less than 28 weeks and no previous diagnosis of diabetes were collected. A standardized 2-h 75-g oral glucose tolerance test was performed in 370 women. Gestational diabetes and its subcategories-diabetes and gestational impaired glucose tolerance-were defined according to the Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Part 1:Diagnosis and Classification of Diabetes Mellitus Provisional Report of a WHO Consultation. Screening properties of fasting plasma glucose were evaluated by calculating sensitivity and specificity with receiver operator characteristic curves.

Results:

In this study, fasting plasma glucose level of ≥7.0 mmol/l has a very low sensitivity (17.8%) in detecting gestational diabetes mellitus as a whole. The sensitivity (62.5%) improves if the cut-off level is used to detect subcategory gestational diabetes mellitus. However, fasting plasma glucose level of ≥7.0 mmol/l is highly specific (>98%) in

3.2 ENGLISH VERSION

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detecting both conditions. Impaired fasting glucose or IFG was found to have sensitivity of only 1.8% and specificity of 97.1% in detecting subcategory gestational impaired glucose tolerance.

Based on this study, fasting plasma glucose of 4.4 mmol/l or more is able to reach a sensitivity of 75.3% and a specificity of 66.3% in detection of GDM as a whole. Taking 4.3 mmol/l as the upper limit of normal and 7.0 mmol/l or more as confirmed gestational diabetes mellitus, oral glucose testing in 61.9% of patients could be eliminated. By using this strategy, 19 or 5.1% were misclassified with 18 or 4.9% being false negative.

Advancing age was significantly associated with increase incidence of GDM. Although the proportions of patients who were grandmultiparous and great grandmultiparous (25.1%) were high, it was not shown to be significantly associated with GDM. Majority of those diagnosed as GDM were Malay as majority of patients in this study were Malay. Although slight increase in incidence of GDM were shown with increase BMI in this study but it was not statistically significant. There was also no significant difference in incidence of GDM among various income groups. Using historical factors as a screening, 45.3% of normal patients were noted to have one or more risk factor for developing GDM, which means that nearly half of normal or 36.4% of all patients would undergo unnecessary oral glucose testing. Furthermore, 30.1% of GDM without a risk factor would be totally missed out.

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Conclusions:

While previously neglected as a screening test for GDM, in our population the FPG offers a potentially simple, practical algorithm to screen for GDM by being cost-effective and patient friendly.

4 INTRODUCTION AND THEORETICAL ASPECTS OF FASTING PLASMA GLUCOSE AS A SCREENING TEST FOR GESTATIONAL DIABETES MELLITUS (GDM)

4.1 INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as any degree of glucose intolerance with onset or first recognition during pregnancy. The definition applies regardless of whether insulin or only diet modification is used for treatment or of whether the condition persist after pregnancy. It does not exclude the possibility that unrecognized glucose intolerance may have antedated or begun concomitantly with the pregnancy (1). Six weeks or more after pregnancy ends, the woman should be reclassified, into one of the following categories (2):

- Diabetes mellitus (DM)
- Impaired fasting glucose (IFG)
- Impaired glucose tolerance (IGT)
- Normoglycaemia

In the majority of cases of GDM, glucose regulation will return to normal after delivery. Women who become pregnant and who are known to have diabetes mellitus which antedates pregnancy do not have gestational diabetes but have 'diabetes mellitus and pregnancy' and should be treated accordingly before, during and after the pregnancy (2).

4.2 PREVALENCE

GDM complicates 4% of all pregnancy in United States (3). The prevalence may range from 1 to 14% of pregnancies, depending on population studied (3). The prevalence of GDM is highly dependent on ethnicity and geographical variations (4). Compared with the white European women, the prevalence rate for GDM is increased approximately eightfold in South East Asian women (5). Using the O'Sullivan screening with 50-g glucose followed by 75-g 2-h oral glucose tolerance test (OGTT) as the diagnostic tool, the prevalence of gestational diabetes in Malaysia was 12.7% with 10.2% in the Malays, 19.5% in the Indians and 17.5% in the Chinese (6).

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4.3 SCREENING METHODS: WHO TO TEST

Clinical recognition of GDM is important because therapy including diet, insulin when necessary, and antepartum fetal surveillance, can reduce the well-described GDM-associated perinatal morbidity and mortality (7). It is also related to maternal complications that include an increased rate of caesarean section and chronic hypertension (7-9). Although many patients diagnosed with GDM will not develop diabetes later in life, others will be diagnosed many years postpartum as having type 1 diabetes, type 2 diabetes, IFG or IGT (10-15).

The purpose of a screening test is not to diagnose a disease, but to identify a subgroup of a given population that is at risk for a given disorder. To maximize the utility of a screening test, it should be well defined, easily administered, inexpensive, reproducible, and it should optimize sensitivity, perhaps at the expense of some specificity.

Previous recommendations have been that screening for GDM be performed in all pregnancy. However there are certain factors that place women at lower risk for development of glucose intolerance during pregnancy, and it is likely not cost effective to screen such patients. Thus, selective screening is currently widely accepted.

Advancing maternal age was noted to be associated with increased incidence of GDM. Using National Diabetes Data Group (NDDG) criteria in a population based study of 6,214 gravidae, Coustan et al. (16) found the incidence of GDM to be 0.5% in women less than twenty years of age. It rose to 4.0% in pregnant women in the age group of thirty-five to thirty-nine years. Based on this, proposals have been made that because the majority of cases of GDM occurs in women over the age of twenty-four years,

screening for GDM should be limited to those gravidae more than twenty-four years old. Of pregnant women under the age of twenty-four years, only those with one or more of the historical or clinical risk factors mentioned previously would be included in the screened group.

Other low risk group patients are women who are of normal body weight, have no family history (i.e., first degree relative) of diabetes, and are not members of an ethnic/racial group of high prevalence of diabetes (e.g. Hispanic, Native American, Asian, African-American) need not be screened for GDM (17-19). Being Asian, this puts most of pregnant women in our population in a high-risk group.

The other option is to narrow the population to be screened by taking the historical risk factors into account. From the very beginning, it was apparent that there were items that were more frequent in the histories or clinical presentations of women found to have GDM. Among these factors were reproductive events, including a prior neonate weighing more than 4.0 kg or a prior neonatal death, congenital anomaly, or prematurity, a family history of overt diabetes; and clinical findings during pregnancy that include obesity, excessive weight gain, glycosuria, proteinuria and hypertension. Several investigators have examined the efficiency of these historical risk factors at narrowing the group to be screened (Table 4.1; 16,17,20,21). Very consistently, these investigators have found these historical risk factors in only roughly half of the women known to have GDM. That means that if risk factors alone determined who was to be screened, one half of GDM would not be detected.

Table 4.1 Maternal historical and clinical risks factors in gestational diabetes mellitus

Reference	n (GDM/population)	Percentage of GDM subjects with risk factors (%)
O'Sullivan et al. (20)	15/752	53
Lavin (21)	30/2,077	47
Marquette et al. (17)	12/434	50
Coustan et al. (16)	125/6,214	56

Moses et al. (22) evaluated the effect of excluding lean young Caucasian women with no family history of diabetes and not coming from an ethnic/racial group with high prevalence of diabetes from screening and found that outcomes in low risk women were similar to those in high risk women. Women from low risk group have a 2.8% prevalence rate of GDM and nearly 10% of cases of GDM would be missed.

A group from University of Michigan (23) has also done the same evaluation and found that although only 4% of women will be missed but approximately 90% of pregnant women will still need to be screened for GDM.

4.4 SCREENING METHODS: HOW TO TEST

Screening method using 50-g glucose challenge test as suggested by American Diabetes Association (ADA) is widely practiced and accepted in the U.S. Table 4.2 (24) presents the sensitivities and specificities associated with several thresholds in use.

Table 4.2 Sensitivity and specificity of 50-g 1-h oral glucose challenge as a function of threshold value

	Threshold (mmol/l)		
	7.2	7.5	7.8
Sensitivity (%)	100	98	79
Specificity (%)	78	80	87

In 1989, Sacks et al. (25) performed 50-g glucose screens on two consecutive days on 110 women, 30 with confirmed GDM and 80 without GDM. Of 30 gravidae with confirmed GDM, 3 had glucose screen values < 7.5 mmol/l on both days, and 10 more had values that straddled 7.5 mmol/l on successive days. Of 80 normal control subjects, 11 had glucose screen values that straddled 7.5 mmol/l on successive days. Had they relied on a single normal test value, Sacks et al. would have missed 8 of the 30 cases of GDM on a given day. Relying on normal test values on both days would miss 3 of 30 cases of GDM. Keeping in mind that reproducibility was one of the criteria for a good screening test, it was concluded that the 50-g 1-h glucose screen was moderately reliable, and caution was given not to rely on a single normal test result, particularly in someone with risk factors.

Other than being troublesome and at times not palatable, the cost of screening our population for GDM with the 50-g glucose screen would be considerable.

Test other than the 50-g oral glucose challenge that could be used to screen for GDM is the measurement of glycated proteins. This method allows the blood to drawn from an unprepped patient, which is more convenient. Glycation is a non-enzymatic process that is both time dependent and glucose-concentration dependent and occurs largely at the NH2-terminal amino acids or side-chain lysine groups. Being time and glucose-concentration dependent, some potential problems may interfere with using glycated proteins as screening tests for GDM.

These problems include the following:

- Pregnant women have lower fasting blood glucose than non pregnant women
- Pregnant women have higher postprandial blood glucose than non pregnant women
- Because of increased erythropoeisis in pregnancy, the red blood cells of pregnant women are younger and their haemoglobin less glycated than those of non pregnant women
- At the time of GDM screening, the interval of any potential carbohydrate intolerance would have been of relatively short duration

Table 4.3 presents sensitivity and specificity of various glycated proteins used in screening of GDM.

Table 4.3 Sensitivity and specificity of glycated proteins in screening for GDM

Reference	Protein	Sensitivity (%)	Specificity (%)
Roberts et al. (26)	Albumin	85	95
Nasrat et al. (27)	Albumin	50	-
Shah et al. (28)	Haemoglobin	22	90
Artal et al. (29)	Haemoglobin	73	34
Cousins et al. (30)	Haemoglobin	80	57
Hughes et al. (31)	Albumin	79	77

Other alternatives to the 50-g oral glucose challenge are fasting plasma glucose (FPG), timed blood glucose (TBG), random blood glucose (RBG) and glycosuria (Table 4.4)

Table 4.4 Alternatives to the 50-g oral glucose screen for GDM

Method	Reference	Comments
Fasting plasma glucose (FPG)	Sacks et al. (32)	For FPG 4.9 mmol/l, sensitivity = 80%; specificity = 40% For FPG 4.7 mmol/l, sensitivity = 90%; specificity = 21% For FPG 4.5 mmol/l, sensitivity = 95%; specificity = 11%
Timed blood glucose (TBG)	Nasrat et al. (33)	TBG >5.9 mmol/l and > 2 h postprandial or TBG >6.9 mmol/l and < 2 h postprandial Sensitivity = 29%; specificity = 89%
Random blood glucose (RBG)	Stangenberg et al. (34)	RBG >6.5 mmol/l in 174 of 1,500 women 10 had abnormal GTT; GDM incidence of 0.7% suggests substantial false negative
Glycosuria	Lind (35)	Glycosuria found in 50% of all pregnancies

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4.5 SCREENING METHODS: WHEN TO TEST

Screening is customarily done between 24 and 28 weeks gestation. Recommendations that screening for GDM be done between 24 and 28 weeks are based on the physiology of GDM: a gradual decrease in carbohydrate intolerance in the second trimester leads to increased blood glucose concentrations and increased postprandial insulin-to-glucose ratios. In 1985, Jovanovic and Peterson (36) performed 50-g glucose challenges on 300 gravidae at 9-20 weeks. They repeated the challenge at 27-31 weeks on original 300 minus those found to have abnormal glucose tolerance tests (GTT) after the first screen, plus an additional 300 women. Finally, they repeated the challenge on the whole group at 33-36 weeks. The interval of 27-31 weeks had the highest percentage of positive screens. That interval also had the highest percentage of abnormal GTT. Additionally; a positive screen between 27 and 31 weeks was associated with macrosomia more often than positive screen at the other times. These data provide strong support for the custom of screening in interval from week 24 to week 28 of pregnancy.

4.6 SCREENING METHODS: FASTING PLASMA GLUCOSE (FPG)

The interest to evaluate fasting plasma glucose as a screening tool for GDM arise as a result of the current trend of utilizing FPG in diagnosis of diabetes in non pregnant subject.

In 1997, an International Expert Committee, working under the sponsorship of the American Diabetes Association modified diagnostic criteria for diabetes mellitus in non-pregnant subjects as shown in Table 4.5. Three ways to diagnose diabetes are possible, and each must be confirmed, on subsequent day, by any one of the three methods given in Table 4.5 (2).

Table 4.5 Criteria for diagnosis of diabetes mellitus in non pregnant individuals by ADA

1. Symptoms of diabetes plus casual plasma glucose concentration ≥ 11.1 mmol/l

   Casual is defined as any time of day without regard to time since last meal.
   The classic symptoms of diabetes include polyuria, polydypsia and unexplained weight loss.

   or

2. FPG ≥ 7.0 mmol/l
   Fasting is defined as no caloric intake for at least 8 hours.

   or

3. 2hPG ≥11.1 mmol/l
   The test should be performed as described by WHO (37), using glucose load containing the equivalent of 75g anhydrous glucose dissolved in water.

Impaired glucose tolerance (IGT) and impaired fasting glucose (IFG) refer to a metabolic stage intermediate between normal glucose homeostasis and diabetes. The Expert Committee recognizes this group of subject whose glucose levels, although not meeting criteria for diabetes, are nevertheless too high to be considered altogether normal.

Thus, the categories of FPG values are as follows:

Normal fasting glucose	FPG < 6.1 mmol/l
Impaired fasting glucose	FPG ≥ 6.1 and < 7.0 mmol/l
Provisional diagnosis of diabetes	FPG ≥ 7.0 mmol/l

The corresponding categories when the OGTT is used are the following:

Normal glucose tolerance	2-h post load glucose (2hPG) < 7.8 mmol/l
Impaired glucose tolerance	2hPG ≥ 7.8 and < 11.1 mmol/l
Provisional diagnosis of diabetes	2hPG ≥ 11.1 mmol/l

The 2-h OGTT cutoff of 7.8 mmol/l will identify more people as having impaired glucose homeostasis than will the fasting cutoff of 6.1 mmol/l. Almost all individuals with FPG ≥7.8 mmol/l have 2hPG ≥11.1 mmol/l if given OGTT, where as only about one fourth of those with 2hPG ≥11.1 mmol/l and without previously known diabetes have FPG ≥7.8 mmol/l(38). Thus, the cut point of FPG ≥7.8 mmol/l defined a greater degree of hyperglycaemia than did the cut point of 2hPG ≥11.1 mmol/l.

The major change in the diagnostic criteria for diabetes mellitus from previous WHO recommendation is the lowering of the diagnostic value of the fasting plasma glucose concentration to 7.0 mmol/l and above, from the former level of 7.8 mmol/l and above. The new fasting criterion is chosen, as it approximately equal in diagnostic significance to 2-h post-load concentration. Furthermore, several studies have shown increased risk in microvascular and macrovascular disease in persons with fasting plasma glucose concentration of 7.0 mmol/l and over.

In summary, the diagnostic criteria are now revised to

- avoid the discrepancy between the FPG and 2hPG cut point values
- facilitate and encourage the use of simpler and equally accurate test (FPG) for diagnosing diabetes
- reproducibility is another important property of a diagnostic test, a property for which the FPG appears to preferable
- when OGTTs were repeated during 2 – 6-week interval, the intra-individual coefficients of variation were 6.4 % for FPG and 16.7% for the 2hPG (39)

However, for epidemiological studies, estimates of diabetes prevalence and incidence should be based on an FPG 7.0 mmol/l as OGTT may be difficult to perform, time consuming and not cost effective.

In the report of the Expert Committee of ADA and American College of Obstetricians and Gynaecologists (ACOG), the two-step process – a 50-g screening test and, if that is positive, a 100-g diagnostic test (Table 4.6) – is the testing scheme recommended for the pregnant women as it is so widely accepted and practiced in the U.S (1).

Table 4.6 Screening and diagnosis scheme for GDM

Plasma glucose	50 g screening test (mmol/l)	100 g diagnostic test (mmol/l)
Fasting	-	5.8
1-h	7.8	10.6
2-h	-	9.2
3-h	-	8.1

There have been challenges to the above diagnostic scheme. Carpenter and Coustan (40) have suggested that the National Diabetes Data Group (NDDG) conversion of the O'Sullivan and Mahan values from the original Somogyi-Nelson determinations may have resulted in values that are too high. They proposed cut off values for plasma glucose that appear to represent more accurately the original O'Sullivan and Mahan determinations. In three studies, these criteria identified more patients with GDM whose infants had perinatal morbidity (41-43). In addition, efforts are being made to established internationally agreed upon diagnostic testing procedures: for example, using the 75-g oral glucose load, as recommended by WHO, because that protocol identifies a greater number of pregnancies with maternal or perinatal complications associated with high plasma glucose (44-46).

In 1998, WHO Consultation has taken place in parallel with the report by the American Diabetes Association Expert Committee to re-examine its own diagnostic criteria. Since 1980, the WHO panels recommends the use in pregnancy of the same diagnostic procedures used for non-pregnant adults: a 75-g oral load with fasting and a 2-h plasma glucose test (47-49). The revised criteria for diagnosis of diabetes in non pregnant subjects agreed by both ADA Expert Committee and WHO in 1998 are shown in Table 4.7.

Table 4.7 Values for diagnosis of diabetes mellitus and other categories of hyperglycaemia

	Glucose concentration (mmol/l)
Diabetes Mellitus: Fasting ***or*** 2-h post glucose load ***or both***	≥ 7.0 ≥ 11.1
Impaired Glucose Tolerance (IGT): Fasting ***and*** 2-h post glucose load	< 7.0 ≥ 7.8 and < 11.1
Impaired fasting glycaemia (IFG): Fasting	≥ 6.1 and < 7.0

As proposed by ADA Expert Committee, WHO has also changed its criteria by lowering of the diagnostic value of fasting plasma glucose concentration to 7.0 mmol/l from the former level of 7.8 mmol/l. The new fasting criterion is chosen to represent a value, which in most persons is of approximately equal diagnostic significance to that of 2-h post load concentration.

Following that, WHO classifies pregnant women who meet WHO criteria for diabetes mellitus or IGT as having GDM. The significance of IFG in pregnancy remains to be established. Any woman with IFG, however, is recommended to have a 75-g OGTT.

In Europe, the 75-g, 2-h OGTT is popular as the diagnostic test for GDM without any screening procedure. However, there is less agreement on glucose values used for diagnosis with the WHO, the European Diabetic Pregnancy Study Group and Fourth International Workshop-Conference on GDM interpreting the results differently (49).

In view of the current move towards using FPG as a diagnostic tool, it is also important to evaluate its usefulness as a screening test in detecting GDM.

The fasting plasma glucose was compared with the one-hour post glucose test as a screening test for identification of gestational diabetes by Sacks et al. (32). Of 4,561 consecutive patients screened with a 50-g glucose test, 968 (21.2%) had results ≥ 7.5 mmol/l; 141 (14.6%, or 3.1% of total) were found to have diabetes. In the 968 patients, the area under the fasting plasma glucose receiver operating characteristic curve was greater than that under the glucose screening test curve, indicating greater discriminatory value of the former test.

Furthermore, of the 116 patients who had sequential glucose screening tests and fasting plasma glucose performed twice during pregnancy, a significant correlation was found for fasting plasma glucose values, but not for glucose screening test values.

FPG appears to have a better reproducibility property and remains relatively stable throughout pregnancy (50). If compared with OGTTs that were repeated in adults during a two to six weeks interval, the intra-individual coefficients variation were 6.4% for FPG and 16.7% for the 2hPG (39)

A group of researchers in Brazil (51) had performed a study to evaluate FPG as a screening test and found that for detection of subcategory gestational diabetes, a FPG of 4.9 mmol/l jointly maximizes sensitivity (88%) and specificity (78%). For detection of subcategory gestational impaired glucose tolerance (GIGT), a value of 4.7 mmol/l jointly maximizes sensitivity and specificity (68%). The performance of FPG assessed against GDM as a whole is comparable to those reported by Sacks et al. (Table 4.8)

Table 4.8 Selected sensitivities, corresponding specificities and screening test threshold values

Reference	FPG (mmol/l)	Sensitivity (%)	Specificity (%)
Sacks et al. (32)	4.9	80	40
	4.7	90	21
	4.5	95	11
Reichelt et al. (51)	4.7	69	68
	4.5	82	54

Agarwal et al. (52) in their study concluded that while previously neglected as a screening test for GDM, in selected high-risk populations the FPG offers a potentially simple, practical algorithm to screen for GDM by being cost-effective and patient friendly.

5 OBJECTIVES OF STUDY

5.1 To evaluate fasting plasma glucose as a screening test for gestational diabetes mellitus – its' sensitivity and specificity.

5.1.1 To assess sensitivity and specificity of fasting plasma glucose level of ≥7.0 mmol/l in detecting gestational diabetes mellitus as a whole.

5.1.2 To assess sensitivity and specificity of fasting plasma glucose level of ≥7.0 mmol/l in detecting subcategory gestational diabetes mellitus.

5.1.3 To assess sensitivity and specificity of fasting plasma glucose level between ≥ 6.1 to < 7.0 mmol/l or impaired fasting glucose (IFG) in detecting subcategory gestational impaired glucose tolerance.

5.1.4 To select the cut point that jointly maximizes sensitivity and sensitivity in detecting gestational diabetes mellitus as a whole.

5.2 To determine demographic distribution of gestational diabetes mellitus.

5.3 To assess the proportions of gestational diabetes mellitus picked up by selective screening using historical risk factors alone.

6 METHODOLOGY

This is a hospital-based, cross-sectional study done in Obstetric and Gynaecology clinic in Hospital University Science Malaysia from July 1999 till October 2000. Selection of patients was done during booking clinic.

All patients were included in the study except those who are:

- diabetics outside pregnancy
- at more than 28 weeks of gestation during booking
- not willing to participate in the study

At enrollment, explanation was given regarding the study and verbal consent was obtained. A standardized questionnaire was completed and weight and height of each patient was measured. Patient was given an appointment for the oral glucose tolerance test (OGTT) between 24th and the 28th weeks of pregnancy. However, there were patients who defaulted and some of them presented later than the initial appointment given after being reminded.

A standardized 2-h 75-g anhydrous glucose tolerance test was done after an overnight fast of at least 8 hours. GDM is defined according to the Definition, Diagnosis and Classification of Diabetes Mellitus and its Complications. Part 1:Diagnosis and Classification of Diabetes Mellitus Provisional Report of a WHO Consultation (53).

Venous plasma glucose level was measured using glucose oxidase method in the hospital laboratory.

Glycemic alterations were defined on the basis of the fasting and 2-h post glucose levels and pregnant women who meet WHO criteria for diabetes mellitus or IGT are classified as having GDM as a whole.

Table 6.1 Values for diagnosis of subcategories of gestational diabetes mellitus

	Glucose concentration (mmol/l)
Subcategory Gestational Diabetes Mellitus: Fasting ***or*** 2-h post glucose load ***or both***	≥ 7.0 ≥ 11.1
Subcategory Gestational Impaired Glucose Tolerance (GIGT): Fasting ***and*** 2-h post glucose load	< 7.0 ≥ 7.8 and < 11.1
Gestational Diabetes Mellitus as a whole:	Both subcategories included

Screening properties of calculated sensitivity, specificity, predictive values (positive and negative) and the percentage of women categorized as positive for each value of FPG were calculated according to standard procedures.

Receiver operator characteristic (ROC) curves were plotted to allow the choice of cut points that optimize sensitivity and specificity. With this, a comparison of sensitivity with the false-positive rate is made for each cut point (27.9,10). The left superior corner of the curve represents the cut point that jointly maximizes sensitivity and specificity. When this is not clearly evident, the point at which a diagonal line (from maximal sensitivity to minimal false-positive rate) intercepts the curve can be used. Secondly, a

value that maximizes sensitivity without undue loss of specificity of at least 50% was examined.

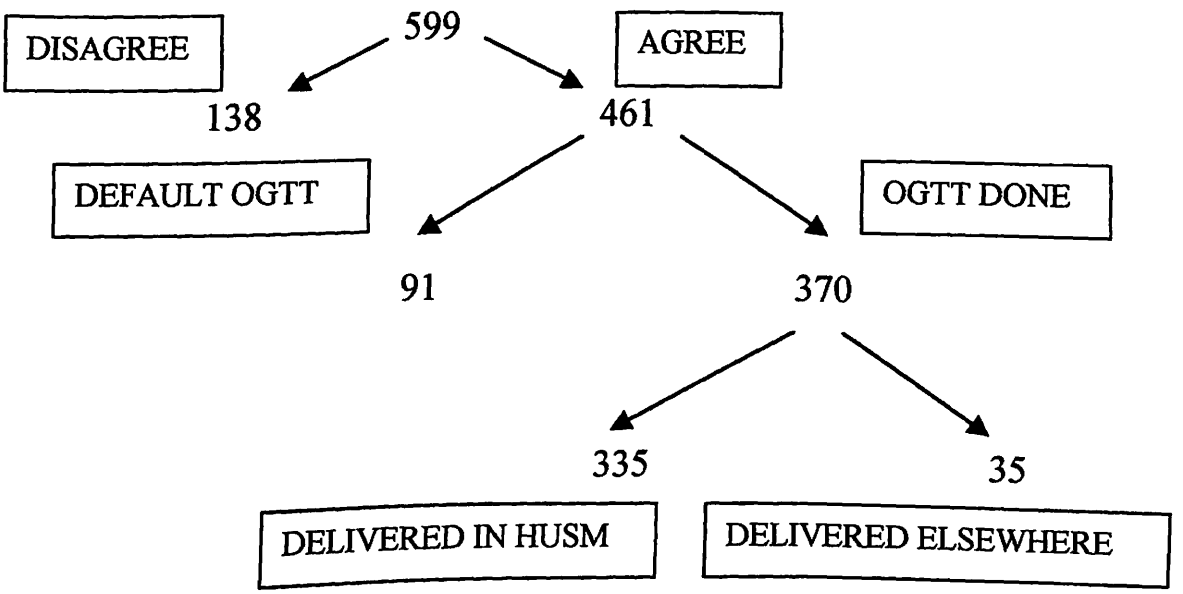
Analyses were performed using Epi-Info version 6.02 and SPSS 9.0 for Windows.

7 RESULTS

7.1 General outcome

This is a hospital-based study conducted from July 1999 till October 2000 during antenatal booking clinic. Out of 599 patients who were interviewed, 461 agreed to participate in the study. However, 91 of them did not turn up for an oral glucose tolerance test (OGTT) at the appointed time. From 370 patients who completed the test, 35 of them delivered at another delivery centre.

Figure 7.1 Outcome of patients who enrolled for the study

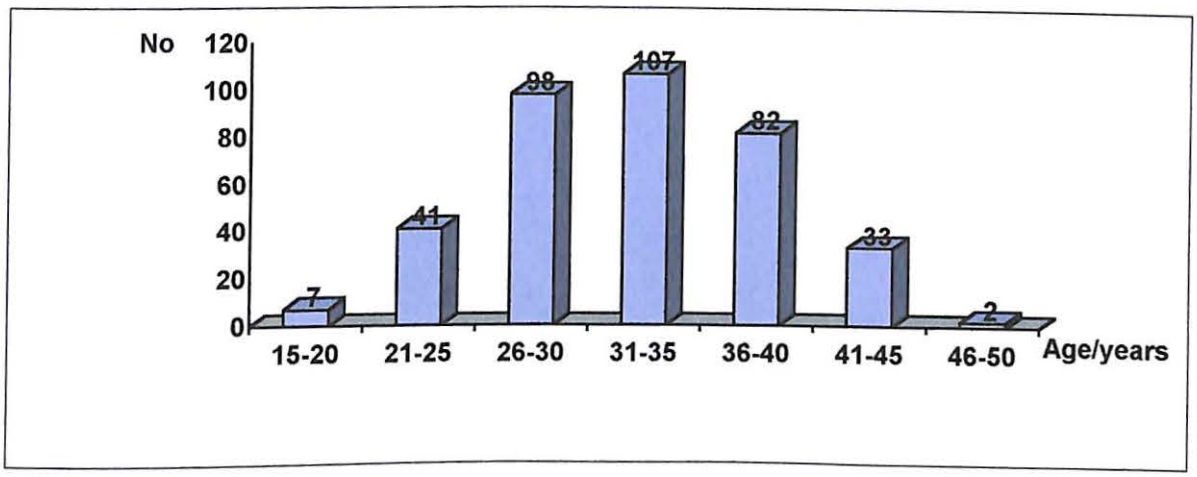


7.2 Epidemiological background

7.2.1 Age group

The patients' age were noted in term of 'completed years' then converted into various age groups. The mean age of the 370 women was 32.34 ± 6.01 years of age.

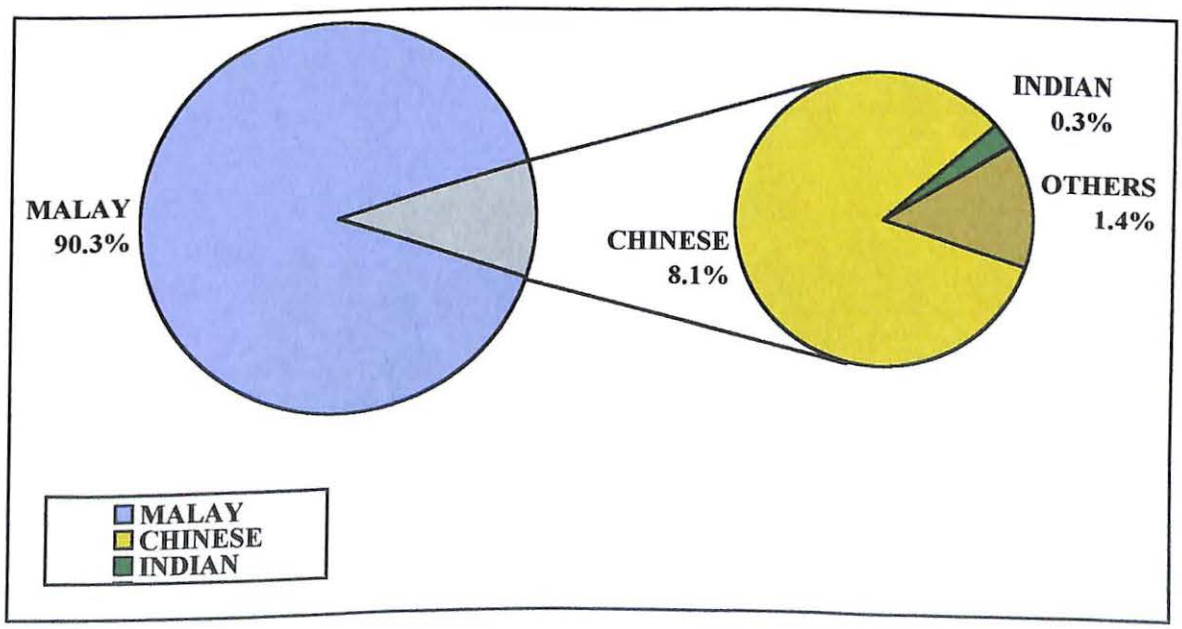
Figure 7.2 Distribution of patients according to age groups (completed years)



7.2.2 Ethnic group

The majority of patients involved in this study were Malay followed by Chinese, others (Siamese) and Indian. This correlate well with the distribution of population in the state.

Figure 7.3 Distribution of patients according to ethnic distribution

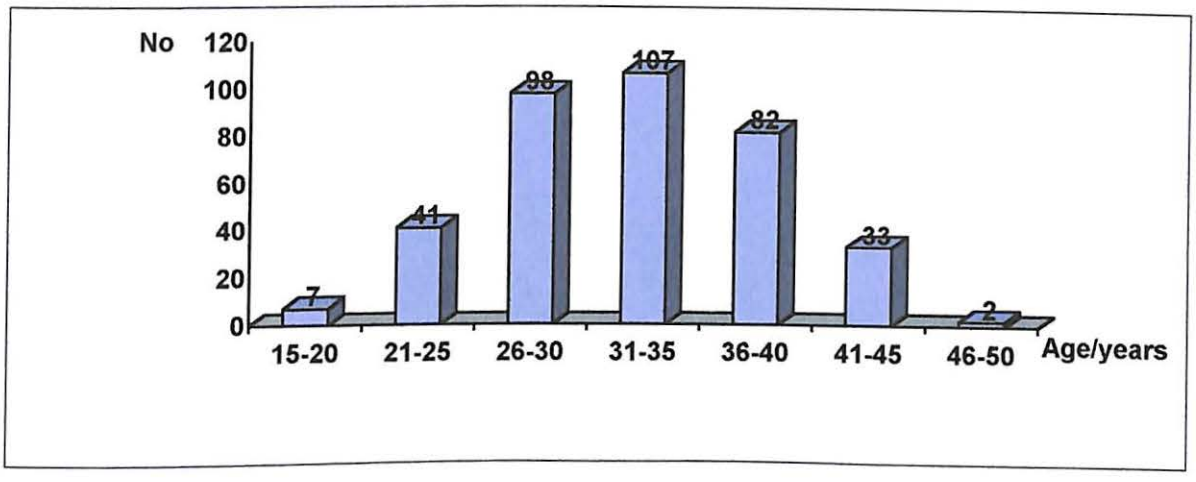


7.2 Epidemiological background

7.2.1 Age group

The patients' age were noted in term of 'completed years' then converted into various age groups. The mean age of the 370 women was 32.34 $\pm$ 6.01 years of age.

Figure 7.2 Distribution of patients according to age groups (completed years)



7.2.2 Ethnic group

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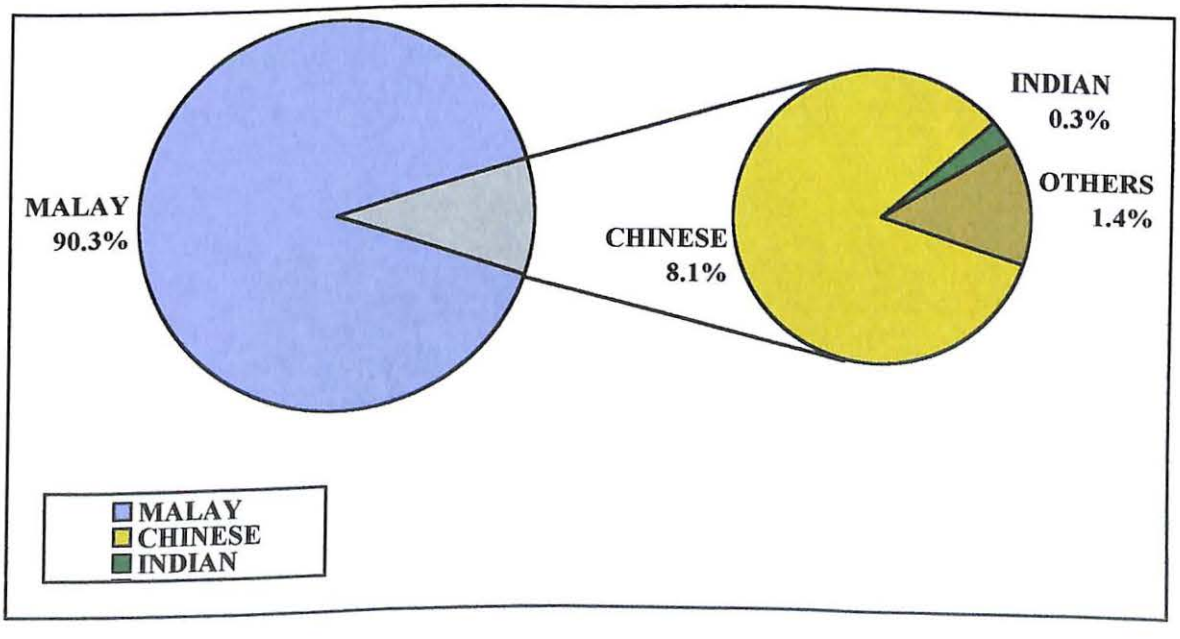
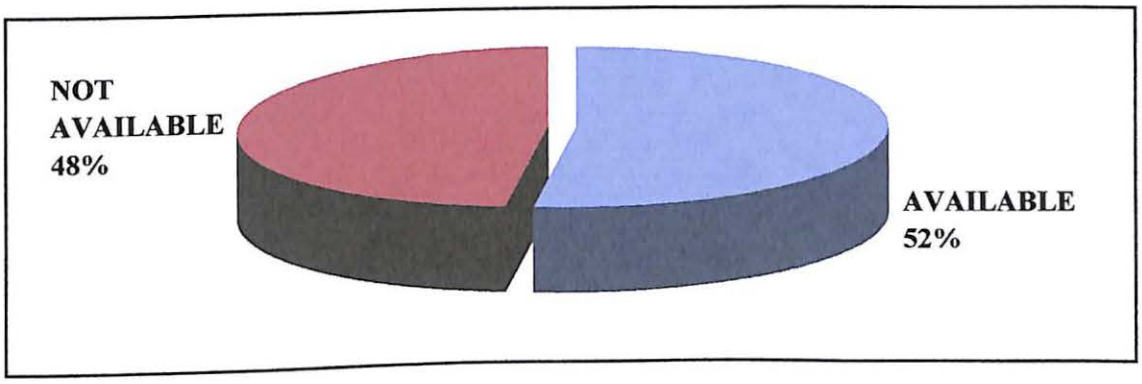


7.2.3 Prepregnancy weight data

To calculate body mass index, patients were asked about their prepregnancy weight from their memory. Only about more than half of total could recall the data. Among those who were not able to give their prepregnancy weight, weight at booking were taken which were either in the first trimester (9.2%), the second trimester (32.4%) or the third trimester (6.2%).

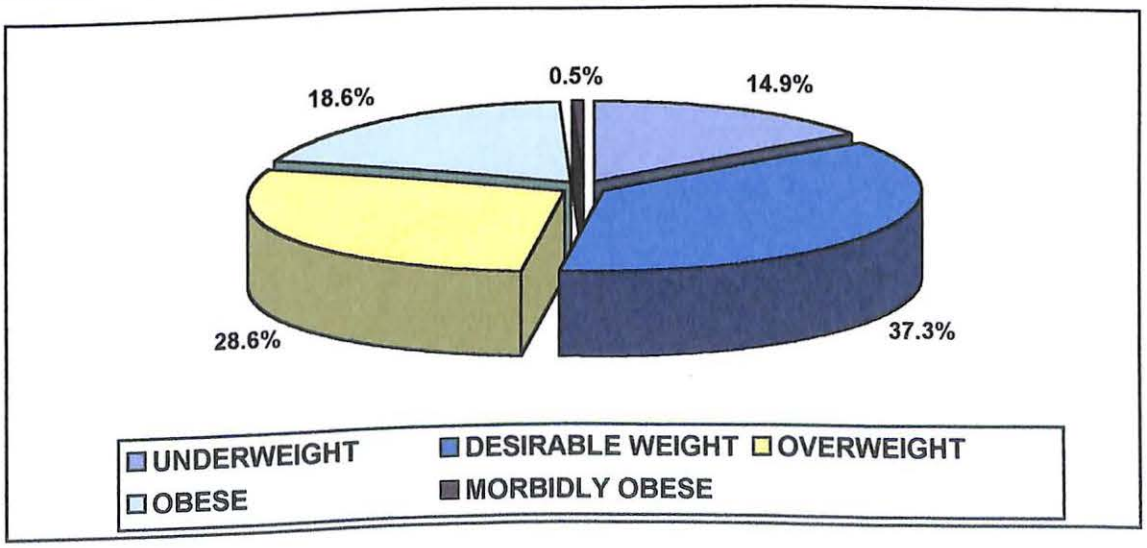
Figure 7.4 Prepregnancy weight data



7.2.4 Grades of obesity according to body mass indices (BMI)

BMI that was calculated from the available data ranged from 15.0 to 49.1 kg/m² with a mean of 25.15 ± 5.1 kg/m². From 370 patients, 177 (47.8%) of patients had BMI more than the desirable weight.

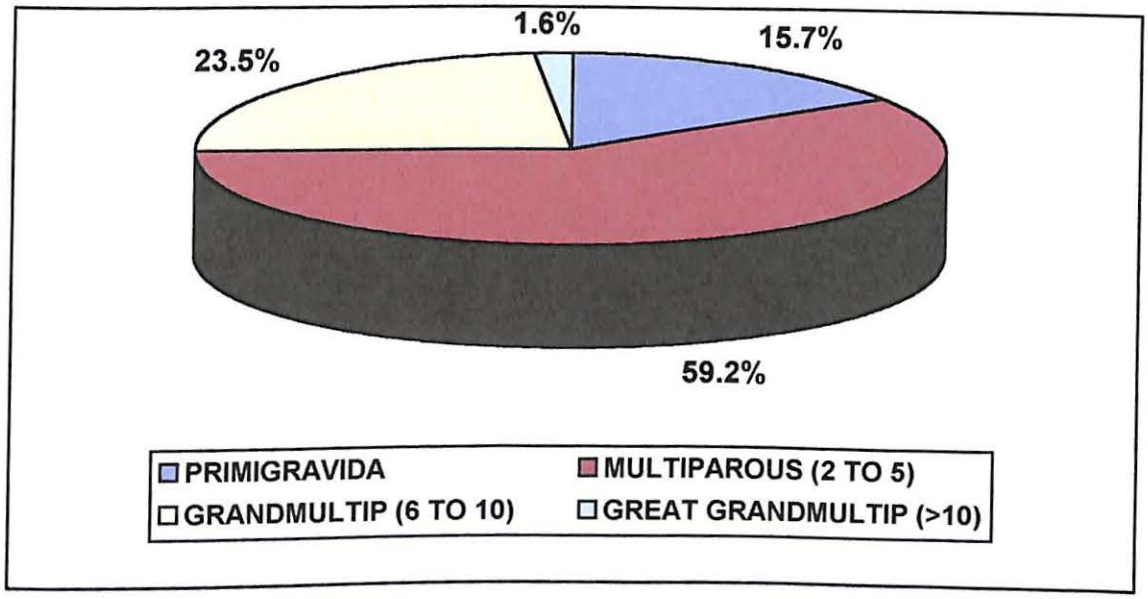
Figure 7.5 Distribution of patients according to grades of obesity



7.2.5 Gravidity

Majority of patients were multigravidas with 59.2% were gravidae 2 to 5 and 23.5% were gravidae 6 to 10. The highest gravidity is 14. Primigravida made up15.7% of the studied population.

Figure 7.6 Distribution of patients according to gravidity



7.2.6 Income group

Middle-income group made up 64.3% of the patients in the study group. Almost a third of them were in the high-income group.

Figure 7.7 Distribution of patients according to income groups