

## Glycaemic, Blood Pressure and Low Density Lipoprotein Cholesterol Control in Adult Patients with Diabetes in Singapore: A Review of Singapore Literature Over Two Decades

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### Abstract

**Introduction:** Diabetes mellitus is a burgeoning global health epidemic, with an estimated 422 million people living with diabetes in 2014. The number of adult diabetic patients in Singapore is expected to rise to 1 million in 2050. Despite advances made in the management of diabetes and improvements in healthcare accessibility and delivery, the rate and complications of diabetes (myocardial infarction, stroke, kidney failure and lower limb amputation) in Singapore have not decreased. Gaps between guidelines and practice have been reported in several parts of the world. In this narrative review, we aimed to describe the control of diabetes in Singapore over the past 20 years. **Materials and Methods:** We reviewed studies describing, or trials intervening in, the glycaemic, blood pressure (BP) and low density lipoprotein cholesterol (LDL-C) control of adult diabetic patients in Singapore published over the past 20 years (1997-2016). Studies selected from comprehensive electronic databases searches were reviewed by 4 reviewers (2 primary care physicians, 1 diabetologist and 1 public health epidemiologist). The GRADE approach was used to evaluate the quality of evidence. **Results:** We included 23 articles involving 257,097 subjects. There were 9 longitudinal, 12 cross-sectional and 2 case-control studies. All studies reported mean/median HbA1c between 7.2%-8.6%. BP ranged between 126.5-144 mmHg (systolic) and 70-84 mmHg (diastolic) in 9 studies. Nine studies reported LDL-C between 2.4-3.3 mmol/L. **Conclusion:** Mirroring global patterns, the glycaemic, BP and LDL-C control in adult diabetic patients in Singapore do not appear to be treated to target in the majority of patients.

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**Key words:** Glycated Haemoglobin (HbA1c), Hypertension, Lipid

Diabetes mellitus (DM) is a burgeoning global health epidemic, with an estimated 422 million people living with DM in 2014.<sup>1</sup> The prevalence of DM amongst Singaporean adults aged 18 to 69 years mirrors global trends, increasing from 8.2% in 2004<sup>2</sup> to 11.3% in 2010.<sup>3</sup> It is estimated that Singapore will have half a million people with diabetes by 2020, and this will rise to 1 million by 2050.<sup>4</sup>

According to figures from the Singapore National Registry of Diseases, 1 in 2 diabetics suffered from ischaemic heart disease; 2 in 3 who had newly diagnosed renal failure were diabetics; 2 in 5 with strokes suffered from DM; and about

1500 amputations per year arose as a complication of DM.<sup>5</sup> In Singapore, the total direct and indirect economic costs of diabetes for the entire working-age diabetes population was US\$787 million in 2010. This is expected to increase to US\$1867 million in 2050.<sup>6</sup>

It is well established that glycaemic control (measured by glycosylated haemoglobin, HbA1c) correlates with both microvascular and macrovascular complications.<sup>7-10</sup> Hypertension also contributes to the risk of DM complications. The coexistence of both hypertension and DM increases the risks of heart failure, nephropathy and

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other microvascular events.<sup>11-12</sup>

Low density lipoprotein cholesterol (LDL-C) is an important determinant in the atherogenic pathway leading to cardiovascular diseases<sup>13</sup> and is identified as a primary target of lipid treatment in all diabetic guidelines.<sup>14</sup>

Current international guidelines recommend management of patients with DM to HbA1c <7.0%, blood pressure (BP) <140/90 mmHg and 30%-50% reduction in LDL-C for most patients.<sup>14-15</sup> Singapore also adopts rather similar glycaemic, BP and LDL-C targets of <7.0% or <53 mmol/L, 140/80 mmHg and <2.6 mmol/L for the majority of non-pregnant diabetic adults.<sup>16</sup> The Singapore lipid clinical practice guidelines (CPG) stratifies patients according to risk of coronary artery disease and recommends a treat-to-target strategy for lipid control.<sup>17</sup>

Despite advances made in understanding the pathophysiology of diabetes and its management, as well as improvements in healthcare accessibility and delivery, the rates of cardiovascular endpoints and amputation in Singapore have not decreased, and in some cases, increased. Despite established guidelines, a gap between guidelines and practice in the management of diabetes has been reported in several parts of the world.<sup>18-21</sup> It is important to identify if such gaps also exist in Singapore. By reviewing the literature published over the past 20 years, we aimed to provide an overview of the glycaemic, BP and LDL-C control in adult patients with diabetes in Singapore. In this paper, we reviewed studies describing, or trials intervening in, the glycaemic, BP and LDL-C control of adult patients with diabetes in Singapore.

## Materials and Methods

### Search Strategy

Comprehensive searches of electronic databases including PubMed and the Cochrane Central Register of Controlled Trials (CENTRAL) were made in October 2016 for relevant articles. The references of review articles and of included original publications were also screened for potentially relevant studies.

PubMed and CENTRAL database searches were conducted with a combination of 'Diabetes Mellitus', 'Glycaemic control', 'HbA1c', 'Haemoglobin A, glycosylated', 'Blood pressure/BP', 'Cholesterol, LDL' and 'Singapore' as search terms.

The initial search identified 2167 citations from PubMed and 38 from CENTRAL, respectively. After screening of the titles of the citations for relevance, 103 articles were accepted for further screening and abstracts of these articles were reviewed. Articles that did not discuss glycaemic, BP or lipid control in diabetic patients managed in Singapore

were excluded.

Of these, a total of 28 studies were identified as potentially meeting the inclusion criteria and were included for the review. Another 3 studies were identified by hand search of bibliographic references of the 28 shortlisted studies. From these 31 articles, 8 were excluded due to similar study cohorts (3 studies), non-representative study (2 studies) and no relevant outcome parameters measured (3 studies). Eventually, 23 studies (9 longitudinal cohort, 12 cross-sectional and 2 case-control) were selected for review.

The selection process is shown in Figure 1. The following information was extracted from the 23 articles: type of study, grade of evidence, characteristics of study population, glycaemic control measured by glycosylated haemoglobin (HbA1c in %), BP readings (mmHg) and LDL-C (mmol/L).

### Inclusion and Exclusion Criteria

Articles with adult diabetic cohorts managed in Singapore were included. Clinical parameters included HbA1c, BP and lipid control. Article types were restricted to clinical trials, cohort, case-control and cross-sectional studies involving human subjects, practice guidelines and review articles that were published within the past 20 years (1997 onwards). Studies focusing on paediatric and youth populations, gestational diabetes, surgical interventions, animal studies and non-English language articles were excluded.

### Methods of Review

Members of the study team included 2 family physicians, a diabetologist and public health epidemiologist. One reviewer independently screened citations and abstracts to identify potentially suitable articles meeting the inclusion criteria. Full text articles were retrieved and data extraction of relevant study information of articles meeting the inclusion criteria was summarised. This was then reviewed by 3 other reviewers.

### Validity Assessment

The GRADE (Grades of Recommendation, Assessment, Development and Evaluation) approach that is adopted by major international organisations including the World Health Organisation (WHO) and Cochrane Collaboration was used to evaluate the quality of evidence. The strength of evidence was graded as high, moderate, low, very low or insufficient.

### Analyses

Descriptive statistics present the data from the selected articles tabulated by outcome parameters (HbA1c, BP and LDL-C) and methodology (longitudinal cohort studies, case-control studies, cross-sectional studies).

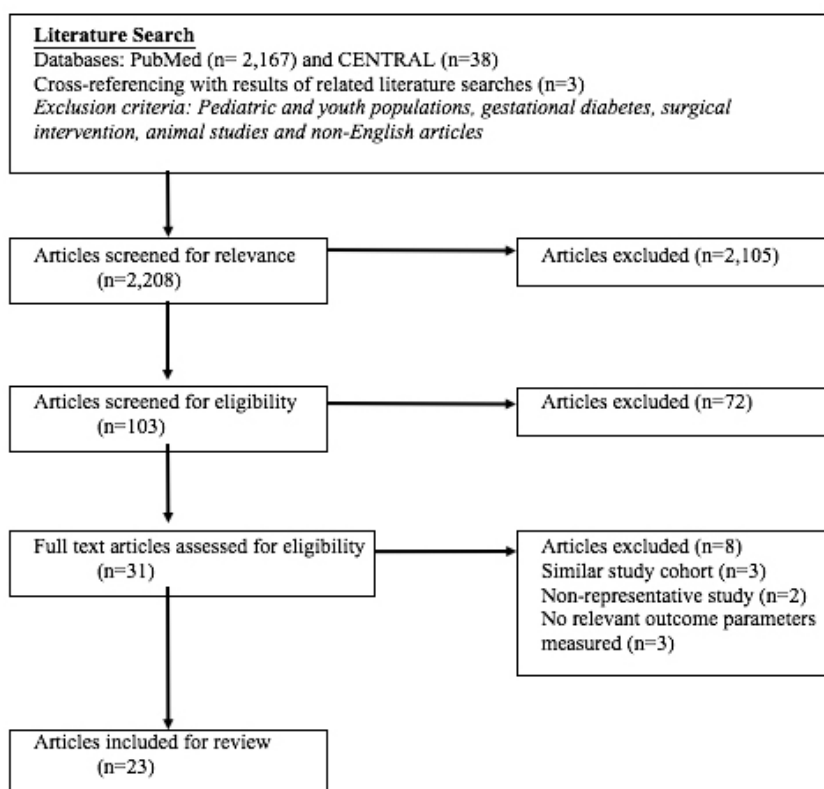


Fig. 1. Chart showing the selection process.

## Results

A total of 23 studies that reported quantitative information about the glycaemic and/or BP and/or LDL-C control in Singaporean patients are included in this review.<sup>2,3,22-42</sup> We summarised the findings by individual outcomes of interest, study design and site of care.

### Glycaemic Control

The level of glycaemic control measured by HbA1c (%) is presented in Tables 1-3. In general, the average HbA1c of 257,097 subjects studied across 23 studies ranged between 7.2% to 8.6%. Of the 23 studies, 9 were conducted in the primary healthcare setting, while 7 were in tertiary care. The remaining 7 cohorts had patients managed in both primary and tertiary care.

All except one were conducted on multiethnic cohorts, with Chinese being the predominant ethnic group. Chinese had consistently better glycaemic control compared to Malays and Indians.<sup>2,3,23,25,26,30,32</sup> In the Malay-only study, 3280 Malay diabetic adults aged 40-80 years had a mean HbA1c of 8.0% with only 26.9% having an optimal HbA1c <7%.<sup>39</sup>

The average age of subjects in the studies ranged between

46-62 years old. About 43.1%-92.7% of the subjects were reported to be on oral antidiabetic drugs (OADD), while 3.9%-38.8% were on insulin therapy. The reported average duration of diabetes ranged between 7.0-12.1 years.

In addition, elderly patients appeared to have better glycaemic control. Heng et al reported more than half of those aged 65-84 years, and about 2/3 of all aged 85 years and above achieved HbA1c <7%.<sup>30</sup> Toh et al reported the mean HbA1c among patients under Geriatric Medicine to be 6.9%. This was the lowest when compared to those managed in other subspecialties. Furthermore, significantly more patients in Geriatric Medicine had HbA1c <7% (65% vs 40.9%-52.5%,  $P = 0.003$ ).<sup>37</sup> A similar finding was observed by Quah et al in their study based in the primary care setting.<sup>31</sup> When compared to patients aged <60 years, those aged between 60-69 years and >70 years were less likely to have HbA1c >8.0% (adjusted OR 0.42 and 0.38, respectively).<sup>31</sup>

Those with macro- and micro-albuminuria had poorer glycaemic control compared to those with normoalbuminuria (7.7% vs 7.4% vs 7.2%,  $P < 0.001$ ).<sup>33</sup> Also, Foo et al reported the intrapersonal mean HbA1c (iM-HbA1c) to be higher in multiethnic cohort of patients with moderate diabetic

Table 1. Longitudinal Studies

Managed in Primary Care Setting	Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Ng et al, 2005* GRADE: low	Prospective cohort study (follow-up of 3 years) Sample size: 500	<ul style="list-style-type: none"> <li>Recruitment from 2 polyclinics in 1999</li> <li>Multiethnic/type 2 DM, not on insulin</li> <li>Mean age: 53.9 ± 6.9 years</li> <li>Median duration of DM: 7.0 years</li> <li>Type of treatment: not reported</li> </ul>	Baseline mean HbA1c (%) All 8.3 ± 1.7% Malay 8.7 ± 1.7%/Chinese 8.2 ± 1.7%/Indian 8.2 ± 1.6% ( <i>P</i> < 0.032) Mean HbA1c at 3-year follow-up (%) All 7.6 ± 1.1 Chinese 7.4 ± 0.2/Malay 7.9 ± 1.3/Indian 7.8 ± 1.3 ( <i>P</i> = 0.003)	Data not available	Data not available	
Tan et al, 2015† GRADE: low	Longitudinal cohort study Sample size: 1256	<ul style="list-style-type: none"> <li>Recruited from single polyclinic in 2007</li> <li>Multiethnic/type 2 DM</li> <li>Mean age: 57.5 ± 8.9 years</li> <li>Duration of DM: not reported</li> <li>Type of treatment: OADD (76%)/insulin (15%); anti-hypertensive medications (85%); ACEI 252 (24%)</li> </ul>	Baseline mean HbA1c (%) 7.7 ± 1.7	Baseline mean BP (mmHg) 131.9 ± 16.2 75.0 ± 9.7		

ACEI: Angiotensin converting enzyme inhibitor; BP: Blood pressure; CVA: Cerebrovascular accident; DM: Diabetes mellitus; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; HbA1c: Glycated haemoglobin; IHD: Ischaemic heart disease; LDL: Low density lipoprotein; NHG: National Healthcare Group; OADD: Oral antidiabetic drugs; PCC: Primary care clinic; PHC: Primary health clinic; RH: Restructured hospital; SOC: Specialist outpatient clinic

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†Tan NC, Barbier S, Lim WY, Chia KS. 5-Year longitudinal study of determinants of glycaemic control for multi-ethnic Asian patients with type 2 diabetes mellitus managed in primary care. *Diabetes Res Clin Pract* 2015;110:218-23.

‡Wee SL, Tan CGP, Ng HS, Su S, Tai VU, Flores JV, et al. Diabetes outcomes in specialist and general practitioner settings in Singapore: challenges of right-siting. *Ann Acad Med Singapore* 2008;37:929-35.

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Table 1. Longitudinal Studies (Cont'd)

Managed in Tertiary Care	Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Wee et al, 2008 <sup>‡</sup> GRADE: very low	Retrospective cohort study Sample size: 383	Recruited consecutive referrals to single tertiary DM clinic from January to March 2005	<ul style="list-style-type: none"> <li>• Mean age: 57.5 ± 12.7 years</li> <li>• Duration of DM: not reported</li> <li>• Type of treatment: not reported</li> </ul>	Baseline mean HbA1c (%) 8.43 ± 2.14	Baseline mean BP (mmHg) 134.9 ± 21.0 77.6 ± 10.6	Baseline mean LDL (mmol/L) 2.89 ± 1.05
Hoe et al, 2012 <sup>§</sup> GRADE: low	Prospective cohort study Sample size: 87	Recruited from tertiary care DM clinic between April to June 2007	<ul style="list-style-type: none"> <li>• Multietnic/type 2 DM patients</li> <li>• A total of 14.6% had a history of IHD and 4.9% had CVA</li> <li>• Mean age: 54.9 ± 13.0 years</li> <li>• Mean duration of DM: 8.8 ± 7.4 years</li> <li>• Type of treatment: not reported</li> </ul>	Baseline median HbA1c (%) 7.7 (range 5.6 to 13.8)	Data not available	Data not available

ACEI: Angiotensin converting enzyme inhibitor; BP: Blood pressure; CVA: Cerebrovascular accident; DM: Diabetes mellitus; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; HbA1c: Glycated haemoglobin; IHD: Ischaemic heart disease; LDL: Low density lipoprotein; NHG: National Healthcare Group; OADD: Oral antidiabetic drugs; PCC: Primary care clinic; PHC: Primary health clinic; RH: Restructured hospital; SOC: Specialist outpatient clinic

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Table 1. Longitudinal Studies (Cont'd)

Managed in Tertiary Care	Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
	Dalan et al, 2013 <sup>1</sup> GRADE: low	Retrospective cohort study Sample size: 246	<ul style="list-style-type: none"> <li>Recruited from DM clinic from a single regional hospital between 2007 to 2008</li> <li>Multiethnic population/type 2 DM patients</li> <li>Mean age: 55.8 ± 13 years</li> <li>Mean duration of DM: not reported</li> <li>Type of treatment: not reported</li> </ul>	Baseline mean HbA1c (%) 8.1 ± 1.7	Baseline mean BP (mmHg) 135.0 ± 19.8 73.4 ± 10.3	Baseline mean LDL-C (mmol/L) 2.7 ± 0.9
	Liu et al, 2015 <sup>†</sup> GRADE: low	Prospective cohort study Sample size: 2337	<ul style="list-style-type: none"> <li>Recruited from tertiary care DM clinics from a single regional hospital</li> <li>Multiethnic/type 2 DM patients</li> <li>Mean age at entry: 57.9 ± 11.9 years</li> <li>Duration of DM: 10 years (range: 5.0 to 17.0)</li> <li>Type of treatment: not reported</li> </ul>	Baseline mean HbA1c (%) All 8.3 ± 1.8 Chinese 8.2 ± 1.8 Malay 8.5 ± 2.1 Indian 8.5 ± 1.5 <i>P</i> < 0.0001	Baseline mean BP (mmHg) All 136 ± 20 Chinese 137 ± 19/ Malay 140 ± 23/ Indian 131 ± 18 ( <i>P</i> < 0.0001) All 78 ± 11 Chinese 78 ± 11/ Malay 78 ± 12/ Indian 77 ± 10 ( <i>P</i> = 0.383)	Baseline mean LDL (mmol/L) All 2.8 ± 0.9 Chinese 2.8 ± 0.9/ Malay 3.0 ± 1.1/ Indian 2.9 ± 0.8 ( <i>P</i> < 0.0001)
	Low et al, 2016 <sup>#</sup> GRADE: low	Retrospective cohort study Sample size: 3006	<ul style="list-style-type: none"> <li>Recruited from DM clinic from single regional hospital managed between 2003 to 2011</li> <li>Multiethnic population/type 1 + 2 DM patients</li> <li>Mean age: 46.1 ± 12.2 years</li> <li>Mean duration of DM: 12.1 ± 8.8 years</li> <li>Type of treatment: not reported</li> </ul>	Baseline mean HbA1c (%) 8.6 ± 2.0 Indian 8.6 ± 2.0 Malay 8.5 ± 2.3 Chinese 8.2 ± 1.9 ( <i>P</i> = 0.0001)	Baseline mean systolic BP (mmHg) 136.9 ± 20.7 Malay 139.6 ± 24.0 Chinese 137.0 ± 20.0 Indian 132.7 ± 18.7 ( <i>P</i> = 0.0001)	Baseline mean LDL (mmol/L) 2.8 ± 1.0 Malay 3.0 ± 1.2 vs Indian 2.9 ± 0.9 vs Chinese 2.8 ± 1.0 ( <i>P</i> = 0.050)

ACEI: Angiotensin converting enzyme inhibitor; BP: Blood pressure; CVA: Cerebrovascular accident; DM: Diabetes mellitus; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; HbA1c: Glycated haemoglobin; IHD: Ischaemic heart disease; LDL: Low density lipoprotein; NHG: National Healthcare Group; OADD: Oral antidiabetic drugs; PCC: Primary care clinic; PHC: Primary health clinic; RH: Restructured hospital; SOC: Specialist outpatient clinic

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Table 1. Longitudinal Studies (Cont'd)

Managed in Primary and Tertiary Care	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Lee et al, 2001** GRADE: low	Retrospective cohort study Sample size: 1697	<ul style="list-style-type: none"> <li>Recruited from 22 centres (1145 PHC, 552 RH) from 1 March 1998 to 30 April 1998</li> <li>Multiethnic/type 1 + 2 DM patients</li> <li>Mean age: PHC 61.3 ± 11.2 years, RH 51.5 ± 17.7 years</li> <li>Mean duration of DM: PHC 9.2 ± 6.8 years, RH 12.0 ± 8.5 years</li> <li>Types of treatment: insulin (PHC – 6.4%, RH – 52.5%) OADD only (PHC – 83.5%, RH 43.1%)</li> </ul>	<p>Baseline mean HbA1c (%)</p> <p>7.8 ± 1.9 (PHC) 8.2 ± 1.9 (RH)</p> <p>Baseline proportion of type 2 DM with HbA1c &lt; 7%</p> <p>Chinese males (highest in all age groups except 85+ year old)</p> <p>&lt;45 year old – 36.4% 45 to 64 year old – 43.6% 65 to 84 year old – 55.7%</p> <p>Malay males (highest in 85+ year old age group)</p> <p>85+ year old – 68.0%</p> <p>Chinese females (highest in all age groups except 85+ year old)</p> <p>&lt;45 year old – 35.2% 45 to 64 year old – 42.6% 65 to 84 year old – 53.8%</p> <p>Malay females</p> <p>85+ year old – 69.8% (highest in 85+ year old age group)</p>	<p>Baseline systolic BP</p> <p>≥140 mmHg</p> <p>31% (PHC) 26% (RH)</p> <p>Baseline diastolic BP</p> <p>≥90 mmHg</p> <p>4% (PHC) 7% (RH)</p>	Data not available
Heng et al, 2010** GRADE: low	Retrospective cohort study Sample size: 170,513	<ul style="list-style-type: none"> <li>Recruited from the NHG chronic disease registry between 2005 to 2008</li> <li>Multiethnic population/type 2 DM patients</li> <li>Patients managed at tertiary and primary care</li> <li>Median age: males 59-61/females 63-64</li> <li>Duration of diabetes: not reported</li> <li>Type of treatment: insulin (PCC – 13.8%, SOC – 31.3%, OADD (PCC – 86.2 to 89.2%, SOC 68.7 to 71.1%)</li> </ul>	<p>Baseline proportion of type 2 DM with HbA1c &lt; 7%</p> <p>Chinese males (highest in all age groups except 85+ year old)</p> <p>&lt;45 year old – 36.4% 45 to 64 year old – 43.6% 65 to 84 year old – 55.7%</p> <p>Malay males (highest in 85+ year old age group)</p> <p>85+ year old – 68.0%</p> <p>Chinese females (highest in all age groups except 85+ year old)</p> <p>&lt;45 year old – 35.2% 45 to 64 year old – 42.6% 65 to 84 year old – 53.8%</p> <p>Malay females</p> <p>85+ year old – 69.8% (highest in 85+ year old age group)</p>	Data not available	Data not available

ACEI: Angiotensin converting enzyme inhibitor; BP: Blood pressure; CVA: Cerebrovascular accident; DM: Diabetes mellitus; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; HbA1c: Glycated haemoglobin; IHD: Ischaemic heart disease; LDL: Low density lipoprotein; NHG: National Healthcare Group; OADD: Oral antidiabetic drugs; PCC: Primary care clinic; PHC: Primary health clinic; RH: Restructured hospital; SOC: Specialist outpatient clinic

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‡‡Heng BH, Sun Y, Cheah JTS, Jong M. The Singapore National Healthcare Group diabetes registry – descriptive epidemiology of type 2 diabetes mellitus. *Ann Acad Med Singapore* 2010;39:348-52.

Table 2. Cross-Sectional Studies  
Managed in Primary Care Setting

Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Hong et al, 2004 <sup>*</sup> GRADE: low	Cross-sectional study Sample size: 967	<ul style="list-style-type: none"> <li>Recruited from single polyclinic between April 1995 to June 1997</li> <li>Multithnic/type 2 DM patients</li> <li>Mean age: Chinese 61.6 + 10.6 years, Malay 56.0 + 11.0 years, Indian 59.9 + 10.6 years (<math>P &lt; 0.001</math>)</li> <li>Median duration of diabetes: Chinese 7.0 years (IQR 9.0), Malay 4.0 years (IQR 8.0), Indian 6.5 years (IQR 11.0) <math>P = 0.11</math></li> <li>Type of treatment: OADD(%): Chinese 82.6, Malay 89.9, Indian 83.0</li> <li>Insulin (%): Chinese 4.7, Malay 4.3, Indian 5.0</li> </ul>	<p>Mean HbA1c (%)</p> <p>Chinese 7.65, Malays 8.18, Indians 8.36 (<math>P &lt; 0.01</math>)</p> <p>Age and mean HbA1c</p> <p>&lt;50 – 8.7%</p> <p>50 to &lt;70 – 8.1%</p> <p>70 and above – 7.4%</p> <p><math>P &lt; 0.01</math></p>	Data not available	Data not available
Narayanan et al, 2010 <sup>*</sup> GRADE: low	Cross-sectional study Sample size: 521	<ul style="list-style-type: none"> <li>Recruited in 9 polyclinics over 5 consecutive working days in January 2004</li> <li>Patients with PAD were older (66.8 vs 59.1 years; <math>P &lt; 0.001</math>)</li> <li>Patients with PAD had longer duration of DM: 13.92 ± 9.7 years vs 9.81 vs 8.32 years (<math>P &lt; 0.001</math>)</li> <li>More patients with PAD were on insulin (24.4% vs 10.2%; <math>P &lt; 0.001</math>)</li> </ul>	<p>Mean HbA1c (%)</p> <p>PAD 8.19 ± 1.48</p> <p>No PAD 7.89 ± 1.43</p> <p><math>P = ns</math></p>	Data not available	<p>LDL-C (mmol/L)</p> <p>PAD 3.04 ± 0.85</p> <p>No PAD 3.14 ± 1.08</p> <p><math>P = ns</math></p>

ACEI: Angiotensin converting enzyme inhibitor; ARB: Aldosterone receptor blocker; BP: Blood pressure; CAD: Coronary artery disease; CV: Cardiovascular; DM: Diabetes mellitus; DR: Diabetic retinopathy; GM: General Medicine; GP: General practitioner; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; GRM: Geriatric medicine; HbA1c: Glycated haemoglobin; IQR: Interquartile range; LDL: Low-density lipoprotein; NHGP: National Healthcare Group Polyclinics; OADD: Oral anti-diabetic drug; PAD: Peripheral arterial disease

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†Narayanan RML, Koh WP, Phang J, Subramaniam T. Peripheral arterial disease in community-based patients with diabetes in Singapore: results from a primary healthcare study. Ann Acad Med Singapore 2010;39:525-31.

‡Shim YT, Lee J, Toh MP, Tang WE, Ko Y. Health-related quality of life and glycaemic control in patients with type 2 diabetes mellitus in Singapore. Diabet Med 2012;29:e241-8.

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††Wu AY, Tan CB, Eng PH, Tan KT, Lim SC, Tan EK. Microalbuminuria prevalence study in hypertensive patients with type 2 diabetes mellitus in Singapore. Singapore Med J 2006;47:315-20.

‡‡National Health Survey 2010. Epidemiology & Disease Control Division. Ministry of Health, Singapore.

§§Huang OS, Lamoureux EL, Tay WT, Tai ES, Wang JJ, Wong TY. Glycemic and blood pressure control in an Asian Malay population with diabetes and diabetic retinopathy. Arch Ophthalmol 2010;128:1185-90.

¶¶Low SK, Sum CF, Yeoh LY, Tavintharan S, Ng XW, Lee SB, et al. Prevalence of chronic kidney disease in adults with type 2 diabetes mellitus. Ann Acad Med Singapore 2015;44:164-71.



Table 2. Cross-Sectional Studies (Cont'd)

Managed in Primary Care Setting	Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
	Shim et al, 2012 <sup>*</sup> GRADE: low	Cross-sectional study Sample size: 282	<ul style="list-style-type: none"> <li>Recruited from 2 polyclinics between September to December 2009</li> <li>Multithemic/type 2 DM patients/diet control excluded</li> <li>Mean age: 58.1 ± 8.8 years</li> <li>Duration of diabetes: 1 to &lt;5 years (26.2%), 5 to &lt;10 years (28.7%), 10 to &lt;15 years (17.4%), 15 to &lt;20 years (14.2%), &gt;20 years (13.5%)</li> <li>Type of treatment: insulin (30.1%)</li> <li>Presence of end-organ damage: 31.6%</li> </ul>	Mean HbA1c (%) 8.0 ± 1.6 HbA1c >8.0% 39.7%	Data not available	Data not available
	Quah et al, 2013 <sup>§</sup> GRADE: low	Cross-sectional study Sample size: 688	<ul style="list-style-type: none"> <li>Recruited from 8 polyclinics in January 2009</li> <li>Multithemic/type 2 DM patients</li> <li>Mean age: 62.2 ± 11.1 years</li> <li>Duration of DM: &lt;5 years (32.8%), 5 to 9.9 years (21.6%), 10 to 14.9 years (17.5%), 15 to 19.9 years (9.6%), &gt;20 years (18.5%)</li> <li>Type of treatment: OHA 92.7%, insulin 10.8%</li> </ul>	Mean HbA1c (%) 7.6 ± 1.35 Median HbA1c (%) 7.3 (5.0 to 14.0) 25.4% had HbA1c >8.0% ≥70 years HbA1c ≤8.0% (32.5%) vs HbA1c >8% (20.6%) ( <i>P</i> <0.001) <60 years HbA1c ≤8.0% (30.7%) vs HbA1c >8% (51.4%) ( <i>P</i> <0.001)	Data not available	Data not available

ACEI: Angiotensin converting enzyme inhibitor; ARB: Aldosterone receptor blocker; BP: Blood pressure; CAD: Coronary artery disease; CV: Cardiovascular; DM: Diabetes mellitus; DR: Diabetic retinopathy; GM: General Medicine; GP: General practitioner; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; GRM: Geriatric medicine; HbA1c: Glycated haemoglobin; IQR: Interquartile range; LDL: Low-density lipoprotein; NHGP: National Healthcare Group Polyclinics; OADD: Oral anti-diabetic drug; PAD: Peripheral arterial disease

<sup>\*</sup>Hong CY, Chia KS, Hughes K, Ling SL. Ethnic differences among Chinese, Malay and Indian patients with type 2 diabetes mellitus in Singapore. *Singapore Med J* 2004;45:154.

<sup>†</sup>Narayanan RML, Koh WP, Phang J, Subramaniam T. Peripheral arterial disease in community-based patients with diabetes in Singapore: results from a primary healthcare study. *Ann Acad Med Singapore* 2010;39:525-31.

<sup>‡</sup>Shim YT, Lee J, Toh MP, Tang WE, Ko Y. Health-related quality of life and glycaemic control in patients with type 2 diabetes mellitus in Singapore. *Diabet Med* 2012;29:e241-8.

<sup>§</sup>Quah JHM, Liu YP, Luo N, How CH, Tay EG. Younger adult type 2 diabetic patients have poorer glycaemic control: a cross-sectional study in a primary care setting in Singapore. *BMC Endocrine Disorders* 2013;13:18.

<sup>||</sup>Lee ES, Tang WE. The prevalence of albuminuria among diabetic patients in a primary care setting in Singapore. *Singapore Med J* 2015;56:681-6.

<sup>¶</sup>Loh PT, Toh MP, Molina JA, Yathsala A. Ethnic disparity in prevalence of diabetic kidney disease in an Asian primary healthcare cluster. *Nephrology (Carlton)* 2015; 20:216-23.

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<sup>\*\*</sup>National Health Survey 2004. Epidemiology & Disease Control Division. Ministry of Health, Singapore.

<sup>††</sup>Wu AY, Tan CB, Eng PH, Tan KT, Lim SC, Tan EK. Microalbuminuria prevalence study in hypertensive patients with type 2 diabetes mellitus in Singapore. *Singapore Med J* 2006;47:315-20.

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<sup>§§</sup>Huang OS, Lamoureux EL, Tay WT, Tai ES, Wang JJ, Wong TY. Glycemic and blood pressure control in an Asian Malay population with diabetes and diabetic retinopathy. *Arch Ophthalmol* 2010;128:1185-90.

<sup>|||</sup>Low SK, Sum CF, Yeoh LY, Tavintharan S, Ng XW, Lee SB, et al. Prevalence of chronic kidney disease in adults with type 2 diabetes mellitus. *Ann Acad Med Singapore* 2015;44:164-71.

Table 2. Cross-Sectional Studies (Cont'd)

Managed in Primary Care Setting	Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
	Lee et al, 2015 <sup>†</sup> GRADE: low	Cross-sectional cohort study Sample size: 786	<ul style="list-style-type: none"> <li>Recruitment from single polyclinic from 1 August 2010 to 28 February 2011</li> <li>Multiethnic/type 2 DM patients</li> <li>Mean age: 63.95 ± 10.36 years</li> <li>Mean DM duration years: 7.04 ± 5.16 years</li> <li>Hypertensives (83.1%)</li> <li>Hypertension duration years: 7.45 ± 4.90 years</li> <li>Type of treatment: 55.7% on ACEI and/or ARB</li> </ul>	Mean HbA1c (%) 7.2 ± 1.0	Systolic BP (mmHg) 126.5 ± 19 Diastolic BP (mmHg) 70 ± 13	LDL (mmol/L) 2.40 ± 0.75
	Loh et al, 2015 <sup>†</sup> GRADE: low	Cross-sectional cohort study Sample size: 57,594	<ul style="list-style-type: none"> <li>Recruited from 11 NHGP polyclinics between 1 January 2006 to 31 December 2009</li> <li>Multiethnic/type 2 DM patients</li> <li>Mean age: 65.7 ± 11.5 years</li> <li>Mean duration of DM: 8.4 ± 5.3 years</li> <li>Type of treatment: not reported</li> </ul>	Mean HbA1c (%) 7.5 ± 1.3 HbA1c <7% 36.9% HbA1c >8% 25.2%	Data not available	Data not available

ACEI: Angiotensin converting enzyme inhibitor; ARB: Aldosterone receptor blocker; BP: Blood pressure; CAD: Coronary artery disease; CV: Cardiovascular; DM: Diabetes mellitus; DR: Diabetic retinopathy; GM: General Medicine; GP: General practitioner; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; GRM: Geriatric medicine; HbA1c: Glycated haemoglobin; IQR: Interquartile range; LDL: Low-density lipoprotein; NHGP: National Healthcare Group Polyclinics; OADD: Oral anti-diabetic drug; PAD: Peripheral arterial disease

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Table 2. Cross-Sectional Studies (Cont'd)

Managed in Tertiary Care Setting	Study, Year of Publication, and Quality of Study	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Toh et al, 2007 <sup>#</sup> GRADE: low	Cross-sectional study Sample size: 575	<ul style="list-style-type: none"> <li>Recruited from 6 medical specialties at 3 acute hospitals</li> <li>Patients on continuous care for minimum of 15 months from October 2003 to April 2005</li> <li>Multithnic/type 2 DM patients</li> <li>Excluded if co-managed by diabetes centres or primary clinics</li> <li>Age: &lt;55 years – 20.2%, 55 to 64 years – 24.0%, 65 to 74 years – 27.0%, 75 to 84 years – 21.6%, &gt;85 years – 7.3%</li> <li>Duration of diabetes: not reported</li> <li>Type of treatment: not reported</li> </ul>	<p>Mean HbA1c (%)</p> <p>7.3 ± 1.5</p> <p>Cardio 7.5 ± 1.4</p> <p>GM 7.5 ± 1.6</p> <p>GRM 6.9 ± 1.3</p> <p>Others 7.3 ± 1.6</p> <p>P = 0.016</p>	<p>Mean BP (mmHg)</p> <p>137.1 ± 19.4</p> <p>77.6 ± 9.0</p>	<p>LDL-C (mmol/L)</p> <p>2.72 ± 0.85</p> <p>Cardio 2.56 ± 0.83</p> <p>GM 2.88 ± 0.92</p> <p>GRM 2.6 ± 0.94</p> <p>Others 2.75 ± 0.68</p> <p>P = 0.011</p>	
<b>Managed in Primary and Tertiary Care Setting</b>						
Epidemiology & Disease Control Division, Ministry of Health, Singapore 2004 <sup>**</sup> GRADE: very low	Population-based national health survey Sample size: 7275 (57.3% response rate, 4168 responders)	<ul style="list-style-type: none"> <li>National cross-sectional survey done 10 September to 4 December 2004</li> <li>Multithnic/type 1+2 DM patient aged 18 to 74 years old</li> <li>Patients managed at tertiary and primary care</li> <li>Mean/median age: not reported</li> <li>Duration of diabetes: not reported</li> </ul>	<p>Mean HbA1c</p> <p>7.6%</p> <p>Proportion of known diabetic patients with HbA1c &gt;8.0%</p> <p>27.6%</p> <p>Proportion of patients on treatment with HbA1c &gt;8.0%</p> <p>28.7%</p> <p>Proportion of HbA1c &gt;8.0% by ethnicity</p> <p>Indian (36.8%), Malay (31.1%), Chinese (24.2%)</p>	Data not available	Data not available	Data not available

ACEI: Angiotensin converting enzyme inhibitor; ARB: Aldosterone receptor blocker; BP: Blood pressure; CAD: Coronary artery disease; CV: Cardiovascular; DM: Diabetes mellitus; DR: Diabetic retinopathy; GM: General Medicine; GP: General practitioner; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; GRM: Geriatric medicine; HbA1c: Glycated haemoglobin; IQR: Interquartile range; LDL: Low-density lipoprotein; NHGP: National Healthcare Group Polyclinics; OADD: Oral anti-diabetic drug; PAD: Peripheral arterial disease

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Table 2. Cross-Sectional Studies (Cont'd)

Managed in Primary and Tertiary Care Setting	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Wu et al, 2006 <sup>**</sup> GRADE: low	Cross-sectional study Sample size: 499	<ul style="list-style-type: none"> <li>Recruited from 5 diabetes and 15 GP clinics between May to December 2002</li> <li>Multiethnic/type 2 DM patients</li> <li>Mean age: 58.26 ± 11.48 years</li> <li>Mean duration of hypertension: 7.54 ± 7.67 years</li> <li>Mean duration of DM: 8.64 ± 7.61 years</li> <li>A total of 97.2% were receiving antihypertensive therapy</li> <li>Type of treatment: not reported</li> <li>A total of 16.8% of patients had known CV complications</li> </ul>	<p>Mean HbA1c (%)</p> <p>7.9</p>	<p>Mean BP (mmHg)</p> <p>144 ± 19</p> <p>84 ± 9</p> <p>Systolic/diastolic BP</p> <p>&lt;130/85 mmHg</p> <p>22.2%</p>	Data not available
Epidemiology & Disease Control Division, Ministry of Health, Singapore, 2010 <sup>**</sup> GRADE: very low	Population-based national health survey Sample size: 7512 (57.7% response rate, 4337 responders)	<ul style="list-style-type: none"> <li>National cross-sectional survey done from 17 March to 13 June 2004</li> <li>Multiethnic/type 1+2 DM patient aged 18 to 79 years old</li> <li>Patients managed at tertiary and primary care</li> <li>Mean/median age: not reported</li> <li>Duration of diabetes: not reported</li> </ul>	<p>Mean HbA1c</p> <p>7.7%</p> <p>Proportion of known diabetic patients with HbA1c &gt;8.0%</p> <p>32.0%</p> <p>Proportion of patients on treatment with HbA1c &gt;8.0%</p> <p>28.6%</p> <p>Proportion of HbA1c &gt;8.0% by ethnicity</p> <p>Malay (47.6%), Indian (37.9%), Chinese (24.9%)</p>	Data not available	Data not available

ACEI: Angiotensin converting enzyme inhibitor; ARB: Aldosterone receptor blocker; BP: Blood pressure; CAD: Coronary artery disease; CV: Cardiovascular; DM: Diabetes mellitus; DR: Diabetic retinopathy; GM: General Medicine; GP: General practitioner; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; GRM: Geriatric medicine; HbA1c: Glycated haemoglobin; IQR: Interquartile range; LDL: Low-density lipoprotein; NHGP: National Healthcare Group Polyclinics; OADD: Oral anti-diabetic drug; PAD: Peripheral arterial disease

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Table 2. Cross-Sectional Studies (Cont'd)

Managed in Primary and Tertiary Care Setting	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
Huang et al, 2010 <sup>§§</sup> GRADE: low	Cross-sectional study Sample size: 3280	<ul style="list-style-type: none"> <li>• Population-based survey between 2004 to 2006</li> <li>• Only Malays aged 40 to 80 years old surveyed</li> <li>• Mean age: 62.5 ± 9.4 years</li> <li>• Mean duration of DM: 12.1 ± 8.7 years</li> <li>• Type of treatment: OADD (58.3%), insulin (10.5%), antihypertensives (41.5%)</li> </ul>	<p>Mean HbA1c (%)</p> <p>8.0 ± 2.0</p> <p>No DR 8.2 ± 2.0 vs DR 8.9 ± 2.0 (<i>P</i> &lt; 0.001)</p> <p>Optimal HbA1c</p> <p>26.9%</p> <p>No DR 31.9% vs DR 17.4% (<i>P</i> &lt; 0.001)</p>	<p>Mean systolic BP (mmHg)</p> <p>154.6 ± 23.7</p> <p>No DR 152.1 ± 22.8 vs DR 159.4 ± 24.5 (<i>P</i> &lt; 0.001)</p> <p>Mean diastolic BP (mmHg)</p> <p>79.2 ± 11.0</p> <p>BP &lt; 130/80 mmHg 13.4%</p>	<p>LDL (mg/dL)</p> <p>127.4 ± 38.6</p> <p>No DR 131.3 ± 38.6</p> <p>DR 123.6 ± 38.6</p> <p><i>P</i> = 0.02</p>
Low et al, 2015 <sup>¶¶</sup> GRADE: low	Cross-sectional study Sample size: 1861	<ul style="list-style-type: none"> <li>• Recruited from 1 tertiary care DM clinic and 1 polyclinic from August 2011 to November 2013</li> <li>• Multiethnic/type 2 DM patients</li> <li>• HbA1c &gt; 12% excluded</li> <li>• Mean age: 57.5 ± 10.7 years</li> <li>• Mean duration of DM: 10 years (range: 4 to 16)</li> <li>• Type of treatment: insulin (29%), use of statins (81.2%)</li> <li>• Cardiovascular complications: PAD 10.1%, neuropathy 9.6%, CAD 9.7%, stroke 3.3%</li> </ul>	<p>Mean HbA1c (%)</p> <p>7.5 (6.8 to 8.5)</p> <p>HbA1c</p> <p>&lt; 7% – 30.9%</p> <p>7% to 7.9% – 31.6%</p> <p>8% to 8.9% – 19.6%</p> <p>9% to 12% – 17.9%</p> <p>HbA1c &lt; 7%</p> <p>30.9%</p>	<p>Mean systolic BP (mmHg)</p> <p>139 (127 to 152)</p> <p>Mean diastolic BP (mmHg)</p> <p>79.1 ± 9.6</p> <p>BP &lt; 140/80 mmHg 53.4%</p>	<p>LDL (mmol/L)</p> <p>2.6 (2.2 to 3.2)</p> <p>LDL &lt; 2.6 mmol/L 48.5%</p>

ACEI: Angiotensin converting enzyme inhibitor; ARB: Aldosterone receptor blocker; BP: Blood pressure; CAD: Coronary artery disease; CV: Cardiovascular; DM: Diabetes mellitus; DR: Diabetic retinopathy; GM: General Medicine; GP: General practitioner; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; GRM: Geriatric medicine; HbA1c: Glycated haemoglobin; IQR: Interquartile range; LDL: Low-density lipoprotein; NHGP: National Healthcare Group Polyclinics; OADD: Oral anti-diabetic drug; PAD: Peripheral arterial disease

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Table 3. Case-Control Studies

Managed in Primary Care Setting	Study Design and Sample Size	Study Population Characteristics	Glycaemic Control	BP Control	LDL-Cholesterol Control
<p>Foo et al, 2016<sup>*</sup> GRADE: low</p>	<p>Retrospective case-control Sample size: 172 diabetic patients with moderate retinopathy, with 226 matched controls</p>	<ul style="list-style-type: none"> <li>Recruited at single polyclinic between 2012 to 2013</li> <li>Multithemic/type 2 DM with moderate DR</li> <li>Controls = type 2 DM without DR</li> <li>Mean age (cases vs controls): 59.7 ± 11.5 years vs 62.0 ± 10.6 years (<i>P</i> = 0.04)</li> <li>Duration of DM (cases vs controls): 10.9 ± 10.1 years vs 7.3 ± 9.0 years (<i>P</i> = 0.53)</li> <li>Hypertensives and hyperlipidaemia (cases vs controls): no significant differences</li> <li>Type of treatment: antihypertensive treatment (cases vs controls): 29.8% vs 60.4% (<i>P</i> = 0.06)</li> <li>Lipid-lowering treatment (83%)</li> <li>Antidiabetic treatment (cases vs controls): 91.8% vs 74.3% (<i>P</i> &lt;0.001)</li> <li>OADD (cases vs controls): 88.3% vs 74.3% (<i>P</i> = 0.002)</li> <li>OADD + insulin (cases vs controls): 18.7% vs 6.8% (<i>P</i> = 0.002)</li> </ul>	<p>HbA1c (%), intrapersonal (iM) mean</p> <p>DR 8.2 ± 1.8 Controls 7.3 ± 1.2 (<i>P</i> = 0.001)</p>	<p>iM SBP (mmHg)</p> <p>DR 136.8 ± 16.2 vs controls 129.6 ± 13.6 (<i>P</i> = 0.001)</p> <p>iM DBP (mmHg)</p> <p>DR 73 ± 9.4 vs controls 73.0 ± 10.2 (<i>P</i> = 0.99)</p>	<p>LDL-C (mmol/L)</p> <p>DR 2.4 ± 0.8 vs controls 2.4 ± 0.7 (<i>P</i> = 0.70)</p>
<p>Managed in Primary and Tertiary Care Setting</p> <p>Puar et al, 2012<sup>†</sup> GRADE: low</p>	<p>Retrospective case-control Sample size: 558 diabetic patients admitted with hip fracture with 558 matched controls</p>	<ul style="list-style-type: none"> <li>Cases and controls recruited at acute hospital between 1 January 2005 to 31 December 2010</li> <li>Controls selected from a registry of diabetics managed in the same hospital's DM clinic</li> <li>Cases were managed at both primary and tertiary care</li> <li>Mean age (cases vs controls): no significant difference</li> <li>Duration of diabetes (cases vs controls): 11.9 ± 7.9 years vs 12.5 vs 10 years (<i>P</i> = 0.30)</li> <li>Type of treatment (cases vs controls): insulin 12.1% vs 14.5%</li> </ul>	<p>Median HbA1c (%)</p> <p>Cases 6.8 (range 6.2 to 7.8) Controls 7.4 (range 6.7 to 8.5)</p> <p>HbA1c &lt;6%</p> <p>Cases 19.4%, controls 10.4%</p> <p>HbA1c 6.1% to 7.0%</p> <p>Cases 40.1%, controls 27.4%</p> <p>HbA1c 7.1% to 8.0%</p> <p>Cases 20.4%, controls 28.5%</p> <p>HbA1c &gt;8%</p> <p>Cases 20.1%, controls 33.7%</p>	<p>Data not available</p>	<p>Data not available</p>

DBP: Diastolic blood pressure; DM: Diabetes mellitus; DR: Diabetic retinopathy; GRADE: Grade of Recommendation, Assessment, Development and Evaluation; HbA1c: Glycated haemoglobin;

OADD: Oral anti-diabetic drug; SBP: Systolic blood pressure

\*Foo V, Quah J, Cheung G, Tan NC, Ma Zar KL, Chan CM, et al. HbA1c, systolic blood pressure variability and diabetic retinopathy in Asian type 2 diabetics. *J Diabetes* 2017;9:200-7.

†Puar TH, Khoo JJ, Cho LW, Xu Y, Chen YT, Chuo Am, et al. Association between glycaemic control and hip fracture. *J Am Geriatr Soc* 2012;60:1493-7.

retinopathy (DR) compared to matched controls who were managed in the primary care setting (8.2% vs 7.3%;  $P = 0.001$ ).<sup>41</sup> There was no significant difference in diabetic control between those with peripheral arterial disease (PAD) and those who did not.<sup>33</sup>

### *Blood Pressure Control*

The BP control is presented in Tables 1-3. The average systolic and diastolic BP in 12 studies range between 126.5-144.0 mmHg and 70-84 mmHg, respectively.<sup>22,24-27,29,35,37-41</sup> The mean duration of hypertension was 6.7-7.54 years. Overall, the results for BP control were mixed. Lee et al observed that the proportion of patients whose BP were treated to target were 69% in the primary health clinic and 74% in restructured hospitals.<sup>29</sup>

However, Toh et al reported 26.2% achieving optimal BP in a multiethnic cohort managed in various medical subspecialists,<sup>37</sup> while Low et al reported that nearly half (46.6%) had BP >140/80.<sup>40</sup> The only Malay cohort reported an average systolic and diastolic BP of 154.6 mmHg and 79.2 mmHg respectively.<sup>39</sup> Indians had significantly better BP control compared to Chinese and Malays.<sup>25,26</sup> A similar trend was also reported by Dalan et al.<sup>27</sup>

The prevalence of kidney disease (including micro- and macro-albuminuria) in 4 studies was between 19.9%-72%.<sup>35,36,38,40</sup> There were between 24%-73% who were on angiotensin converting enzyme inhibitor (ACEI) or angiotensin receptor blocker (ARB).

Foo et al reported significantly higher intrapersonal mean systolic blood pressure (iM-SBP) in patients with moderate DR compared to matched controls (136.8 mmHg vs 129.6 mmHg;  $P = 0.001$ ). There was no difference in diastolic BP (iM-DBP) at about 73.0 mmHg in both groups.<sup>41</sup>

### *LDL-Cholesterol (LDL-C) Control*

The mean LDL-C control is presented in Tables 1-3. The mean LDL-C in 9 studies was between 2.4 and 3.3 mmol/L.<sup>24-27,35,37,39-41</sup> The use of statin in 1 study was 81.2%. However, 51.5% in this study did not achieve optimal LDL-C (<2.6 mmol/L).<sup>40</sup> Liu et al reported Malays to have significantly poorer LDL-C control compared to Chinese and Indians.<sup>25</sup>

Amongst various medical subspecialists, those managed under Cardiology and Geriatric Medicine had lower LDL-C at 2.56 mmol/L and 2.60 mmol/L, respectively. A higher proportion of patients in these 2 disciplines also achieved LDL-C control <2.6 mmol/L (56.8% and 62.0%, respectively), when compared to other medical specialties (44.8%-45.2%).<sup>37</sup> The LDL-C control was not significantly different between those with PAD and those without.<sup>33</sup>

The mean LDL-C in those with moderate DR and

matched controls were similar at 2.4 mmol/L (note: LDL reported in mg/dL converted to mmol/L by multiplying 0.02586). Although 90.1% and 92.4% had hyperlipidaemia in both arms, only 83.0% and 83.3% were on any form of lipid-lowering treatment in the cases and control groups, respectively.<sup>41</sup>

### **Discussion**

To the best of our knowledge, this is the first study reviewing the glycaemic, BP and LDL control of adult diabetic patients in Singapore. This qualitative review demonstrates that achievement of these cardiovascular risk factor targets has generally been suboptimal over the past 20 years in Singaporean patients with diabetes, and are comparable to several parts of the world including the United States of America, Australia and Asia.<sup>43-47</sup>

With the advent of new and novel antidiabetic treatment as well as advances in models of diabetic care programmes over the past 10 years, it is reasonable to expect significant strides in achieving diabetic targets in a developed nation such as Singapore where healthcare is easily accessible. Despite the availability of published guidelines, translation of guidelines into practice to achieve recommended diabetes management and targets, still fall short globally.

Although the heterogeneity of the various cohorts reviewed does not permit a quantitative assessment of the data, there appears to be marginal improvements since the last large study of 12 Asian countries including Singapore that documented poor achievement of glycaemic targets nearly 20 years ago.<sup>47</sup> The lower rates of progression to proliferative DR and visual loss due to diabetes provides further indirect evidence to the improvement of risk factor control.<sup>48</sup> This observation, however, requires further validation. Suffice to say, diabetes care remains challenging and its complexity cannot be underestimated. In fact, diabetes continues to be a challenging healthcare problem in Singapore, and was made a healthcare priority by the Minister of Health when he declared “war on diabetes” in a Parliamentary sitting in April 2016.<sup>49</sup>

In Singapore, private general practitioners (GPs) are the main provider of primary care services, seeing 81% of primary care attendances. The remaining 19% are seen by polyclinic doctors. However, private GPs look after only 55% of chronically ill patients, while the rest are managed by polyclinic doctors.<sup>50</sup>

From the epidemiological viewpoint and based on the local healthcare resource allocation, it may be postulated that those with early and uncomplicated disease are managed in the private sector. Due to cost and availability of healthcare resources, those with more complex comorbidities and higher pill burden are managed in the public primary healthcare setting, while those with advanced end-organ

complications are managed at tertiary care.

This may be particularly so in Singapore even though the costs of many chronic diseases may be defrayed using governmental subsidies such as the Pioneer Generation (PG) and Community Health Assist Scheme (CHAS) for eligible patients. Given the difference in drug costs between the public and private healthcare, those who require multiple medications for complex comorbidities will have lesser out-of-pocket payment in public healthcare compared to private care even after utilising these subsidies, as well as their Medisave account (a national medical savings scheme that helps individuals put aside part of their income for future medical expenses). Anecdotally, these patients tend to transfer their care from the private to the public sector once the out-of-pocket payment becomes unmanageable.

It has been shown that diabetes management programmes and resource allocation such as the extension of Medisave coverage to outpatient treatment increased compliance to processes of diabetes care, reduced hospitalisation risk and total healthcare cost, albeit only in the first 2 years.<sup>51</sup>

Apart from a single study that included patients managed in the private sector,<sup>38</sup> the remaining studies reviewed in this article were all conducted in the public polyclinics and hospitals. There remains a dearth of information regarding the glycaemic, BP and LDL-C targets of the majority of diabetic patients in Singapore. Due to the aforementioned reasons, the glycaemic, BP and LDL control from public sector data may be an overestimation of how Singapore is performing nationally.

It is well established that a target-driven, long-term and intensive multifactorial intervention reduces risk of cardiovascular and microvascular complications.<sup>52</sup> Potential factors that may hinder the attainment of these targets include time and resource constraints faced by doctors during consultation, as well as patient's variable knowledge of these targets as a result of poor concordance between managing doctors, especially when the patient consults more than 1 primary doctor.<sup>53</sup> Furthermore, such intensity can be resource-intensive to sustain.

We find it interesting that the elderly population appeared to have better glycaemic control compared to younger patients.<sup>30,37</sup> This may have been due to shorter duration of diabetes in older individuals. However, the duration of diabetes in these 2 studies were not reported. The elderly are also less likely to benefit from tight glycaemic control in the long-term, and treatment has to be individualised.<sup>54</sup> In addition to the U-shaped HbA1c mortality relationship,<sup>55</sup> older patients with lower HbA1c levels may also suffer from poor nutritional status, frailty or sarcopaenia, that may all contribute to a higher mortality risk.<sup>56</sup> Similar to the local American Heart Association (AHA) and American

Diabetes Association (ADA) guidelines, the American Geriatrics Society recommends a less stringent HbA1c target of 8% or less in frail older adults or those with a short life expectancy.<sup>57</sup> However, with much of the focus on treating to target, more is needed to identify a threshold of de-escalating treatment, those at risk and how to safely de-escalate treatment.

Finally, the unique multiethnic Singapore population demands special attention. The profile of the diabetic population in Singapore has changed dramatically because of socioeconomic transformation in the last 2 decades. For example, the age-standardised prevalence of diabetes in the Malay population had increased from 11.3% to 16.6% between 1992 and 2010, whereas it did not change very much in the Chinese population (10.8% to 9.7%) during the same period. Among the 3 main racial groups, Indians ranked first in the prevalence of DM, followed by Malays and Chinese. On the other hand, hypertension and hyperlipidaemia was most prevalent in Malays, followed by Chinese and Indians.<sup>3</sup> In order to be effective, chronic disease management programmes have to be specifically tailored to meet the changing needs and profiles of these racial groups.

As alluded to, the limitations of this study include the lack of data from the private primary care setting. All but one study is from public primary and tertiary care settings, and do not adequately represent the entire diabetes cohort in Singapore. Apart from ethnicity, factors such as socioeconomic status, patient education, patient knowledge about diabetes and availability of healthcare facilities are also known to affect control of diabetes.<sup>58,59</sup> In addition, all the studies included in the analysis were assessed to be of either low or very low quality. Furthermore, the heterogeneity of the studies also does not facilitate quantitative meta-analysis to be performed. Finally, the primary limitation of this review is the lack of longitudinal follow-up data on control of these indices.

These limitations notwithstanding, this review provides the first overview of glycaemic, BP and LDL-C control in adult patients with diabetes in Singapore over the past 20 years.

## Conclusion

This 20-year overview of the glycaemic, BP and LDL-C control in adult diabetic patients in Singapore mirrors global trends, as these indices do not appear to be treated to target in the majority of patients. There appears to be marginal improvements reported in the studies over the past 20 years, although this requires further validation. There are gaps in translating guidelines into practice in the management of diabetes in Singapore. Data from the private primary care setting is urgently required.

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