



# BMJ Open Type 2 diabetes and hypertension in Vietnam: a systematic review and meta-analysis of studies between 2000 and 2020

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**To cite:** Biswas T, Tran N, Thi My Hanh H, *et al.* Type 2 diabetes and hypertension in Vietnam: a systematic review and meta-analysis of studies between 2000 and 2020. *BMJ Open* 2022;**12**:e052725. doi:10.1136/bmjopen-2021-052725

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-052725>).

Received 17 May 2021  
Accepted 20 March 2022



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## ABSTRACT

**Objectives** The objective of this study was to determine the level of type 2 diabetes (T2DM) and hypertension (HTN) in Vietnam and to assess the trend and recommend the future direction of prevention research efforts.

**Design** We searched scientific literature, databases including PubMed, EMBASE, CINHAL and Google Scholar; grey literature and reference lists for primary research published, nation database websites between 1 January 2000 and 30 September 2020. We adapted the modified Newcastle Ottawa Scale for assessing the quality of the study, as recommended by the Cochrane Collaboration.

**Results** In total, 83 studies met our inclusion criteria, representing data of approximately 239 034 population of more than 15 years of age in Vietnam. The findings show that prevalence rates varied widely across studies, from 1.0% to 29.0% for T2DM and 2.0% to 47.0% for HTN. For the total study period, pooled prevalence of T2DM and HTN in Vietnam for all studies was 6.0% (95% CI: 4.0% to 7.0%) and 25% (95% CI: 19% to 31%), respectively. Prevalence rate of both T2DM and HTN was higher among the male population compared with female counterpart.

**Conclusion** There is evidence of a rising trend of HTN and T2DM prevalence in Vietnam. Future research should focus on the major drivers, incidence and prognosis of T2DM and HTN. Policy approaches should base upon the trends of T2DM and HTN in Vietnam over the last 20 years and pay more attention on the effective interventions to combat T2DM and HTN. In our study, we included both English and Vietnamese language articles and seems that majority of the articles came from Vietnamese language.

**PROSPERO registration number** CRD42020182959.

## INTRODUCTION

Globally, the non communicable diseases (NCDs) have become the leading cause of death.<sup>1</sup> Due to the high number of deaths, non-communicable diseases,<sup>2</sup> including cardiovascular diseases (CVDs), diabetes, cancer and chronic respiratory diseases, have appeared as key public health challenges worldwide.<sup>3</sup> As a result, NCDs are included in sustainable development goal target 3.4,

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This is the first systematic review and meta-analysis on type 2 diabetes (T2DM) and hypertension (HTN) in Vietnam that collected data and documents over 20 years.
- ⇒ This is also the first review combining available documents published in both English and Vietnamese languages across domestic and international databases.
- ⇒ The study reported that prevalence of T2DM and HTN among adult population in Vietnam increased over the time.
- ⇒ While the current study followed the Meta-analyses Of Observational Studies in Epidemiology guideline, findings from the review were heterogeneous in nature due to the study design, the outcome measurement and the potential biases in identified documents. Additionally, the estimate prevalence by ethnicity and place of residence were not provided due to the data limitation.

to by '2030 reduce by one-third premature mortality from NCDs through prevention and treatment and promote mental health and well-being'.<sup>2,4</sup> NCD mortality rate, which was high in low middle-income countries (LMICs), nearly three-quarters of NCD deaths occurred in LMICs, expected to increase by 20% in coming years.<sup>5</sup> Due to the increasing prevalence of fast food consumption and food insecurity,<sup>6–8</sup> population of LMICs have a higher ability to purchase high-caloric foods, which are associated with higher intake of calories and fat. Such fast food consumption and food insecurity are responsible for increase in the prevalence of diabetes, hypertension (HTN) and other NCDs in LMICs. It is estimated that this condition is likely to increasing.

Like other LMICs, Vietnam has recently been facing the challenge of NCDs. The

**Table 1** PICOS criteria for inclusion and exclusion of studies

Parameter	Inclusion criteria	Exclusion criteria
Population	Those were of age $\geq 15$ years	$< 15$
Intervention/exposure	Collection of data on T2DM and hypertension and sociodemographic factors	Lack of data on T2DM and hypertension
Comparator	T2DM and hypertension status of Vietnamese adult	Lack of data on T2DM and hypertension
Outcome	Prevalence of T2DM and hypertension	No reported prevalence measure
Study design	Observational study Cross-sectional study Cohort study	Editorial Methodological article

PICOS, Population, Intervention, Comparison, Outcome, and Study design; T2DM, type 2 diabetes.

number of deaths due to NCDs in Vietnam rose from 296 900 in 2000 to 371 600 in 2010 and 424 000 in 2016.<sup>9</sup> NCD were estimated to account for 73% of all deaths in Vietnam in 2014<sup>10</sup> and 77% in 2016.<sup>11</sup> Of NCDs, CVDs represented 31% of all deaths in 2016; HTN, one of the main risk factors for CVDs, accounted for 21% of all deaths in the country.<sup>12</sup> It was estimated in 2016 that about 17% of people aged 30–70 in Vietnam will suffer a premature death due to one of the four common NCDs (CVDs, cancer, chronic respiratory diseases and diabetes).<sup>13</sup>

The gross domestic product per capita was increased gradually in Vietnam, which is directly linked to increased behavioural risk factors for NCDs such as the harmful use of alcohol, unhealthy diets and physical inactivity.<sup>3,14</sup> NCD risk factor survey in Vietnam (2015) revealed high prevalence of NCD risk factors among the adult population. For example, prevalence of overweight/obesity (BMI  $\geq 25$ ) was 15.6%, HTN (systolic blood pressure (SBP)  $\geq 140$  mm Hg and/or diastolic blood pressure (DBP)  $\geq 90$  mm Hg or on medication) was 18.9%, raised cholesterol was 30.2%, physical inactivity 28.1%, lack of vegetable/fruit consumption 57.2%, the average population salt intake per day was 9.4 grams, which was almost double the WHO recommendation.<sup>14</sup> These behavioural risk factors play a vital role of rising chronic disease burden including CVD and diabetes.

Over the past two decades, The Government of Vietnam has a number of policies, strategies, plans and programmes responding to NCDs. Two national programmes were implemented for the period 2002–2010 and 2012–2015 focusing on four disease groups of CVDs, diabetes, cancers and mental and neurological disorders<sup>13</sup> and covering a component project of prevention and control of some dangerous diseases, which included some specific NCDs. Despite the efforts, these programmes did not have expected achievements due to lack of intersectoral coordination and direction for NCDs prevention as well as evidence-based research. An

updated National Strategy on Prevention and Control of NCDs for the period of 2015–2025, which followed the WHO Global NCD Action plan 2013–2020 was developed in 2015, providing a strong basis for NCD prevention and control in Vietnam. Under the revised programme, the prevention and control of some dangerous infectious diseases and some common NCDs was included as a project component.<sup>15</sup>

In addition to these national policies and programmes targeting on HTN and type 2 diabetes (T2DM), over the last few decades, a number of studies have been undertaken in Vietnam to measure the prevalence of HTN and T2DM but none have assessed trend of T2DM and HTN except for a 2001–2009 time trends analysis, which showed an annual increase of HTN prevalence of 0.9%. Two reviews on prevalence of HTN and T2DM among adult population in Vietnam were published recently, yet these studies had their own limitations as (1) they were carried out based on the literature available in English<sup>16</sup>; (2) the review employed only surveys, which were conducted by a research institute, therefore the results may have some bias; (3) meta-analysis was not implemented to produce the pool estimation<sup>17</sup>; and (4) they are out of date assessment with regard to the rapid change of T2DM and HTN. There is a need for an updated systematic review and meta-analysis. It is important for both health professionals and policy-makers to better understand the trends of T2DM and HTN to develop effective policies and programmatic interventions. In this review, we conducted a systematic review and meta-analysis to comprehensively (1) determine the extent of research that has been done for HTN and T2DM and (2) to assess the trend and recommend the future direction of prevention research efforts.

## METHODS

We followed the Meta-analyses Of Observational Studies in Epidemiology (MOOSE) guidelines to identify studies.<sup>18</sup> The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) was employed in this study.

### Search strategy

We used the Population, Intervention, Comparison, Outcome, and Study design (PICOS) criteria to define the research question (table 1).<sup>19</sup> Our search included studies published from 1 January 2000 to 30 September 2020 in both English and Vietnamese languages. We used a number of different search engines: PubMed, EMBASE, CINAHL, Google Scholar, Google and national website and database including the Database of National Agency for Science and Technology Information (vista.gov.vn) and some Vietnamese journals in the field, which are not included in the database. A full description of the electronic search strategy is available in online supplemental table S1.

The keywords used in the search were ‘diabetes’, ‘diabetes mellitus’, ‘non-insulin dependent diabetes

**Table 2** Summary of the reported prevalence rate of diabetes in Vietnam (2000–2020)

SI	Author name	Publication year	Study conducted	Community/hospital based	Reference standard	Study design	Sample size	Age range	Prevalence of diabetes
1	Binh and Nhung <sup>58</sup>	2015	2010	Community	The WHO and International Diabetes Federation diagnostic criteria	Cross-sectional	892	35–70	7.60%
2	Miyakawa <i>et al</i> <sup>25</sup>	2017	2014	Community	Elevated fasting plasma glucose (FPG) level $\geq 7.0$ mmol/L (126 mg/dL) or random elevated plasma glucose level $\geq 11.1$ mmol/L (200 mg/dL); or history of treatment for DM (lifestyle guidance including diet or exercise advice, oral medication or insulin)	Cross-sectional	376	20–70	7.20%
3	Duc Son <i>et al</i> <sup>65</sup>	2004	2001	Community	NM	Cross-sectional	2932	$\geq 15$	6.6
4	Binh <i>et al</i> <sup>48</sup>	2014		Community	The glycaemic status was classified as normal glucose tolerance when FPG $< 5.6$ mmol/L and 2-hour PG $< 7.8$ mmol/L	Cross-sectional	2443	48–57	14.30%
5	Kien <i>et al</i> <sup>66</sup>	2013	2013	Community	NM	Cross-sectional	3736	NM	11%
6	Pham <i>et al</i> <sup>67</sup>	2015	2011–2013	Community	Diabetes was diagnosed when FPG was $\geq 7.0$ mmol/L (126 mg/dL) or 2 hours post OGTT $\geq 11.1$ mmol/L (200 mg/dL)	Cross-sectional	16 282	30–69	6.00%
7	Hoa <i>et al</i> <sup>44</sup>	2018	2016	Facility-based	American Diabetes Association	Cross-sectional	870	$> 15$	13.9%
8	Pham <i>et al</i> <sup>26</sup>	2015	2009	Community	Based on STEPS rule	Cross-sectional	1978	25–64	1.00%
9	National Hospital of Endocrinology <sup>27</sup>	2002	2002	Hospital	WHO 1998: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L	Cross-sectional	9122	30–64	2.7
10	Le <i>et al</i> <sup>64</sup>	2004	NM	Community	WHO 1998/ADA 1997: FPG $\geq 7$ mmol/L or using	Cross-sectional	2932	$> 15$	3.8
11	Do and Le <sup>68</sup>	2008	NM	Community	WHO 1998: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L or self-report	Cross-sectional	1456	30–69	7.0
12	Ta <i>et al</i> <sup>66</sup>	2010	NM	Community	WHO 1998: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L	Cross-sectional	2142	30–64	4
13	Dao-Tran <i>et al</i> <sup>63</sup>	2012	NM	Community	WHO 1998: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L or self-report	Cross-sectional	2710	40–64	3.7
14	National Hospital of Endocrinology <sup>37</sup>	2012	NM	Hospital	WHO 1998: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L	Cross-sectional	11 191	30–69	5.4
15	Nguyen <i>et al</i> <sup>49</sup>	2008	2008	Workplace	NM but not self-report	Cross-sectional	383	NM	2%
16	Le <i>et al</i> <sup>69</sup>	2014	2011	Community	NM but not self-report	Cross-sectional	1401	40+	9.30%
17	Pham and Truong <sup>70</sup>	2019	2018	Community	Decision 3319/QĐ-BYT, 19 July 2017 – MOH	Cross-sectional	3000	30–69	6.50%

Continued

**Table 2** Continued

SI	Author name	Publication year	Study conducted	Community/hospital based	Reference standard	Study design	Sample size	Age range	Prevalence of diabetes
18	Nguyen and Le <sup>71</sup>	2014	2014	Community	NM but not self report	Cross-sectional	5190	21–70	4.2%
19	Pham <i>et al</i> <sup>72</sup>	2019	2014–2015	Workplace	Elevated FPG level $\geq 7.0$ mmol/L	Cross-sectional	1595	NM	5.50%
20	Vu and Dang <sup>73</sup>	2018	2017	Community	Capillary blood glucose by Accu-Chek D10-BIORAD; 2-hour OGTT $\geq 11.1$ mmol/L=diabetes; OGTT from 7.8 to 11.0=abnormal; WHO-IDF 2008 updated 2010: The glycaemic status was classified as abnormal when FPG range 5.6–6.9 mmol/L; FPG $\geq 7$ mmol/L=diabetes	Cross-sectional	1,450	$\geq 25$	6.5
21	Nguyen <i>et al</i> <sup>74</sup>	2017	2016	Community	Diabetes prevention and control Project, National Institute of Endocrinology; using Onetouchverio machine (Johnson&Johnson)	Cross-sectional	400	45–69	3.5
22	Vo <i>et al</i> <sup>75</sup>	2017	2015–2016	Community	ADA 2005: FPG $\geq 7$ mmol/L ( $\geq 126$ mg/dL) or self-reporting having been diagnosed by a health professional	Cross-sectional	758	$\geq 40$	14.5
23	Hoang <i>et al</i> <sup>76</sup>	2016	2014	Community	FPG and post OGTT: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L (MoH 2011); IGT: FPG $< 7$ mmol/L and 2-hour OGTT $\geq 7.8$ – $11.1$ mmol/L or normal but self-report having been diagnosed	Cross-sectional	2402	30–69	7.9
24	Do <i>et al</i> <sup>77</sup>	2015	2013	Community	FPG and post OGTT (WHO 1999: FPG $\geq 7$ mmol/L or 2-hour OGTT $\geq 11.1$ mmol/L or self-report and MoH 2011)	Cross-sectional	1200	40–59	5.3
25	Nguyen and Nguyen <sup>78</sup>	2013	2011	Community	ADA/WHO 2010: FPG 100–126 mg/dL or 2-hour OGTT from 140 to 200 mg/dL or HbA1c $\geq 6.5\%$	Cross-sectional	1100	$\geq 45$	11.9
26	Nguyen <i>et al</i> , <sup>79</sup>	2017		Community	WHO STEPS: fasting blood glucose values $> 6.1$ mmol/L or taking medications for diabetes; measured fasting blood glucose by Cardiocheck PA	Cross-sectional	2440	18–69	6.7
27	Do <i>et al</i> <sup>80</sup>	2014	2013	Community	MoH 2011 on screening diabetes in community	Cross-sectional	1200	40–59	16.6

Continued

Table 2 Continued

SI	Author name	Publication year	Study conducted	Community/hospital based	Reference standard	Study design	Sample size	Age range	Prevalence of diabetes
28	Tran <i>et al</i> <sup>81</sup>	2013	2009	Community	WHO-STEPS: fasting blood glucose values $\geq 6.1$ mmol/L or on diabetes medication or having diagnosed by a health professional	Cross-sectional	1714	25–64	4.7
29	Vo and Pham <sup>82</sup>	2017	2015–2016	Community	NM but not self-report	Cross-sectional	1114	>40	16.10%
30	Nguyen <sup>83</sup>	2018	2015–2016	Community	NM but not self-report	Cross-sectional	1250	18–55	16.20%
31	Dang and Nguyen <sup>85</sup>	2016	2012	Community	NM but not self-report	Cross-sectional	2700	>20	5.80%
32	Do <sup>50</sup>	2015	2012	Community	Diabetes was diagnosed when FPG was $\geq 7.0$ mmol/L or 2 hours post OGTT $\geq 11.1$ mmol/L	Cross-sectional	3500	30–96	3.10%
33	Duong <sup>84</sup>	2013	2011	Community	WHO 2006	Cross-sectional	2000	30–69	4.30%
34	Tran and Dam <sup>45</sup>	2013	2011	Community	WHO (not mentioned the year)	Cross-sectional	2400	30–64	10.30%
35	Dao <i>et al</i> , <sup>46</sup>	2012	2010	Community	WHO 1999	Cross-sectional	3100	All age	9.35%
36	Do and Nguyen <sup>85</sup>	2011	2010	Community	OMS 1999, ADA 2005	Cross-sectional	3500	30–69	6.10%
37	Nguyen and Pham <sup>52</sup>	2011	2010	Community	NM but not self-report	Cross-sectional	1855	30–60	4.40%
38	Dzoan <sup>86</sup>	2011	2011	Hospital based	Diabetes was diagnosed when FPG was $\geq 7.0$ mmol/L or 2 hours post OGTT $\geq 11.1$ mmol/L	Cross-sectional	2358	30–60	3.60%
39	Hoang <sup>43</sup>	2008	2005–2007	Community	American Diabetes Association 1998	Cross-sectional	1335	18–70	3.1
40	Vien and Phung <sup>87</sup>	2008	2008	Community	NM but not self-report	Cross-sectional	1620	18–60	2.60%
41	Do <sup>88</sup>	2004	2000	Community	WHO 1999	Cross-sectional	212	$\geq 16$	1.42%
42	To <i>et al</i> <sup>89</sup>	2003	May 2000 to September 2000	Community	Diabetes was diagnosed when FPG was $\geq 7.0$ mmol	Cross-sectional	2017	$\geq 16$	3.62
43	Do <i>et al</i> <sup>90</sup>	2003	March 2002 to December 2002	Community	Diabetes (WHO 1999)	Cross-sectional	890	40–60	6.10%

ADA, The American Diabetes Association; IDF, International Diabetes Federation; IGT, Impaired Glucose Tolerance; MOH or MoH, Ministry of Health; OGTT, Oral Glucose Tolerance Test; QD-BYT, Quyết định - Bô Y Tế (Decision - Ministry of Health); STEPS, WHO STEPS survey.

**Table 3** Summary of the reported prevalence rate of hypertension in Vietnam (2000–2020)

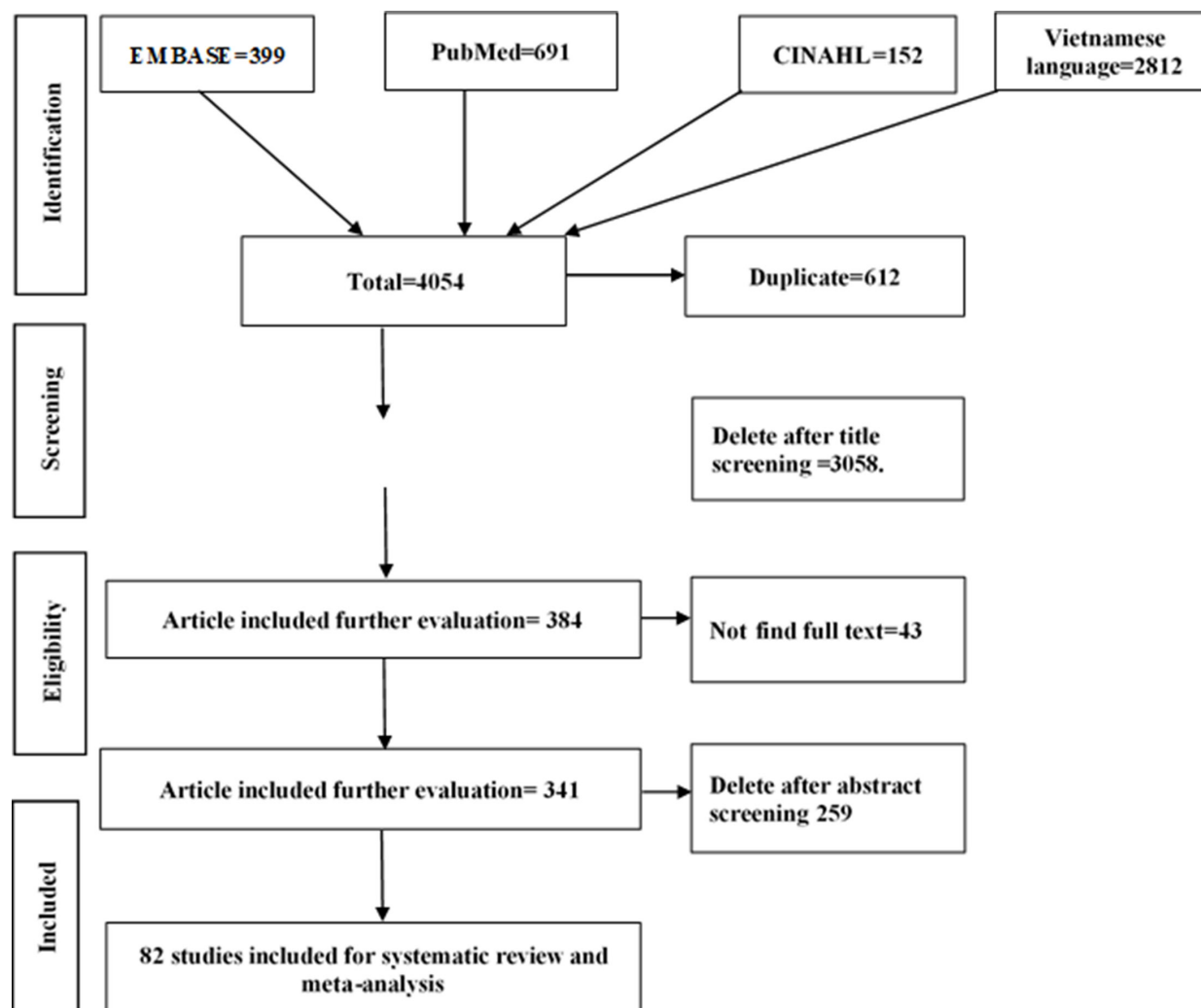
SI	Author name	Publication year	Study conducted	Community/hospital based	Reference standard	Study design	Sample size	Age range	Prevalence of hypertension
1	Pham <i>et al</i> <sup>65</sup>	2009	2015	Community	Raised blood pressure was defined as an average (based on STEPS rule) systolic blood pressure (SBP)≥140 mm Hg and/or average diastolic blood pressure (DBP)≥90 mm Hg and/or self-reported current medication for high blood pressure in the previous 2 weeks	Cross-sectional	1978	25–64	18.9
2	Bao <i>et al</i> <sup>61</sup>	2019	2019	Community	SBP/DBP≥140/90 mm Hg or using antihypertensive medication	Cross-sectional	2203	≥18	24.3
3	Nam <i>et al</i> <sup>61</sup>	2018	2017	Community	HTN was specified that SBP was 140 mm Hg or higher and/or DBP was 90 mm Hg or higher, if the medications used to treat HTN were used by the individuals for 2 weeks. ISH having an SBP≥140 mm Hg and DBP<90 mm Hg was used to diagnose	Cross-sectional	675	≥18	47.3
4	Hoang <i>et al</i> <sup>62</sup>	2019	2015	Community	Raised blood pressure was defined as an average (based on STEPS rule) SBP≥140 mm Hg and/or average DBP≥90 mm Hg and/or self-reported current medication for high blood pressure in the previous 2 weeks	Cross-sectional	3856	18–69	18.9
5	Son <i>et al</i> <sup>63</sup>	2011	2002	Community	Defined as BP≥140/90 mm Hg	Cross-sectional	9832	≥25	25.1
6	Do <i>et al</i> <sup>64</sup>	2014	2005	Community	Hypertension was defined as SBP≥140 mm Hg and/or DBP≥90 mm Hg and/or self-reported current use of antihypertensive medication	Cross-sectional	17 199	25–64	20.7
7	Binh <i>et al</i> <sup>48</sup>	2014	NM	Community	SBP≥130 mm Hg or DBP≥85 mm Hg or hypertension;	Cross-sectional	2443	48–57	14.3
8	Namei <i>et al</i> <sup>61</sup>	2007	2005	Community	SBP was at least 140 mm Hg, their DBP was at least 90 mm Hg, or they were being treated for hypertension	Cross-sectional	2000	25 to 64	18.8
10	Pham and Eggleston <sup>95</sup>	2015	2011–2013	Community	Hypertension was defined as SBP 140 mm Hg and/or DBP 90 mm Hg or current use of antihypertensive medication	Cross-sectional	5602 men and 10 680 women	30–69	47.0
11	Nam <i>et al</i> <sup>61</sup>	2005	2002	Community	Hypertensive subjects were defined as those with SBP equal to or more than 140 mm Hg or DBP equal to or more than 90 mm Hg 18 or those being treated for hypertension	Cross-sectional	2000	25–64	14.1
12	Miyakawa <i>et al</i> <sup>65</sup>	2017	2014	Community	Hypertension was defined as elevated BP, with SBP≥140 mm Hg and/or DBP≥90 mm Hg	Cross-sectional	376	20–70	15
13	Tran <sup>96</sup>	2007	2005	Community	JNC VII (2003)	Cross-sectional	1991	25–65	26.5
14	Vo and Dang <sup>97</sup>	2007	2005	Community	JNC VII	Cross-sectional	1288	25 +	28.4
15	Le and Nguyen <sup>98</sup>	2011	2010	Community	SBP≥140 mm Hg and/or DBP≥90 mm Hg	Cross-sectional	1991	25–64	16.0
16	Nguyen <i>et al</i> <sup>99</sup>	2008	2008	Community (workplace)	NM but not self-report	Cross-sectional	383	NM	16.0
17	Vu <i>et al</i> <sup>99</sup>	2005	2004	Community	SBP≥140 mm Hg and/or DBP≥90 mm Hg	Cross-sectional	2366	18+	21.8
18	Nguyen <i>et al</i> <sup>100</sup>	2013	2013	Hospital based	NM but not self-report	Cross-sectional	379	NM	13.3
19	Tran and Nguyen <sup>101</sup>	2014	2012	Community	SBP≥140 mm Hg and/or DBP≥90 mm Hg	Cross-sectional	872	25–64	15.0
20	Le <i>et al</i> <sup>69</sup>	2014	2011	Community	Decision 3192/QĐ-BYT dated 31 August 2010, Vietnam Ministry of Health	Cross-sectional	1401	40+	30.6
21	Nguyen <sup>102</sup>	2019	2016–2018	Hospital based	NM but not self-report	Retrospective	65	NM	49.2
22	Lam and Lam <sup>103</sup>	2019	2012–2018	Community	National hypertension programme: SBP≥140 mm Hg or DBP≥90 mm Hg	Cross-sectional	10 188	≥40	22.2

Continued

Table 3 Continued

SI	Author name	Publication year	Study conducted	Community/hospital based	Reference standard	Study design	Sample size	Age range	Prevalence of hypertension
23	Pham <i>et al.</i> <sup>72</sup>	2019	2014–2015	Community (workplace)	NM (SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg)	Cross-sectional	1595	NM	15.4
24	Vo <i>et al.</i> <sup>75</sup>	2017	2015–2016	Community	SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg or reporting having diagnosed and on medication by a health professional	Cross-sectional	1153	$\geq$ 18	33.8
25	Nguyen <i>et al.</i> <sup>104</sup>	2017	2011–2015	Community	MoH 2010, SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	20 000	$\geq$ 25	28.5
26	Pham <i>et al.</i> <sup>105</sup>	2017	2014	Community	STEPS, SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	459	45–64	35.5
28	Nguyen <i>et al.</i> <sup>106</sup>	2017	2016	Community	SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	2699	18–69	18.97
29	Tran <i>et al.</i> <sup>107</sup>	2017	2016	Workplace	NM but not self-report	Cross-sectional	1930	NM	2.3
30	Do <i>et al.</i> <sup>77</sup>	2015	2013	Community	JNC7, MoH 2010, SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	1200	40–59	19.7
31	Hong <sup>108</sup>	2015	2013	Community	NM (must be SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg because this was a baseline survey of an intervention with control group)	Cross-sectional	1619	$\geq$ 25	20.7
32	Le <i>et al.</i> <sup>109</sup>	2015	2013	Community	WHO –SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	800	$\geq$ 18	16.8
33	Do <i>et al.</i> <sup>80</sup>	2014	2012	Community	JNC-7 –SBP $\geq$ 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	1200	40–59	19.7
34	Chu <sup>110</sup>	2014	2014	Community	MOH, 2010: 140 mm Hg or DBP $\geq$ 90 mm Hg	Cross-sectional	2085	$\geq$ 25	18.0
35	Nguyen <sup>111</sup>	2014	2011	Community	140 mm Hg or DBP $\geq$ 80 mm Hg	Cross-sectional	1833	$\geq$ 25	11.8
37	Tran <i>et al.</i> <sup>81</sup>	2013	2009	Community	WHO–STEPS: 140 mm Hg or DBP $\geq$ 90 mm Hg or on medication	Cross-sectional	1714	25–64	17.8
38	Vien and Phung <sup>87</sup>	2008	2008	Community	NM but not self-report	Cross-sectional	1620	18–60	15.8
39	Do <i>et al.</i> <sup>90</sup>	2003	March 2002 to December 2002	Community	Hypertension diagnosis ( $>$ 140/90) Diabetes (WHO 1999)	Cross-sectional	890	40–60	12.7

HTN, Hypertension; ISH, International Society of Hypertension; JNC VII, The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure; MoH, Ministry of Health; NM, Not mentioned; QD-BYT, Quyét định - Bộ Y tế (Decision - Ministry of Health); STEPS, WHO STEPS survey.



**Figure 1** Consort diagram: search strategy and selection of studies included in this review.

mellitus', 'NIDDM', 'type 2 diabetes', 'cardiovascular disease', 'CVD', 'myocardial infarction', 'ischemic heart disease', 'hypertension', 'high blood pressure', 'coronary artery disease', 'Vietnam', 'đái tháo đường', 'tiểu đường', 'tăng đường huyết', 'tăng huyết áp' 'cao huyết áp'. We limited the search to studies that only involved human participants. We screened the studies using the following inclusion criteria: (1) had prevalence or incidence data available on either HTN or T2DM, (2) had selected a sample included those who are Vietnamese and are living in Vietnam and (3) had published results between 1 January 2000 to 30 September 2020. Once we identified the eligible studies, we made further exclusions based on sample, study design and publication type.

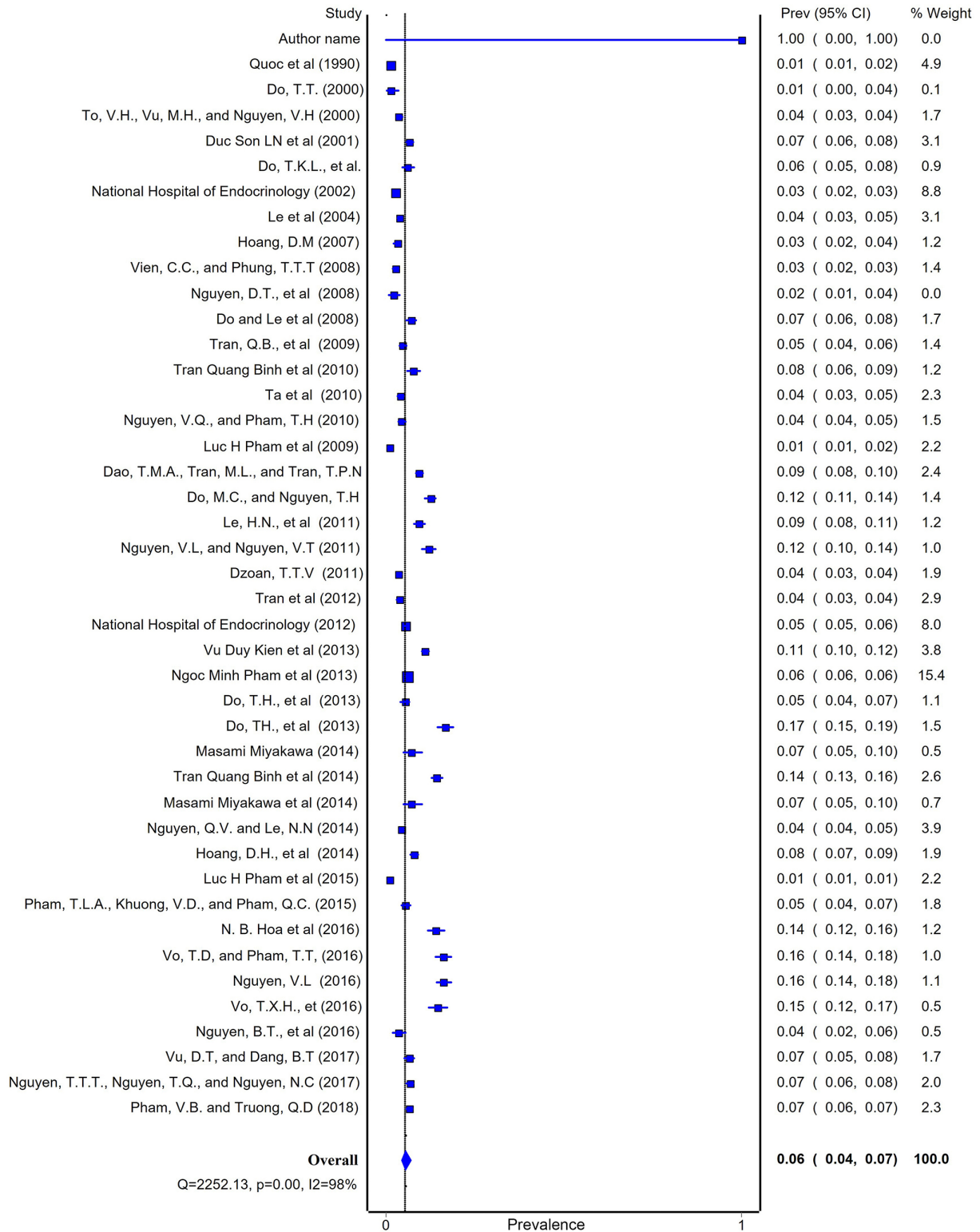
### Inclusion and exclusion criteria

Studies eligible for inclusion met the following criteria: primary or secondary data, published in the English and Vietnamese languages, conducted in humans, studies that provide an estimate of prevalence of either HTN or T2DM and population age group 15 years or older. Studies were excluded if: (1) were reported in reviews, qualitative studies, editorials, abstracts, theses, books,

case reports and letters to the editor; (2) the study had participants with type 1 diabetes, GDM, (3) only on the elderly (60 year old and over) and (4) studies employed RCT designs. HTN was defined as raised blood pressure was defined as an average (based on the WHO's recommended tool for surveillance of NCDs and their risk factors (WHO STEPS survey)) SBP $\geq$ 140 mm Hg and/or average DBP $\geq$ 90 mm Hg and/or self-reported current medication for high blood pressure in the previous 2 weeks. T2DM was defined fasting plasma glucose $\geq$ 7 mmol/L ( $\geq$ 126 mg/dL) or self-reporting having been diagnosed by a health professional.

### Data extraction and quality assessment

Data extraction was carried out by at least two independent reviewers following a piloted version of the Cochrane Effective Practice and Organization of Care Group guidelines.<sup>18</sup> They completed a standard data extraction form, summarising the study design and other relevant data for each article, including author name, sample size, survey year and reference standard (tables 2 and 3). Once article did not report survey year, publication year was listed. The main outcomes were prevalence of T2DM and HTN.

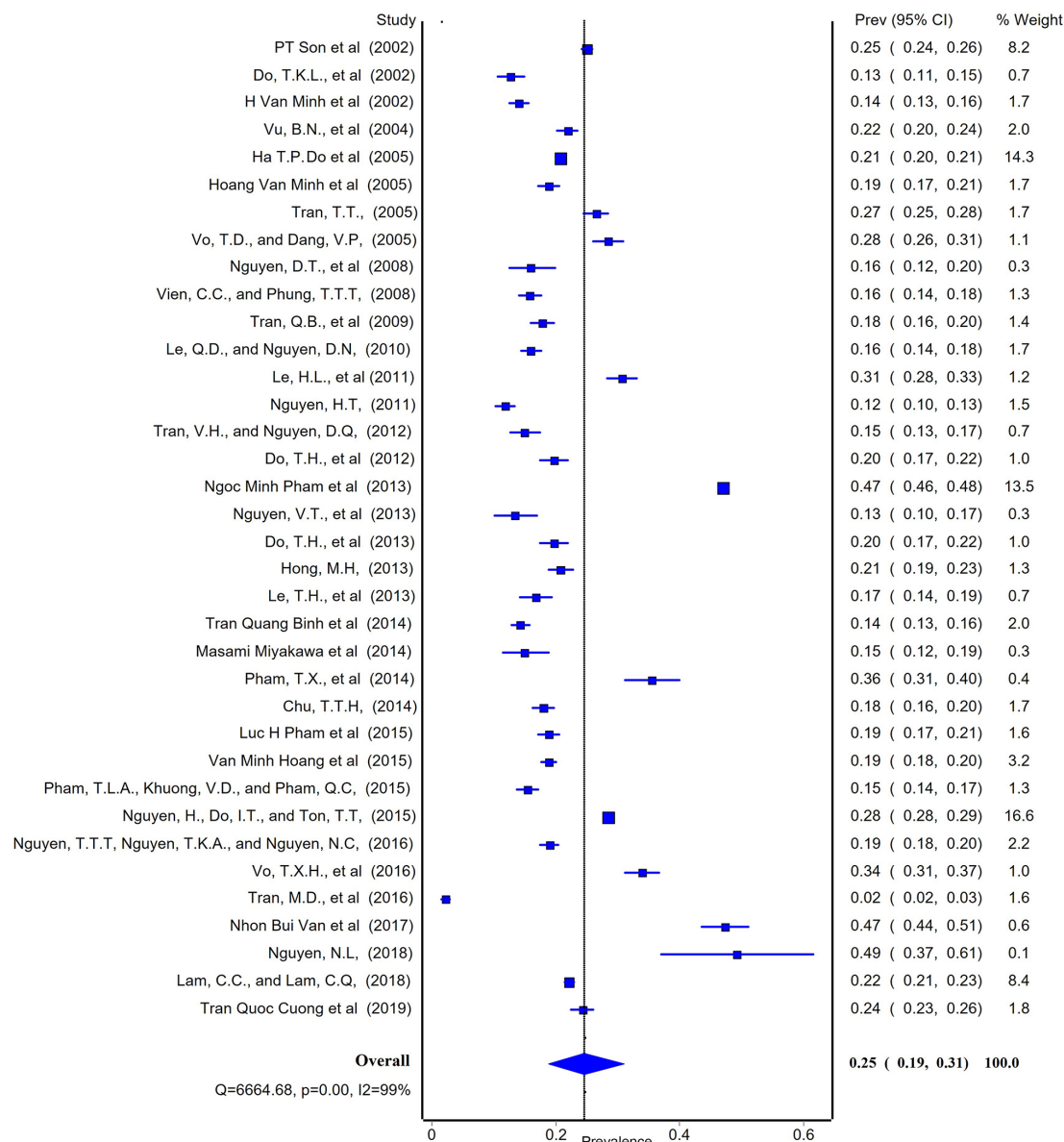


**Figure 2** Pooled prevalence of diabetes in Vietnam.

**Data analysis**

All meta-analyses were performed using MetaXL V.1.4.<sup>20</sup> We calculated pooled prevalence of T2DM and HTN. In addition, we also assessed the pooled prevalence of T2DM and HTN by year interval and sex. We also assessed publication bias using both a graphical (Doi plot) and quantitative (Luis Furuya-Kanamori index) examination

for potential small study effects.<sup>21</sup> The methodology that we followed for the meta-analysis was described in details by Neyeloff *et al.*<sup>22</sup> Briefly, for each study, we calculated the following variables: (1) SE of the prevalence, (2) variance, (3) study weights (inversed variance), (4) study weight\*prevalence estimate, (5) study weight\* (prevalence estimate)<sup>2</sup> and (6) (study weight)<sup>2</sup>. We used these



**Figure 3** Pooled prevalence of hypertension in Vietnam.

variables to estimate  $Q$  measure. We adapted the modified Newcastle Ottawa Scale for assessing the quality of the study, as recommended by the Cochrane Collaboration.<sup>23</sup> Four criteria were used to score studies as ‘high quality’ (4 points), ‘moderate quality’ (2–3 points) and ‘poor quality’ (0–1 points). Criteria included: target population a close representation of the national population (yes=1, no=0), sufficient sample size (yes=1, no=0), random sampling (yes=1, no=0) and ascertainment of T2DM and HTN measure (yes=1, no=0). The cut-off for a sufficient sample size was set at 500 participants.<sup>20 24</sup>

We checked for statistical heterogeneity and inconsistency using the  $Q$  and  $I^2$  statistics, respectively, of heterogeneity among studies) and  $I^2$  (per cent between-studies variability). Based on  $Q$  and  $I^2$  values, we chose quality effects models to report pooled prevalence estimates (HTN, T2DM) and the associated 95% CI to minimise the heterogeneity. We followed the same procedures to calculate the pooled

prevalence of T2DM and HTN by time periods (2000–2004; 2005–2010; 2011–2015; 2016–2020) and sex. We checked for statistical heterogeneity and inconsistency using the  $Q$  and  $I^2$  statistics, respectively.

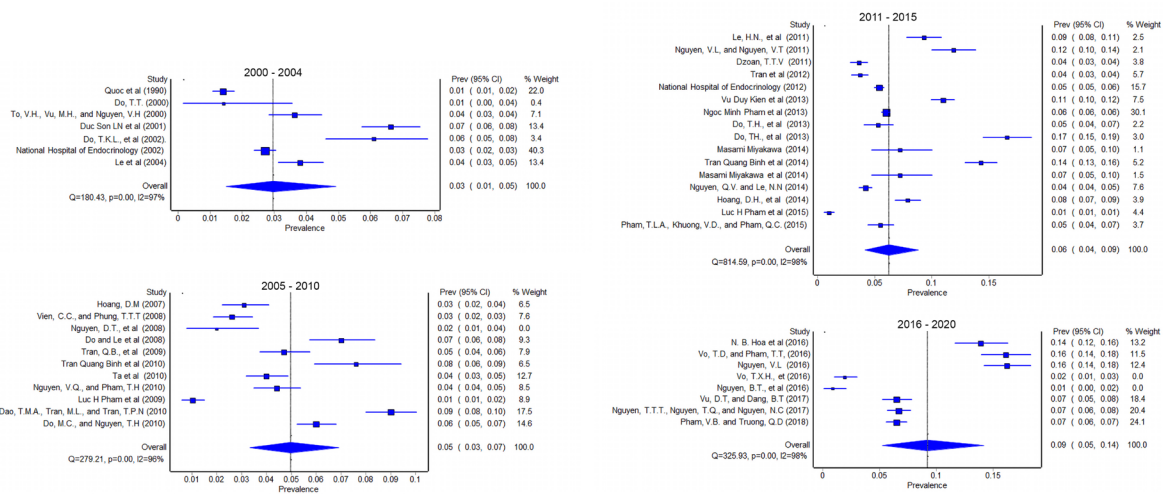
### Patient and public involvement

No patient involved

## RESULT

### Study characteristics and quality

Our literature search yielded 4054 records. After exclusion of duplicates and review of titles and abstracts, articles were included for further evaluation. Of these, full texts could not be found for 43 articles. The full text of the remaining 341 articles were examined and a total of 259 articles excluded after abstract screening. We were unable to access the full text of these documents at the time we searched for relevant



**Figure 4** Prevalence of diabetes in Vietnam by year of study.

papers across databases. These papers were published in Vietnamese language. Of them, about two-thirds were government-funded project reports, which require fees for archived access; the remaining papers were not available on the Vietnamese journal websites. We included 82 articles in the final synthesis (figure 1). These articles presenting data for 239 034 individuals. Out of these, 44 articles reported prevalence of T2DM and 39 articles reported prevalence of HTN. For T2DM, all were cross-sectional in nature (table 2). Majority of the studies (92.4%) were community based and only three studies were facility based (7.6%). For HTN, all were cross-sectional in nature (table 3). Majority of the studies (90%) were community based and only four studies were facility based (10%). Quality score of each study presented in (online supplemental tables S2 and S3. Majority of the articles came from Vietnamese language.

### Estimation of prevalence rates

Prevalence rates varied widely across studies, from 1.0% to 29.0% for T2DM and 2.0% to 47.0% for HTN. The pooled prevalence of T2DM and HTN in Vietnam for all

studies was 6.0% (95% CI: 4.0% to 7.0%) and 25% (95% CI: 19% to 31%), respectively (figures 2 and 3).

### Prevalence rates by year of study

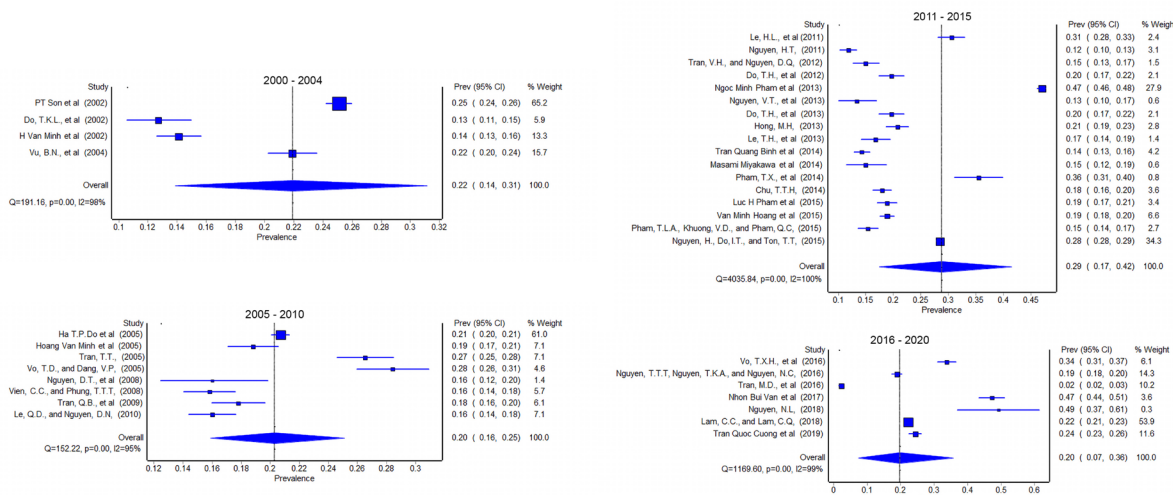
To investigate T2DM and HTN prevalence over time, we arranged outcomes by time of study in four aggregated intervals (i) 2000–2004, (ii) 2005–2010, (iii) 2011–2015 and (iv) 2016–2020.

#### 2000–2004

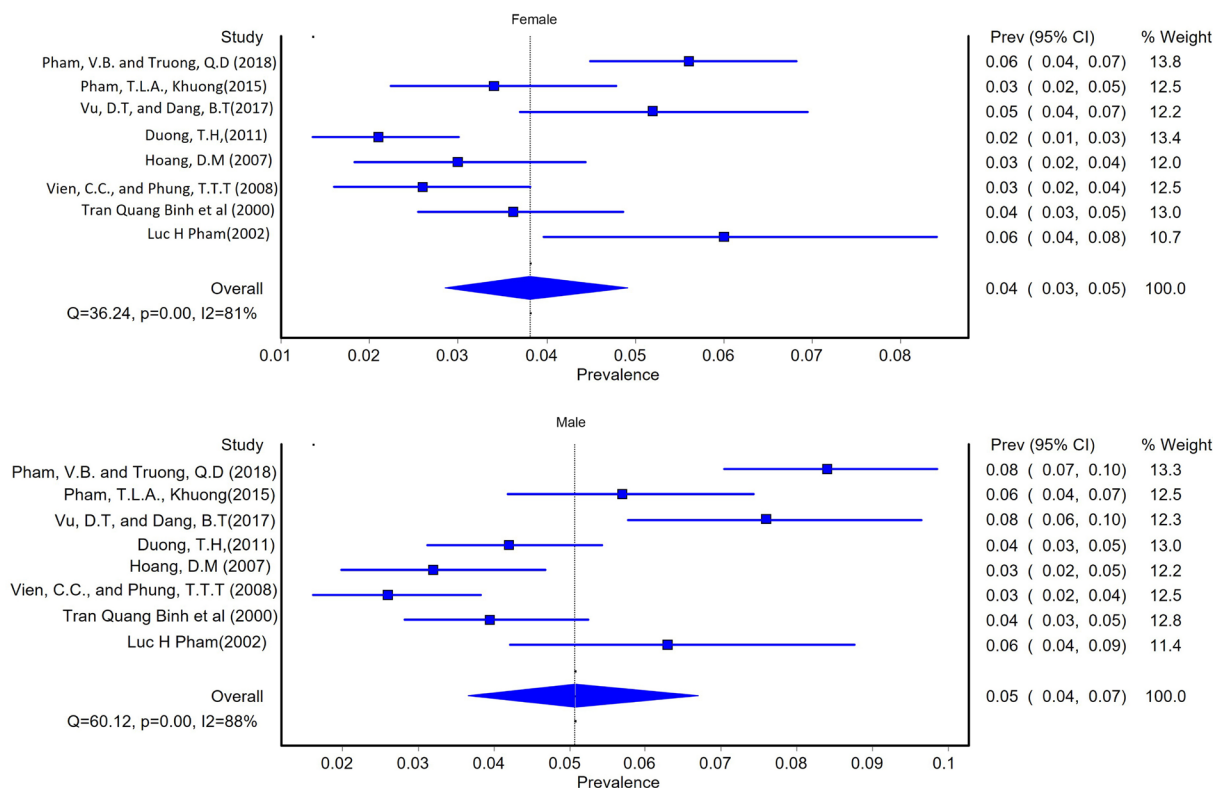
We included nine studies from 2000 to 2004 in our analysis, six of these studies presented findings for T2DM<sup>25–30</sup> and three for HTN.<sup>29 31 32</sup> The pooled estimate of T2DM was 3.0% (95% CI: 1.0% to 5.0%), whereas for HTN it was 22.0% (95% CI: 14.0% to 31.0%) (figures 4 and 5).

#### 2005–2010

Nineteen studies between 2005 and 2010 presented both prevalence of T2DM and HTN in Vietnam in which ten studies<sup>30 33–41</sup> presented prevalence of T2DM



**Figure 5** Prevalence of hypertension in Vietnam by year of study.



**Figure 6** Prevalence diabetes in Vietnam by gender.

and ten studies focused on HTN.<sup>33 34 37 41–47</sup> The pooled estimate of T2DM was 5.0% (95% CI: 3.0% to 7.0%), whereas for HTN it was 20.0% (95% CI: 16.0% to 25.0%) (figures 4 and 5).

### 2011–2015

We identified 37 studies that presented findings for T2DM between the years 2011 and 2015. These resulted in a pooled estimate of T2DM 6.0% (95% CI: 4.0% to 9.0%) from 20 studies.<sup>36 39–41 48–59</sup> We identified 18 studies for the same period in Vietnam that presented findings for HTN<sup>25 31–33 40 41 43 45 46 50–52 54 58–61</sup> resulting in a pooled estimate of 29% (95% CI: 17% to 42%).

### 2016–2020

For the most recent interval, we identified eight studies<sup>31 44 47–49 53 57</sup> for T2DM in Vietnam with a pooled estimate of 9.0% (95% CI: 5.0% to 14.0%). We also identified eight studies<sup>34 44 47–49 53 56 57</sup> for HTN in the region with a pooled estimate of 20.0% (95% CI: 7.0% to 36.0%).

### Gender-specific prevalence

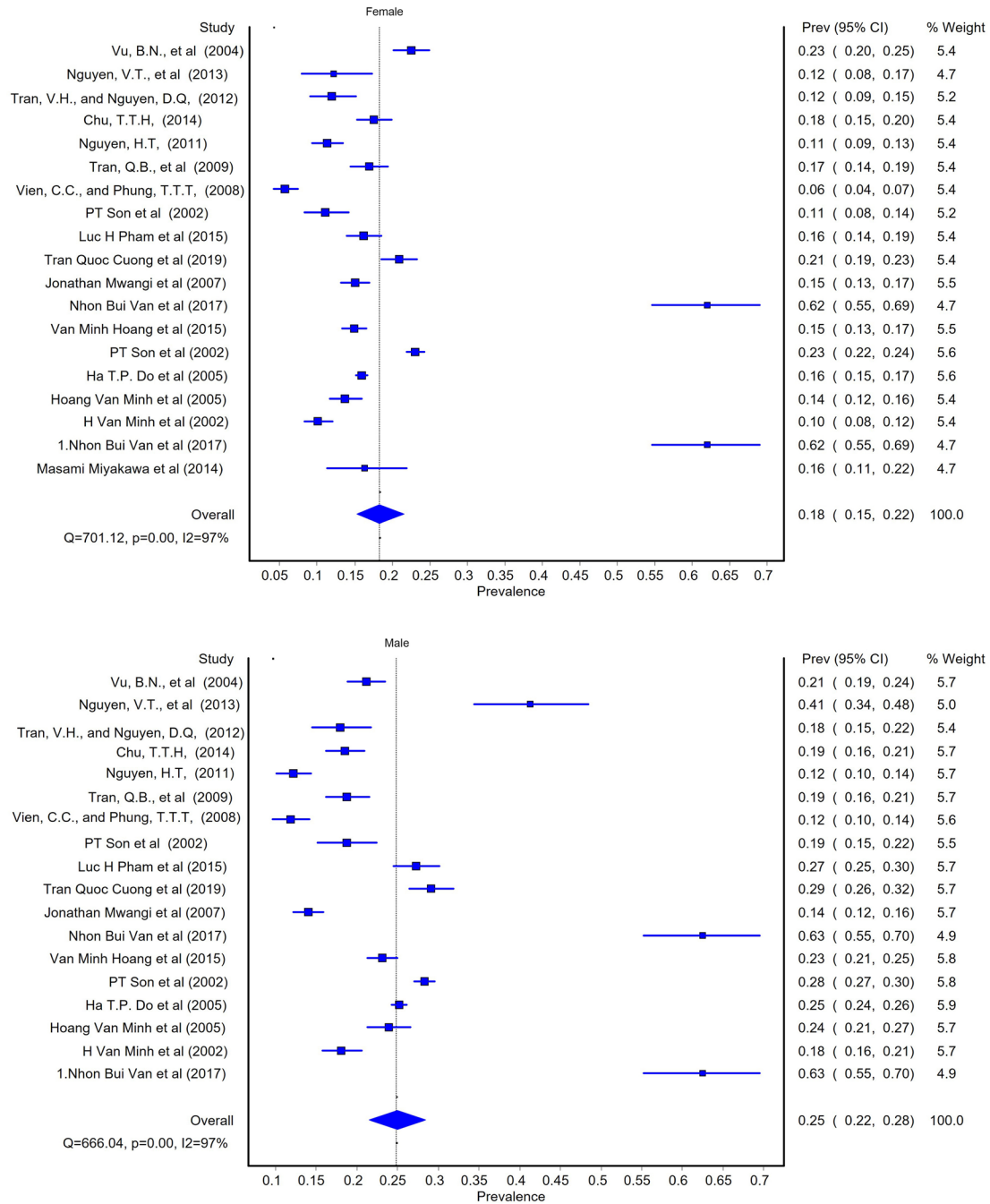
We identified six studies for type T2DM and nineteen for HTN for use in gender-specific prevalence analysis (figures 6 and 7). Pooled estimate for T2DM slightly higher among the male (5.0%, 95% CI: 4.0% to 7.0%) compared with female (4.0%, 95% CI: 3.0% to 5.0%). For HTN, pooled estimate also higher among the male (25.0%, 95% CI: 22.0% to 28.0%) compared with female (18.0%, 95% CI: 15.0% to 22.0%).

### Publication bias

The funnel plots for the T2DM and HTN were presented in online supplemental figures S1a-d and S2a-d. According to these figures, large heterogeneity was observed both for the T2DM and HTN prevalence estimation.

### DISCUSSION

This is the first systematic evaluation and meta-analysis of the scientific literature on the pooled prevalence trend of T2DM and HTN among the adult population in Vietnam. In our study, we found the pooled prevalence of T2DM has increased around three times from 2000 to 2004 (3%) and 2016 to 2020 (9%). A systematic review study by Nguyen *et al* reported that prevalence estimates of T2DM were 2.7% in 2002 and 5.4% in 2012.<sup>17</sup> To our knowledge, this is the updated systematic review and meta-analysis paper on T2DM and HTN in Vietnam. The growing trend of T2DM in Vietnam in the present review is consistent with secular trends in several Asian countries such as China,<sup>62</sup> India,<sup>61</sup> Sri Lanka and Bangladesh<sup>63</sup> where researchers also observed the similar magnitudes of a 10-year increase in T2DM prevalence. It is already well known that older age, urban residence, overweight, increased central adiposity, and physical inactivity, genetic factors, HTN, and high intake of animal protein may contribute to enhanced diabetes.<sup>17</sup> In our study, due to data limitation, we were not able to assess the major drivers of T2DM in Vietnam; however, we expect Vietnam shares similar characteristics such as others in LMICs.



**Figure 7** Prevalence hypertension in Vietnam by gender.

The pooled analysis from this study found that the prevalence of HTN has increased dramatically in Vietnam since 2000–2004. In another systematic review and meta-analysis study, Meiqari *et al* reported that pooled prevalence of measured HTN in Vietnam was 21.1%.<sup>16</sup> In that study, they included the only English language studies but in our study, we included both English and Vietnamese studies, which we believe it gives a proper scenario of HTN in Vietnam. A review study by Hoy *et al* reported that high blood pressure is common among the Vietnamese population and they had knowledge that they have high blood pressure may be low.<sup>64</sup>

The main strength of the current study is that we followed a systematic and comprehensive approach to identify studies

on both T2DM and HTN following MOOSE guidelines and a registered protocol. Risk of bias was assessed using well-established criteria. Within the study, we also investigated the sex-specific prevalence and as well as time trend. The main weakness of this study comes from the research this review identified. Although the majority of studies included in this review were graded as moderate-to-high quality, many were cross-sectional in nature and followed a survey-based approach. In addition, findings of this study were extremely heterogeneous in nature, not only in study design and data collection but also in outcome. To minimise the heterogeneity, we chose the quality effect model, which is now well established. As with all systematic reviews, there is

the potential for publication bias in the identified studies, with some not initially designed to report on the T2DM and HTN. The reference standards for determining T2DM and HTN were not consistent between all studies. In addition, we attempted to explore factors associated with T2DM and HTN but insufficient studies reported this information. Another limitation, we searched PubMed, EMBASE, CINAHL, Google Scholar, Google and national website and database. There may be some other relevant data base we may miss it. But in our study, we included articles from Vietnamese journals. Moreover, information on certain groups, such as ethnicity and place of residence, were not available in enough studies to be included in subgroup analysis.

Although an adequate number of T2DM and HTN prevalence studies have been conducted, they were mostly reported the overall prevalence. Little data exist on the place of residence specific, education specific, wealth index and geographic location-specific prevalence of T2DM and HTN. We did not find any longitudinal cohort studies on T2DM and HTN. This is a significant gap in the knowledge and understanding of these chronic diseases in the context of Vietnam. Such studies would provide essential information on the incidence of these diseases, their associated risk factors, and the groups that are at higher risk of developing them. Further, longitudinal data are necessary to understand disease progression and prognosis.

## Conclusion

We found increase in the prevalence T2DM and HTN among the adult population in Vietnam over the study period. We also found T2DM and HTN higher among the male compared than female. Future research should investigate the driving force behind the increasing rates of T2DM and HTN and explain the major drivers in both conditions. Policy approaches should base upon the trends of T2DM and HTN in Vietnam over the last 20 years and pay more attention on the effective interventions to combat T2DM and HTN.

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**Acknowledgements** The authors are grateful for the generous and helpful comments of the reviewers. We thank The Institute for Social Science Research, The University of Queensland and The Health Strategy and Policy Institute, Vietnam Ministry of Health for their support.

**Contributors** All authors made a substantial contribution to this work. NT, AM, and TTMO conceptualised the review. NT, TB, TTMO, and AM designed the research. TB, NT, HTMH, PHV, PVH, NTTC, and KTA collected data, read, screened abstracts and titles of potentially relevant studies and took responsibilities for extracting data and

rating their quality independently. TB and NT analysed and interpreted the data. TB, NT, and AM drafted manuscript with all the authors critically reviewing it and suggesting amendments prior to submission. NT is acting as guarantor.

**Funding** This work was funded by The University of Queensland (UQ) Global Strategy and Partnership Seed Funding Scheme 2018 and The Institute for Social Science Research for strengthening the collaboration between UQ researchers and Vietnamese researchers (grant number not applicable). NT, TB, and AM are also supported by the Australian Government through the Australian Research Council's Centre of Excellence for Children and Families over the Life Course (Project ID CE200100025).

**Competing interests** None declared.

**Patient and public involvement** Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

**Patient consent for publication** Not applicable.

**Provenance and peer review** Not commissioned; externally peer reviewed.

**Data availability statement** Data are available upon reasonable request.

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