

# Epidemiological Patterns of Hypertension and Type 2 Diabetes Mellitus in Vietnam. Ecological Study

Patrik Sivčo (✉ [patrik.sivco@tvu.sk](mailto:patrik.sivco@tvu.sk))

Universitas Tyrnaviensis Trnavská Univerzita v Trnave <https://orcid.org/0000-0002-3663-326X>

Giang Nguyen Hoang

Health Strategy and Policy Institute

Juliana Melichová

Trnavska Univerzita v Trnave Fakulta zdravotnictva a socialnej prace

Dominika Plančíková

Trnavska Univerzita v Trnave Fakulta zdravotnictva a socialnej prace

Marek Majdan

Trnavska Univerzita v Trnave Fakulta zdravotnictva a socialnej prace

Martin Rusnák

Trnavska Univerzita v Trnave Fakulta zdravotnictva a socialnej prace

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## Research

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# Abstract

Vietnam is a SEA country with a high burden of NCD and hypertension and diabetes are among the top contributors to premature mortality. The recent reviews reported the rapidly growing prevalence of these two chronic conditions in Vietnam. To investigate the epidemiological burden of HT and DM type 2 in Vietnam an ecological study employing secondary data analysis was conducted. The study was a part of the SUNI SEA project implementation with the aim to put the basis for the research hypothesis for the SUNI SEA project in Vietnam. Data from the Institute of Health Metrics and Evaluation and Vietnamese Health statistics years books were analysed by linear and polynomial regression analyses, Kendall rank correlation and Pearson correlation. On average 19% of all deaths and 9% of all DALYs were associated with high SBP and 2% of all deaths and 2% of all DALYs were attributable to DM type 2 between 1990-2017 in Vietnam. Differences between genders were recognizable mainly in CVDs and high SBP death rates. The decrease in the number of elementary nurses, as well as the increase in health insurance expenditures per inpatient, seems to be with the highest certainty correlated with HT and type 2 DM death and DALYs rates. If the tracked progress remains at the same pace, in the category of Good health and well-being Vietnam seems not to be able to achieve the desired threshold by 2030 as committed by United Nations Member States in 2015. Developing regulatory frameworks and social demand for professionalism in Vietnam could encourage nurses to pursue higher education but the essential role of elementary nurses became more sensible. The health financing reform that shifts resources from hospital care to primary care should be developed to improve access to early diagnosis and chronic care.

## Key Message

The decrease in the number of elementary nurses, as well as the increase in health insurance expenditures per inpatient, seems to be with the highest certainty correlated with HT and type 2 DM death and DALYs rates.

## Introduction

Non-communicable diseases (NCDs) have become the leading causes of the global burden of disease, accounting for two-thirds of mortality worldwide<sup>1</sup>, and three quarters occurred in low- and middle-income countries. Cardiovascular diseases (CVDs) are responsible for the largest proportion of these burden contributing to a third of NCDs burden<sup>1,2</sup>. Hypertension (HT) is one of the strongest risk factors for CVDs, which was the leading cause of premature death globally<sup>3,4</sup>. There is a strong association between diabetes mellitus (DM) type 2 and CVDs, which is the most prevalent cause of morbidity and mortality among patients with DM<sup>4,5</sup>. The incidence of HTN and DM keep rising and these two diseases are among the most prevalence and costly chronic disease worldwide<sup>4,6</sup>. The prevalence of HT and DM type 2 among adults is similar or higher in low- and middle-income countries than in high-income countries because of sharper prevalence increase in the past few decades<sup>7,8</sup>.

In 2008, 14.5 million total deaths were estimated in countries of Southeast Asia (SEA) with 7.9 million (55%) attributable to NCDs. CVDs alone accounted for 25% of all deaths, of which HT is responsible for nearly 1.5 million deaths annually<sup>9</sup>. The prevalence of diabetes is also growing at alarming rates and has almost doubled in many SEA countries between 2005-2015<sup>10</sup>. Vietnam is a SEA country with a high burden of NCD and CVD and diabetes are among the top contributors to premature mortality<sup>11</sup>. The recent reviews reported prevalence of HT and DM is estimated to 21.8% and 5.4% respectively and signifies a rapidly growing prevalence of these two chronic conditions in Vietnam<sup>12</sup>.

The 2030 Agenda for Sustainable Development recognizes NCDs as a major challenge for sustainable development. All the member countries have committed to developing a national action plan for combating NCD and achieving NCD-related goals. In the context of high NCD associated burdens in the SEA region, the SEA countries endorsed several policy frameworks and national programs, such as the South-East Asia Regional Network for Prevention and Control of Noncommunicable Diseases in 2005 or the Action plan for the prevention and control of NCDs in SEA<sup>13</sup>. One of these endorsements is project Scaling-up NCD Interventions in South East Asia (SUNI-SEA), which is currently ongoing in three SEA countries (Vietnam, Myanmar, and Indonesia). The project aims to validate effective scaling-up strategies of evidence-based DM and HT prevention and management programs and to enhance sustainable action for the achievement of the Sustainable Development Goals, based on experiences in SEA<sup>14</sup>. This study was a part of the SUNI SEA project implementation with the aim to put the basis for the research hypothesis for the SUNI SEA project in Vietnam. For this purpose, we described and assessed the scale of the burden of CVDs, HT, and DM type 2 respectively, and attached financial and contextual factors affecting its progress.

## Methodology

### Study design and population

To investigate the epidemiological burden of HT and DM type 2 in Vietnam we conducted an ecological study employing secondary data analysis. For a study population, we included all Vietnamese populations between the years 1990-2017 (no exclusions based on different attributes e.g. race or age were made).

### Data sources

Data from the Institute of Health Metrics and Evaluation were accessed using the Global Burden Disease (GBD) Results Tool<sup>15</sup>. In the database, the ICD 10 coding was used. Albeit the wide range of the confidence intervals limiting the validity of these results, these data belong to the most appropriate among accessible data sources up to date<sup>16</sup>. Data were age-standardized using the GBD reference population by researchers in the Global Burden of Disease Study in 2017<sup>17</sup>.

The data from Vietnamese Health statistics years books published by the Vietnamese Ministry of Health were analysed for financial and contextual factors (human resources, health insurance, health expenditures, etc.). The yearbooks published between 2009 and 2016 were selected (in total 8 yearbooks)<sup>18,19,20,21,22,23,24,25</sup>. Because of changes in reports we excluded the yearbooks before 2009 due to missing or incomplete data.

## Variable definitions

To analyse the epidemiological situation of CVDs and DM type 2 we used variables *Cardiovascular diseases* (code B.2) and *Diabetes mellitus type 2* (code B.8.1.2) coded under the Causes category in GBD Results Tool. For the purpose of this study, the burden of hypertension was assessed by variable *High systolic blood pressure* (SBP  $\geq$  110-115 mm HG) coded under Risk factors from all causes' category.

Selected financial and contextual factors represented: citizens per 1 health personnel, the average number of medical consultations per capita, and health expenditures from health insurance per inpatients and outpatients. In the category of health personnel, 23 professions were identified and for the clarity of the study results, some of them were clustered (College and university nurse with Second-degree nurse to Higher degree nurse) or excluded based on the relevance to the aims of the study (pharmacists, midwives, etc.).

For calculation of variables *Citizens per 1 health personnel* and *Number of medical consultations per capita*, the number of all citizens in Vietnam in the selected year was divided by the number of selected health personnel/ number of attended medical consultations in the selected year.

## Statistical analysis

To assess changes in CVDs, high SBP, and DM type 2 death rates and DALYs over time the data were analysed by linear and polynomial regression analyses and Kendall rank correlation. To estimate the correlation between these variables and selected financial and contextual factors the Pearson correlation coefficient was used. The statistical analysis was performed in the R project software<sup>26</sup>.

## Results

As the Sustainable development goals index related to health has increased over time in Vietnam (from 29 in 1990 to 46 in 2015), we observe the widening gap between the distribution of the health burden of communicable (CDs) and non-communicable diseases (NCDs). Overall, the estimated deaths from NCDs represented 78% of all deaths, and estimated DALYs from NCDs represented 73% of all DALYs in Vietnam in 2015. The differences between CDs and NCDs deaths and CDs and NCDs DALYs over time are statistically significant ( $p < 0.001$ ; see Appendix 1).

Deaths caused by CVDs represented 31% of all deaths in Vietnam in 1990–2017 on average, out of which **57% were attributable to high systolic blood pressure** (SBP). Similarly, out of 15% of all DALYs which were

attributable to CVDs, **56% were caused by high SBP. Overall, on average 19% of all deaths and 9% of all DALYs were associated with high SBP and 2% of all deaths and 2% of all DALYs were attributable to DM type 2 between 1990–2017 in Vietnam.** The proportions of deaths and DALYs attributable to CVDs, high SBP, and DM type 2 were steadily rising between 1990–2017 in Vietnam (Fig. 1).

Between the years 1990–2017, there was an increase in mortality for both males and females in all observed variables – CVDs, high SBP, and DM type 2 (Fig. 2). **Differences between genders were recognizable mainly in CVDs and high SBP death rates.** As for DALYs are the results similar except the CVDs DALYs rate in females which tend to decrease over time, but not significantly (Fig. 3). For more details see appendix 3 and 4.

Between the years 2009–2016 has in Vietnam significantly increased health personnel capacities, mainly in the category Bachelor of Public Health (or higher) and among high degree nurses. On the contrary, as many of the nurses persuaded higher education levels there is a significant increase in the number of citizens who pertain to 1 elementary nurse. Over the years the increase is observed also for assistant doctors and traditional medicine practitioners (Table 1).

Table 1  
Citizens per 1 health personnel in Vietnam 2009–2016

Year	MD	BoPH	AD	HDN	EN	MT	TMP
2009	1 518	186 604	1 685	1272	10 422	6 211	319 794
2010	1 390	133 735	1 657	1173	12 173	6 113	329 272
2011	1 364	94 962	1 612	1074	14 113	5 785	401 096
2012	1 363	83 355	1 627	1027	15 372	5 650	374 569
2013	1 310	59 410	1 602	982	16 803	5 264	391 742
2014	1 289	52 354	1 618	931	19 866	5 321	405 040
2015	1 247	52 830	1 684	929	23 160	5 048	465 550
2016	1 169	41 234	1 731	898	26 993	4 965	441 405
<b>r<sup>2</sup></b>	0.92	0.85	0.08	0.92	0.96	0.96	0.83
<b>b</b>	-40.9	-18 737	5.3	-51.4	2257.4	-188.4	18 591
<b>CI 95%</b>	(-52.7; -29.1)	(-26673; -10799)	(-12.3; 22.9)	(-66.5; -36.2)	(1807; 2707)	(-225; -152)	(10104; 27078)
<b>p value</b>	< 0.001	0.001	0.49	< 0.001	< 0.001	< 0.001	0.002
<b>τ</b>	-1	-0.93	0.07	-1	1	-0.93	0.79
<b>p value</b>	< 0.001	0.002	0.9	< 0.001	< 0.001	0.002	0.009
MD = Medical Doctor and higher; BoPH = Bachelor of Public Health and higher; AD = Assistant Doctor; HDN = Higher Degree Nurse; EN = Elementary Nurse; MT = Medical Technicians; TMP = Traditional Medical Practitioners; r <sup>2</sup> = linear regression coefficient of determination; b = linear regression coefficient; τ = Kendall's τ coefficient							

The number of health consultations that citizens attend per year has not changed in 2013–2016 significantly. Between these years in Vietnam there has been a substantial increase in expenditures per inpatients from health insurance, but not in expenditures per outpatients (Table 2).

Table 2

Average number of medical consultations per capita and health expenditures from health insurance per inpatients and outpatients in INT\$, 2013–2016

Year	Average consultations per capita	HI expenditure per inpatient	HI expenditure per outpatient
2013	2.4	85	10
2014	2.2	97	7
2015	2.3	106	7
2016	2.5	121	9
$r^2$	0.16	0.99	0.06
<b>b</b>	0.04	11.9	-0.3
<b>CI 95%</b>	(-0.2;0.3)	(8.8;15)	(-3.9;3.3)
<b>p value</b>	0.6	0.003	0.75
$\tau$	0.33	1	0
<b>p value</b>	0.73	0.09	1
$r^2$ = linear regression coefficient of determination; <b>b</b> = linear regression coefficient; $\tau$ = Kendall's $\tau$ coefficient			

From the results of correlation analysis with relatively narrow confidence intervals (range of 0.1), only two selected contextual variables were identified. **The increasing number of citizens per 1 EN was positively associated with all six main variables** - CVDs, high SBP, and DM type 2 death rates and DALYs rates. **Increasing health insurance expenditures per inpatient were also positively correlated to these variables except DM type 2 DALYs rate with a little wider 95 CI% (0.11)**. 95% confidence intervals in correlation analysis were in all other variables wider (Table 3).

Table 3  
Correlation analysis of selected contextual variables and CVDs, high SBP and DM type 2 death and DALYs rates with  $p < 0.05$

	CVDs death rate		High SBP death rate		DM type 2 death rate	
Variable	r	CI 95%	r	CI 95%	r	CI 95%
MD	-0.94	-0.99; -0.71	-0.95	-0.99; -0.76	-0.95	-0.99; -0.73
BoPH	-0.85	-0.97; -0.36	-0.88	-0.98; -0.44	-0.88	-0.97; -0.47
HDN	-0.9	-0.98; -0.54	-0.92	-0.99; -0.63	-0.93	-0.99; -0.66
EN	0.99	0.98; 0.99	0.99	0.97; 0.99	0.99	0.94; 0.99
MT	-0.95	-0.99; -0.75	-0.96	-0.99; -0.81	-0.97	-0.99; -0.85
TMP	0.88	0.47; 0.98	0.89	0.51; 0.98	0.9	0.52; 0.98
HIEpl	0.99	0.97; 0.99	0.99	0.96; 0.99	0.99	0.9; 0.99
	CVDs DALYs rate		High SBP DALYs rate		DM type 2 DALYs rate	
Variable	r	CI 95%	r	CI 95%	r	CI 95%
MD	-0.95	-0.99; -0.75	-0.96	-0.99; -0.8	-0.95	-0.99; -0.75
BoPH	-0.86	-0.97; -0.39	-0.9	-0.98; -0.53	-0.89	-0.98; -0.49
HDN	-0.91	-0.98; -0.56	-0.94	-0.99; -0.7	- .094	-0.99; -0.68
EN	0.99	0.98; 0.99	0.99	0.95; 0.99	0.99	0.95; 0.99
MT	-0.95	-0.99; -0.75	-0.97	-0.99; -0.84	-0.97	-0.99; -0.85
TMP	0.88	0.48; 0.98	0.9	0.54; 0.98	0.9	0.53; 0.98
HIEpl	0.99	0.96; 0.99	0.99	0.95; 0.99	0.99	0.88; 0.99
r = correlation coefficient; HIEpl = Health Insurance Expenditures per Inpatient						

The variables as citizens per 1 assistant doctor, average number of medical consultations per capita, and health insurance expenditures per outpatient were in strong correlation with CVDs, high SBP and DM type 2 death and DALYs rates (positively or negatively), however with extremely wide confidence intervals and with a p-value greater than 0.05 (see appendix 4).

## Discussion

The health burden of many NCDs in Vietnam has increased over the years since the 1990s, with death rate increased up to almost 78% of all deaths that are attributable to NCDs in 2015. A similar situation

affects the whole Southeast Asia region ranging from 45% in Timur-Leste to 85% in Brunei Darussalam in 2016<sup>27</sup>. The proportion of DALYs attributable to NCDs in Vietnam since the 1990s as well as the proportion of NCDs mortality is progressing accordingly to an estimated proportion of NCDs DALYs and deaths for countries with middle socio-demographic index<sup>28</sup>. However, if the tracked progress remains at the same pace, in the category of Good health and well-being Vietnam seems not to be able to achieve the desired threshold by 2030 as committed by United Nations Member States in 2015<sup>29</sup>.

The Vietnam health workforce reform has been underway in Vietnam, which were strongly committed in the master plan for Vietnam's health system development towards 2025. Vietnam has made significant progress in health workforce development over the last decade. Albeit it still did not meet the World Health Organization (WHO) standard of 1 medical doctor (MD) per 1000 patients<sup>30</sup>, this ratio increased from 0.66 in 2009 (1518 citizens per 1 MD) to 0.86 in 2016 (1169 citizens per 1 MD). Similar progress has been partially made in the nursing profession, in which nurses started to achieve higher-level education. That could be the reason for the decrease in the number of elementary nurses (EN) in Vietnam. Within economic growth, the establishment of the Joint Coordinating Committee on Nursing in 2007, developing regulatory frameworks, and social demand for quality care and professionalism in Vietnam these settings could empower and support nurses to pursue higher education<sup>31</sup>. In our analysis, **the decrease of EN was in strong correlation with an increase in CVDs, high SBP, and DM type 2 death and DALYs rates**. Regarding both medical doctors and nurses as skilled health workers (SHW) and WHO standard to achieve 80% coverage of essential health services, **Vietnam lacks more nurses than medical doctors**. Nurse to patient ratio in Vietnam (also considering midwives) was 1.45 in 2016 while the WHO standard is set to have at least 4 nursing personnel per 1000 patients<sup>32</sup>. Achieving the desirable ratio 2.3 of SHW per 1000 population (updated to 4.45 SHW per 1000 population in 2016)<sup>33</sup> still poses a challenge and obligation for the Vietnam government to ensure the provision of adequate health care. **It also corresponds with a number of medical consultations (MC) per capita in Vietnam, which is much lower than the OECD average of 6.9 consultations per person**. There exists a variation of the number of MC between countries in the Southeast Asia region possibly because of differences in the economic development of these countries or the number of their SHW, e.g. number of MC per capita in 2015 in Cambodia was 0.6, in 2013 in Singapore 1.7 or in 2008 in Brunei Darussalam 3.9<sup>34</sup>. Health insurance expenditures per inpatient (HIEpl) in Vietnam significantly increased within the past few years and as such will be needed to handle in the future. In our analysis, **the increase in HIEpl was in strong correlation with an increase in CVDs, high SBP, and DM type 2 death and DALYs rates**. Such findings can be understood as such utilization of inpatient services is more likely linked with serious NCD-associated conditions and complications. The health financing reform that shifts resources from hospital care to primary care should be developed to improve access to early diagnosis and chronic care and thus mitigate serious NCD-related complications and its associated economic burden of health expenditure on the population.

The increasing CVDs, high SBP, and DM type 2 death rates and DALYs rates since the 1990s in Vietnam become more differentiated between males and females as we go further into the present. Albeit males

have significantly higher rates attributable to CVDs and related to high SBP, **DM type 2 death rate as well as DALYs are higher in the female population**. Even if it has been recognized in the past that the impact of DM type 2 is greater in females than in males for all causes it is not yet fully understood<sup>35</sup>. Possible explanations could be the different cardiovascular risk profile or quality of provided health care but these need to be further examined<sup>36</sup>. The pooled prevalence of HT in Vietnam is estimated to be 21.1%<sup>37</sup> which is lower than HT overall prevalence 27% estimated for member countries of the South Asian Association for Regional Cooperation<sup>38</sup>, 37.8% in middle-income countries or 23.1% in low-income countries<sup>39</sup>. The rate of change in both HT and DM type 2 death rates (increase in these cases) is however much faster than in high-income countries<sup>40</sup>.

Within the estimated burden attributable to CVDs which is expected to further rise in the Southeast Asia region over the next several decades<sup>41</sup>, the policymakers will have a fundamental role in tackling its progress in Vietnam. The economic utility in the implementation of preventive measures to reduce the health burden of both HT and DM type 2 has been demonstrated many times in the past<sup>42,43,44</sup>. Consequently, the Vietnam government has nationally implemented the One Strategic Plan to reduce four main NCDs by 10% between 2017-2021<sup>45</sup>. Similarly, 11 Southeast Asian countries have endorsed national multisectoral NCD action plans to implement the Colombo Declaration on NCDs since 2016, which seems to help to accelerate the necessary progress<sup>46</sup>. To achieve SDG target 3.4 by 2030, decision-makers in Vietnam as well as in other Asian countries will have to endorse networked governance with strong political leadership oriented towards health capacity building and primary health care as the keystones in reducing the NCDs burden<sup>47</sup>.

### **Limits of study**

Limits of the study emerged from the type of data used. First, the ecological character of this study limited our inference possibilities about the individuals thus conclusions must be taken with caution and should serve as the basis for further analysis. Second, we were not able to perform a more advanced time trend analysis of HT and DM type 2 because of the lack of monthly (or quarterly) diversification of reported statistical data. Third, the standardization was performed by GBD 2017 researchers using the GBD reference population, which is not often used. Consecutive comparisons and their interpretations were thus limited to assess progress in time rather than a comparison of specific numbers or rates. And fourth, we were limited by the availability of data on health personnel in the past in Vietnam, as the analysis of older data could reveal further differences.

## **Conclusions**

The burden of CVDs has risen significantly since the 1990s in Vietnam and this progress seems to continue if the government will not endorse effective precautions. Although the health workforce has increased significantly over the years, it still has not achieved the WHO standards, and HT and DM type 2 death rates, as well as DALYs, affect more Vietnamese people each year. Moreover, since 2010 female's

death and DALYs rates are increasing at a much higher pace (in all three selected variables). The decrease in the number of elementary nurses, as well as the increase in health insurance expenditures per inpatient, seems to be with the highest certainty correlated with HT and type 2 DM death and DALYs rates.

## List Of Abbreviations

CVDs cardiovascular diseases

DM diabetes mellitus

GBD global burden disease

HT hypertension

NCDs noncommunicable diseases

SBP systolic blood pressure

SEA Southeast Asia

SUNI-SEA Scaling-up NCD Interventions in South East Asia

## Declarations

### Ethics approval

Not applicable - because of the ecological character of the study employing aggregated data from routine statistics, there was no need for ethical approval.

### Consent for publication

Not applicable.

### Availability of data and materials

The datasets analysed during the current study are available in the:

IHME Data repository, <http://ghdx.healthdata.org/gbd-results-tool?params=gbd-api-2019-permalink/eefe61f0cf949dbfc3609915f3a2de1a>

IHME Data repository, <http://ghdx.healthdata.org/gbd-results-tool?params=gbd-api-2019-permalink/22721d3a9538321b7496ee1140cc1ae5>

The data analysed during the current study are included in the published Vietnamese Ministry of Health's statistics years books (from 2009 to 2016)<sup>18-25</sup>.

### **Competing interests**

The authors declare that they have no competing interests.

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### **Authors' contributions**

PS analysed data and was a major contributor in writing the manuscript. HGN adjusted the discussion section to the Vietnamese setting and contributed to the methodological approach. MJ and PD contributed to the theoretical background of the manuscript and statistical analysis. MM grammatically adjusted the language of the manuscript and provided statistical analysis verification. RM led the methodological approach in the manuscript, provided consultations to all issues, and adjusted the overall manuscript form.

All authors read and approved the final manuscript.

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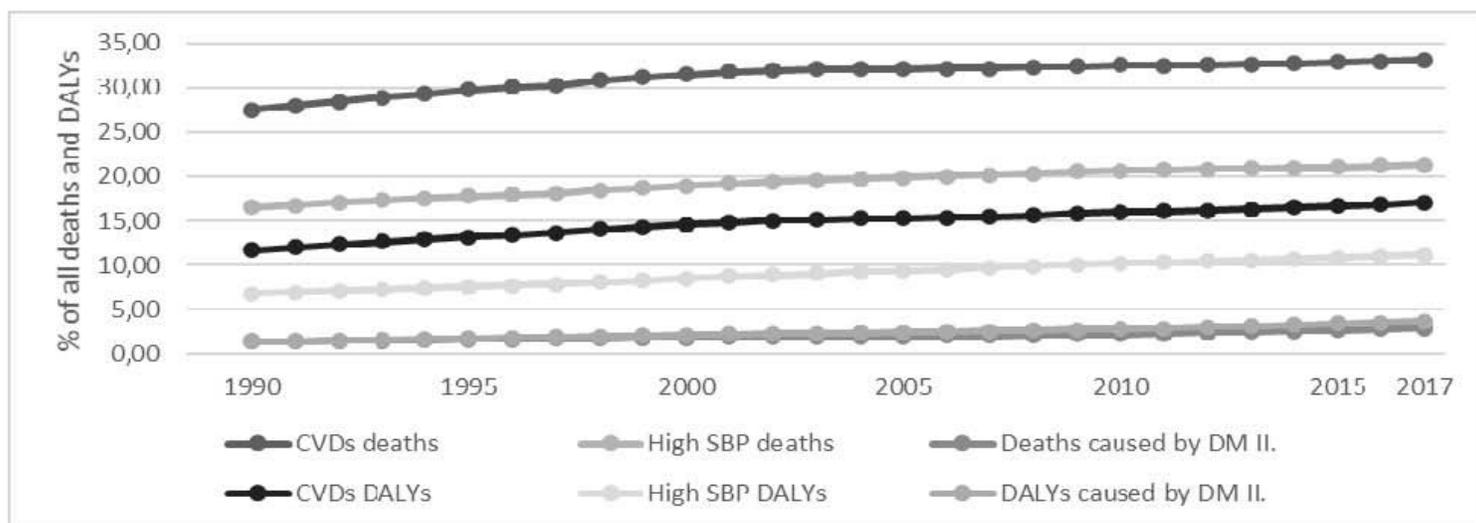
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## Figures



**Figure 1**

Proportion of deaths and DALYs attributable to CVDs, High SBP and DM type 2 as % of all deaths in Vietnam, 1990-2017

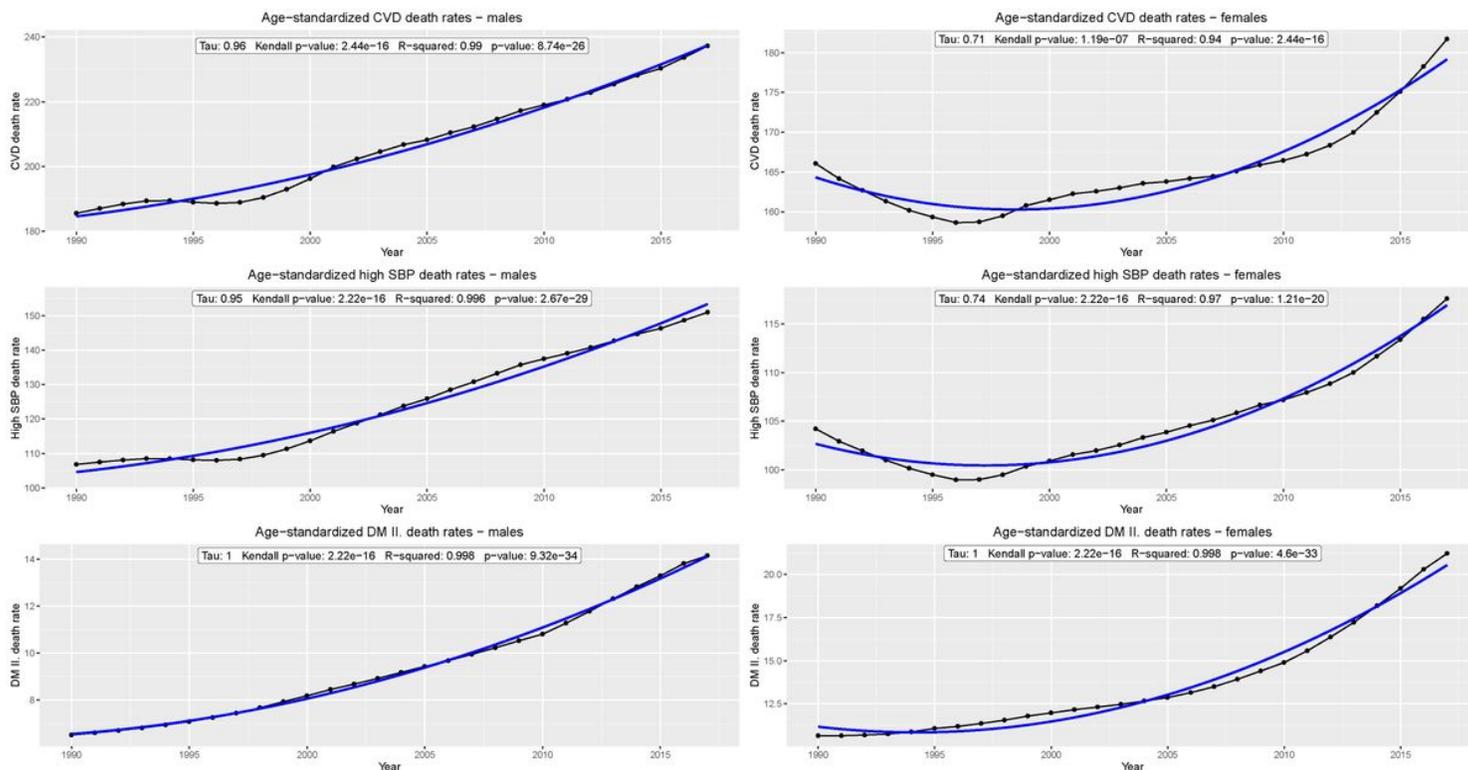


Figure 2

CVDs, high SBP and DM type 2 age-standardized death rates with polynomial curves per 100 000 inhabitants between 1990-2017 by sex

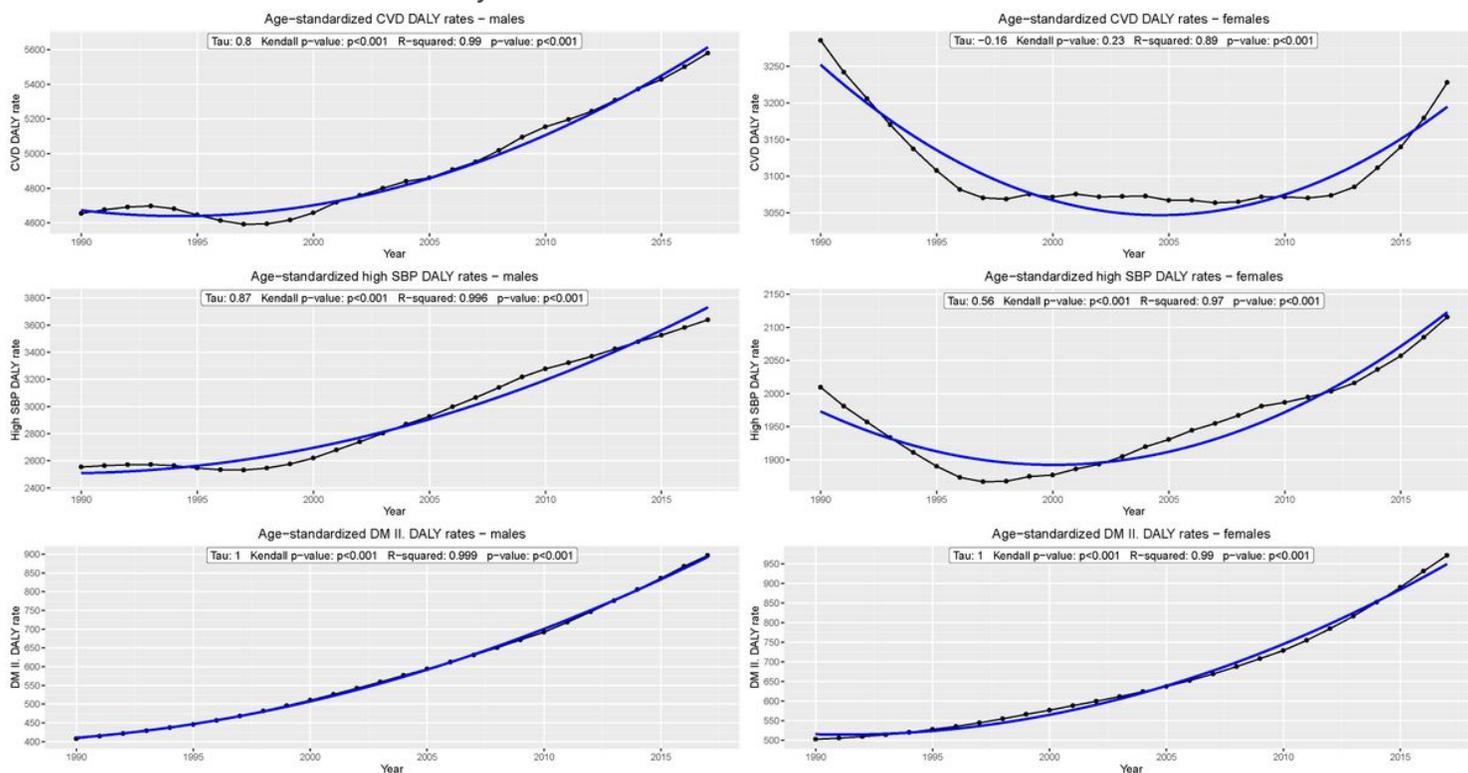


Figure 3

CVDs, high SBP and DM type 2 age-standardized DALY rates with polynomial curves per 100 000 inhabitants between 1990-2017 by sex

## Supplementary Files

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