國立臺灣大學公共衛生學院流行病學與預防醫學研究所

碩士論文

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Master Thesis

臺灣縣市層級可歸因危險因子之疾病死亡負擔：比較性風險評估

Comparative risk assessment of diseases mortality attributable to metabolic, lifestyle, infectious, and environmental risk factors in Taiwan: a subnational level analysis

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Comparative Risk Assessment of Diseases Mortality Attributable to Metabolic, Lifestyle, Infectious, and Environmental Risk Factors in Taiwan: A Subnational Level Analysis

本論文係　曹宇翔　君（學號 R06849007）在國立臺灣大學流行病學與預防醫學研究所完成之碩士學位論文，於民國 108 年 7 月 23 日承下列考試委員審查通過及口試及格，特此證明。

口試委員：林先和（指導教授）（簽名）

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曹宇翔
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摘要

站在公共衛生的角度，如何在有限的資源下制定最有成效的健康介入政策來達到預防與控制疾病的發生、失能與死亡是促進族群健康的關鍵，為了達成這樣的目標，全盤了解族群所面臨的健康問題與其背後的危險因子分布是首要步驟。

臺灣在死因統計的建立與品質的管控是令其他國家所稱羨的，但要如何有效利用這樣的結果來進一步探討成因並提供給各級政府作為政策方針制定的參考依據成為當前的課題，本研究利用全球疾病負擔團隊所發展的比較性風險評估架構來推估臺灣疾病死亡負擔背後可歸因危險因子的分布並利用完善的資料庫將分析解析度推展到縣市層級，主要討論包括血壓過高、血糖過高、血脂過高、肥胖、吸菸、飲酒、嚼食檳榔、缺乏運動、室外空氣汙染、慢性 B 型肝炎和 C 型肝炎感染的分布。

分析結果顯示血壓過高、肥胖與血糖過高是造成國人死亡負擔最重要的危險因子，進一步也發現吸菸與肥胖對於青年與中壯年族群的影響更甚於其他危險因子。而在縣市層級中也發現整體來說，東部地區有較高的死亡負擔可歸因於危險因子的暴露，其次依序為中部、南部與北部地區。以危險因子來看，環境與行為相關危險因子(如:吸菸、檳榔、飲酒)在中部地區造成一定程度的死亡負擔，而東部地區需格外注意中壯年族群中行為相關危險因子與慢性 B 型肝炎感染。

本研究提供危險因子對於國人整體健康影響的量化證據，並呈現不同的縣市層級其所面臨的健康問題與成因，嘗試幫助各級政府制定更針對性的健康政策。在資源有限的前提下，期許這樣的分析結果能夠更有效達成促進健康的目標，也期望未來研究能更全面地納入危險因子做評估，並建立長期性的分析與監測網絡，甚至結合成本效益分析，提供相關政府部會作為健康促進的重要參考。

關鍵字：
比較性風險評估、族群可歸因分率、疾病死亡負擔、危險因子、縣市層級

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Abstract

From the perspective of public health, the key to promoting the population health is developing the most effective health intervention policy under limited resources to prevent and control the occurrence, disability and death. In order to achieve such a goal, fully understood the health problems and the distribution of potential risk factors is the first step.

The completeness and quality of vital statistics in Taiwan has outperformed than other countries. However, how to utilize effectively health data to provide informative reference to governments for policy development is critical. This study estimated the distribution of mortality burden attributable to risk factors in Taiwan according to the comparative risk assessment (CRA) framework developed by the Global Burden of Disease (GBD) project. Eleven risk factors, including high blood pressure, high fasting blood glucose, high low-density cholesterol, obesity, smoking, alcohol drinking, chewing betel nut, low physical activity content, outdoor air pollution, chronic hepatitis B and hepatitis C infection, were included in present study. All analyses were performed at county level.

The results showed that high blood pressure, obesity, and high fasting blood glucose were the most important risk factors in terms of attributable mortality burden. Also, we found that smoking and obesity affected younger and middle-aged groups more than other risk factors especially for males, by contributing 197416 and 172383 YLLs, respectively. At subnational levels, a generally higher mortality burden that attributable to risk factors was observed in the eastern region, followed by the central, southern and

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northern regions in Taiwan. In addition, for people living in the central region, behavior-related risk factors, including smoking, betel nut, and alcohol drinking, accounted for a substantial burden of mortality, while infection and behavior-related risk factors are key drivers of mortality burden for the eastern region.

This study provides quantitative evidence about how much mortality burden attributable to risk exposure at subnational level in Taiwan. Findings of present study will help governments to develop health policies that considering local conditions. Under the premise of limited resources, our analyses provide insight for health policy development from central to local perspectives.

Keywords:
Comparative risk assessment, population attributable fraction, burden of disease, risk factors, subnational level

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Content

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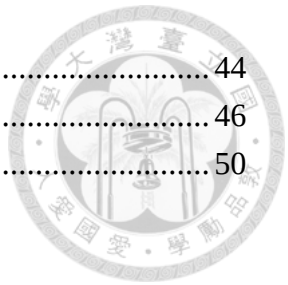

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Chapter 1 Introduction

1.1 Background

Cause of death statistics in Taiwan is quite prominent in both quality and quantity. However, if the cause is not further investigation, it does not improve the health of the population. According to the report of *Health Inequalities in Taiwan 2017* [1] published by Ministry of Health and Welfare, the health inequality situation was found in difference of life expectancy at birth between counties and cities in Taiwan. From a public health perspective, understanding the death burden of disease and the distribution of risk factors are keys to reduce health inequalities. This study used the Comparative Risk Assessment (CRA) framework which built by the Global Burden of Disease (GBD) program to estimate the death burden of diseases and contribution from risk factors. With the advantages of diverse and complete database in Taiwan, we can estimate the distribution of risk factors in various subnational level to further confirm the order of the health problems they facing. The study can provide not only an evidence-based result for government properly formulates health policies and resource allocations but also helps to examine the past interventions of relevant risk factors. Furthermore, it can be an important example and experience reference for disease burden assessment in other countries.

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1.2 Literature Review

1.2.1 Health Inequalities

The health inequalities had been defined as “differences in health status or in the distribution of health determinants between different population groups” by World Health Organization (WHO) [2]. Different levels of living standards affect the accessibility of follow-up education and medical care and ultimately lead to a gap in health [3]. As time goes on, health inequalities can be observed all over the world nowadays [4]. Being deeply concerned about health awareness, many countries had begun to pay attention to the issue of health inequality and embark on evaluation and discussion [5-7].

Despite considerable attention to the issue of health inequalities, striking differences in health still exist among and within countries up to now [8-13]. To improve this problem, it is necessary to understand the distribution of health problems and potential risk factors, and proceed from the basic risk factors to achieve optimal control and prevention. With such evidence-based result, government can formulate appropriate health policies and resource allocations to further address the issue of eliminating health inequalities.

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1.2.2 Global Burden of Diseases and Comparative Risk Assessment framework

The measurement of burden of diseases is a set of methods which developed by Christopher J.L. Murray and Alan Lopez in 1994 to quantify health problems and provide comparable data. [14, 15] With the measurement further to present the disability and death burden caused by different prevalence of disease, the proportion of severity, and the corresponding disability weights in the population. [16]

As time progresses, the GBD program has gradually improved their analytical methods. [12, 17-20] Use a CRA framework to quantify the proportion of disease burden that be mitigated under counterfactual exposure, which called the theoretical minimum-risk exposure distribution (TMRED) and achieve a comparable result. [10-12] As the core of the CRA, the Population Attributable Fraction (PAF) represents the amount of change in the proportion of disease occurrence or death in the population when the exposure of the risk factor changes from the current general condition to the counterfactual. This also indicates how much the proportion or death of the disease is attributable to exposure of specific risk factor. [21, 22]

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1.2.3 Taiwan burden of disease

Taiwan had published an article about mortality of diseases which attributable to metabolic, lifestyle, environmental, and infectious risk factors at national level in 2017. [23, 24] It used YLL to estimate the burden of disease death caused by past main causes of death in Taiwan, and further estimated the distribution of risk factors behind it to bring out the real reasons that cause the health inequality in Taiwan. The leading causes for YLL were high blood glucose (caused 14,900 deaths), tobacco smoking (caused 13,340 deaths) and high blood pressure (caused 11,190 deaths) in 2009. The results of this article suggest that the most dangerous risk factors we should pay attention to and the government can use this result to make policy adjustments.

However, with such the result at national level, we can merely understand the general direction of the problem of health inequality. There is a demand for local government for more accurate data in order to allocate resources under limited resources. According to the 2017 annual cause of death statistics published by the Department of Health and Welfare [25], the cause of death at different counties and cities is not exactly the same. In the case of six municipalities, the main cause of death is heart disease, but the second highest cause of death may be Pneumonia (Taipei, Taichung, Tainan, Kaohsiung and New Taipei City) or cerebrovascular disease (Taoyuan city**)**. With such results, we can only show the distribution of death in Taiwan, but the reason is unknown. Although the

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report of *Health Inequalities in Taiwan 2017* mentioned that inequality distribution of factors like education level, medical accessibility, and other social status in Taiwan [1], but most of them are not affected by the public health. Therefore, it is imperative to confirm the distribution of burden of disease and the attributable risk factors in various counties and cities to shorten the health gap within Taiwan.

In summary, these literatures and research reports use a variety of different-oriented discussions to assess the burden of disease and health differences among people in Taiwan, but there is still lack of analysis of the disease burden caused by exposure to risk factors at subnational level. From the perspective of public health, avoiding or intervening exposure to risk factors to prevent disease and death is the key to promoting health. Therefore, we must assess the distribution of disease burden attributable to risk factors in Taiwan at subnational level. Through the complete database, we further include the exposure of regional risk factors such as betel nut, hepatitis B, and hepatitis C to more comprehensive explore the reasons behind the health inequalities.

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1.3 Research motivation and Importance

From the perspective of public health, the intervention of risk factors can effectively prevent the occurrence of diseases. Understanding the distribution of health problem and potential risk factors would be the keys to eliminate health inequalities. So far, previous CRA studies looking at disease burden in Taiwan only focused on the national level. Therefore, the primary aims of this study are:

1) Estimate the mortality burden at subnational level in Taiwan.
2) Estimate the distribution of attributable risk factors including four parts: metabolic-related, behavioral, infection-related, and environmental risk factor at subnational level in Taiwan.
3) Explore the attributable mortality burden at subnational level and observe whether there is a geographical difference for Taiwan.

We expected to reveal the health gap in terms of mortality burden attributable to risk exposure and provide evidence-based results for local health policy-making and resource allocations. This study would be an important illustration and experience reference for other countries.

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Chapter 2 Methods

2.1 Research framework

This study explored how much proportion of mortality burden for chronic non-communicable diseases was attributable to risk exposure at subnational level in Taiwan. The CRA framework that established by the GBD program was applied for this study. We used PAF to assess the burden of death which attributable to important risk factors in target populations (figure1). We obtained the prevalence of risk factors from national representative survey data, relative risk (RR) functions were collected from literature review, and cause-specific mortality data was estimated by death registration data. In addition to cause-specific mortality, the YLLs were estimated by using life table to present the impact of risk factors on life lost in Taiwan.

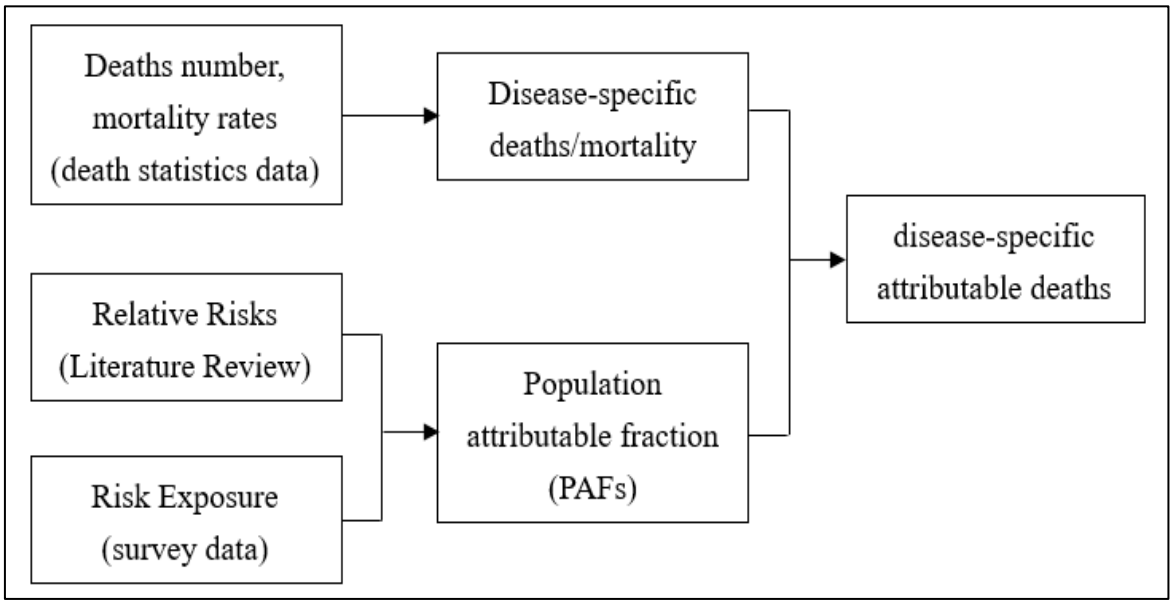

Figure 1 Research framework of CRA

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2.2 Selection and sources of risk factors

The risk factors could be selected when they meet the following criteria [26, 27]:

1) These risk factors are one of the causes of important diseases in the population.
2) Exposure to risk factors can be changed through preventive intervention.
3) The causal relationship between risk factors and diseases must be confirmed by literatures.
4) The prevalence of risk factors can be obtained through representative survey data at the national level or even at the subnational level.

According to the above criteria, we included 11 risk factors and they can be classified into four parts: metabolic related risk factors (blood pressure, fasting blood glucose, low density cholesterol, and BMI), behavioral risk factors (smoking, alcohol drinking, betel nut, and physical activity content), infection-related risk factors (chronic hepatitis B, and chronic hepatitis C), and the environmental risk factor (fine aerosol exposure PM2.5). We included three major databases included National Health Interview Survey (NHIS), Taiwanese Survey on Hypertension, Hyperglycemia, and Hyperlipidemia (TwHHH), and Taiwan Air Quality Monitoring Network database to calculate the prevalence of risk exposure (table1). Detailed background information for these databases and the definition of risk exposure can find in the supplemental methodology.

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2.3 Definition of disease outcome

The data of cause of death at subnational level was obtained from the death statistics of the Ministry of Health and Welfare 2013. It was used the International Classification of Diseases 10th Revision (ICD-10) to encode the disease as a standard (table1). Further the estimation of YLL was based on the life table of Taiwan [28] which published by Ministry of Health and Welfare to calculate the average life expectancy of each age, multiplied by the age of death to calculate the number of years of loss of life.

2.4 Estimation of relative risk

2.4.1 Relative Risk (RR)

The RR data mainly derived from GBD study and previous CRA studies [11-13, 29, 30]. For the domestic risk factors for the Taiwanese population (chewing betel nut, chronic hepatitis B, and chronic hepatitis C), RRs were obtained from previous Taiwan CRA study [26, 31, 32]. (Supplement table1)

2.4.2 Counterfactual Exposure Distribution

Based on previous literature, the TMRED was defined as risk of minimal exposure to death [23, 33]. This study used TMRED as the counterfactual for the reason that zero

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exposure violated normal physiological performance for metabolic-related and environmental risk factor. Other risk factors as behavioral and infection-related were used the zero exposure as the counterfactual (table1).

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Table 1 Measurements, data sources, theoretical minimum risk exposure distributions (TMRED) and corresponding disease outcome.

Risk factor	Exposure unit	TMRED	Database	Disease outcome
High blood pressure	systolic blood pressure (mmHg)	115 (6)*	TW3H 2007	Rheumatic heart disease, Ischemic heart disease, Ischemic stroke, Hemorrhagic stroke, Hypertensive heart disease, Other cardiomyopathy, Atrial fibrillation and flutter Aortic aneurysm, Peripheral vascular disease, Endocarditis, Other cardiovascular and circulatory diseases, Chronic kidney disease
High LDL Cholesterol	LDL Cholesterol (mmol/L)	50.19 (11.58)*	TW3H 2007	Ischemic heart disease, Ischemic stroke
High blood glucose	fasting plasma glucose (mmol/L)	88.29 (8.29)*	TW3H 2007	Ischemic heart disease, Ischemic stroke, Hemorrhagic stroke, Chronic kidney disease
Obesity	BMI (kg/m2)	21 (1)*	NHIS 2013	Esophageal cancer, Colon and rectum cancer, Liver cancer, Gallbladder and biliary tract cancer, Pancreatic cancer, Breast cancer, Uterine cancer, Ovarian cancer, Kidney cancer, Thyroid cancer, Ischemic heart disease, Ischemic stroke, Hemorrhagic stroke, Hypertensive heart disease, Atrial fibrillation and flutter, Asthma, Gallbladder and biliary diseases, Alzheimer's disease and other dementias, Diabetes mellitus, Chronic kidney, Gout, Cataract
Smoking	pack - year	non exposure	NHIS 2013	Lip and oral cavity cancer, Nasopharynx cancer, Esophageal cancer, Stomach cancer, Colon and rectum cancer, Liver cancer, Pancreatic cancer, Larynx cancer, Tracheal, bronchus, and lung cancer, Breast cancer, Cervical cancer, Prostate cancer, Kidney cancer, Bladder cancer, Lymphoid leukemia, Myeloid leukemia, Other leukemia, Chronic obstructive pulmonary disease, Other chronic respiratory diseases, Prostate cancer, Ischemic heart disease,

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				Ischemic stroke, Intracerebral hemorrhage, Subarachnoid hemorrhage, Atrial fibrillation and flutter, Aortic aneurysm, Peripheral vascular disease, Asthma, Peptic ulcer disease, Gallbladder and biliary diseases, Alzheimer's disease and other dementias, Parkinson's disease, Multiple sclerosis, Diabetes mellitus type 2
Second-hand smoke		non exposure	NHIS 2013	Breast cancer, Chronic obstructive pulmonary disease, lung cancer, Ischemic heart disease, Stroke
Physical activity content	METs	3000-4500	NHIS 2013	Colon and rectum cancer, Breast cancer, Ischemic heart disease, Ischemic stroke, Diabetes mellitus
Alcohol	Intake (g/day)	non exposure	NHIS 2013	Esophageal cancer, Liver cancer, Larynx cancer, Breast cancer, Colon and rectum cancer, Lip and oral cavity cancer, Nasopharynx cancer, Other pharynx cancer, Ischemic heart disease, Ischemic stroke, Hemorrhagic stroke, Hypertensive heart disease, Atrial fibrillation and flutter, Cirrhosis and other chronic liver diseases due, Pancreatitis, Epilepsy, Diabetes mellitus
Betel nut		non exposure	NHIS 2013	Oral Cancer, Esophageal cancer, Laryngeal cancer
HBV	Hepatitis B surface antigen positive	no infection	TW3H 2007	Liver cancer, Chronic liver disease, Cirrhosis
HCV	Hepatitis C surface antigen positive	no infection	TW3H 2007	Liver cancer, Chronic liver disease, Cirrhosis
Outdoor air pollution	PM 2.5 ($\mu g/m^3$)	7.5 (0.75)*	TAQMN 2013	Ischemic heart disease, stroke, lung cancer, chronic obstructive pulmonary disease

* The numbers for alternative exposure distribution represent mean and standard deviation

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2.5 Redistribution of garbage code

The Naïve Bayes approach analysis model had been used to redistribute the garbage codes that should not be the root cause of death [34] and to combine multiple causes of death data published by Ministry of Health and Welfare. According to GBD, there were totally 41 types of garbage codes that included in our analysis (supplement table 2). [35] The covariates in the model include age, sex, death pattern, place of death, and degree of urbanization. Three-quarters of the data was used as a training set, and a quarter was used as a test set to establish appropriate predictive model parameters [23].

Cause-specific mortality rates with garbage code reassignment at county level were obtained from the Taiwan Burden of Disease Center..

2.6 Population Attributable Fraction (PAF)

PAF represents the meaning of a reduction in the proportion of disease occurrence or death in a population when the exposure of risk factor changed from the current distribution to counterfactual distribution, which also indicated that how much of the proportion of disease occurrence or death could be attributed to the exposure of specific risk factor[21, 22].

The calculation of the PAF was based on three important assumptions [36]:

1) The causal relationship between exposure to risk factors and disease is establihed.

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2) Exposure of risk factors can change from the current exposure distribution to the counterfactual distribution.

3) Intervention of a risk factor does not change the distribution of other risk factors.

The exposure of risk factors can divide into continuous and categorical type in this study.

The formula for continuous risk factors like metabolic-related risk factors was as follow:

$$\mathrm{PAF_{ij}} = \frac{\int_x \mathrm{RR_{ij}(x)P_{ij}(x)dx} - \int_x \mathrm{RR_{ij}(x)P'_{ij}(x)dx}}{\int_x \mathrm{RR_{ij}(x)P_{ij}(x)dx}}$$

Where RR(x) referred to the RR at the exposure level x; P(x) referred to the current realistic prevalence or distribution of risk factors; P'(x) referred to the counterfactual distribution of risk factors; i referred to the age group; j referred to gender.

The formula for the categorical risk factors like behavioral, and infection-related risk factors is as follow:

$$\mathrm{PAF_{ij}} = \frac{\sum_{k=1}^{n} \mathrm{P_{ijk}\ (RR_{ijk} - 1)}}{\sum_{k=1}^{n} \mathrm{P_{ijk}\ (RR_{ijk} - 1) + 1}}$$

Where RRk referred to the relative risk value of the risk factor k level; Pk referred to the prevalence of the hazard factor k level; i referred to the level of age group; j referred to gender; k referred to the level of exposure of the hazard factor (k = 1, …. , n).

2.7 Mortality Rate and Year Loss of Life (YLL)

We calculated the disease-specific crude mortality rate by different age and gender group

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and stratified into subnational level. YLL estimated by summing the number of deaths multiplied by the residual expected life expectancy by the expected life expectancy. The estimation of attributable diseases death burden is multiplying the PAF by the crude mortality rate or YLL with different age and gender group, further divide by per 100,000 population or person-year to present the truly value of disease death burden. The formula for YLL as follow:

$$YLL = \sum N * e$$

Where N referred by summation of the number of fatal cases multiplied by the residual expected life expectancy (e) at the age of death.

2.8 Uncertainty analysis

Considering sampling variability, we also used statistical simulation methods to assess the uncertainty level of the estimates [37]. According to the distribution of risk factors and the 95% confidence interval of relative risk, the combined grouping of 1,000 times was randomly selected to calculate the corresponding population attributable rate and disease burden. Based on the distribution of these results, the 2.5^{th} and 97.5^{th} percentiles are selected to be 95% uncertainty intervals (UIs) [23].

2.9 Analysis software

The analysis software was SAS (Version 9.4).

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Chapter 3 Results

3.1 Distribution of prevalence of risk factors

For metabolic-related risk factors, the average value is blood pressure 120.63±19.03 mmHg, fasting blood sugar 92.43±27.2mg/dL, and low-density lipoprotein 110.81±32.82 mg/dL. Further compare the value at subnational level, there is a higher average value at eastern Taiwan and so is for HBV and HCV. The average value of BMI is 22.88±4.49 kg/m^2 and the highest administrative district is Taitung (23.88±4.96). In case of behavioral risk factors, the prevalence of betel nut is 6.53% (11.77% for male), smoking 19.76% (34.27% for male), and alcohol use 26.31% (36.09% for male). Meanwhile the highest prevalence of behavioral risk factors is Taitung and Hualien. The distribution of outdoor air pollution is 30.07±20.25 $\mu g/m^3$, and there is a higher distribution at mid-south part of Taiwan. For low physical activity content, mean METs is 2521.7±5343.5 and the lowest value is Tainan and Hsinchu (table 2). (Supplement table 3.)

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3.2 Distribution of PAF

Figure 2 shows the total PAF of each risk factor. There is different target disease for different risk factors. We can find the highest PAF is SBP and betel nut use (more than 60%), and the lowest PAF is alcohol use and HCV (lower than 10%). For most of the risk factors, there is a higher PAF at mid-south part and eastern of Taiwan except for low physical activity content and PM 2.5. For gender, males have a higher PAF than female at behavioral risk factors and reverse at FPG and low physical activity content (figure 2). Through the presentation of PAF, we can understand the impact of a single risk factor at subnational level.

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Table 2 Distribution of prevalence of risk factors at subnational level.

Risk factor[#]	Blood pressure*	Blood glucose*	LDL*	BMI*	HBV	HCV	Alcohol	Betel nut	Smoking	Secondhand smoke	physical activity*	PM2.5*
	mmHg	mg/dL	mg/dL	kg/m^2	**	**	**	**	**	**	METs	μg/m^3
Taiwan	120.63 (19.03)	92.43 (27.20)	110.81 (32.82)	22.88 (4.49)	14.21	4.91	26.31	6.53	19.76	46.99	2521.7 (5343.5)	30.07 (20.25)
Keelung	123.79 (17.91)	94.59 (23.60)	110.81 (30.89)	23.20 (4.40)	16.87	3.81	30.89	4.37	25.24	50.47	2191.74 (4459.9)	18.4 (12.67)
Taipei	120.18 (19.44)	90.09 (25.95)	110.04 (31.27)	22.48 (4.21)	12.51	2.94	32.67	3.22	17.17	46.86	2411.25 (3707.8)	25.55 (15.74)
New Taipei	118.56 (18.19)	89.00 (23.42)	109.27 (32.05)	22.88 (4.62)	16.87	3.81	32.36	6.16	21.68	56.14	2640.85 (4520.5)	28.17 (16.75)
Taoyuan	119.08 (17.75)	91.71 (26.13)	108.49 (32.82)	22.96 (4.53)	12.65	3.17	29.92	6.07	23.85	50.15	2019.39 (3695.9)	25.68 (17.61)
Hsinchu	119.56 (15.93)	84.68 (10.81)	105.41 (28.19)	22.34 (4.43)	12.65	3.17	23.64	4.37	17.94	41.85	2004 (5445.9)	30.14 (17.77)
Hsinchu county	113.97 (19.98)	91.17 (16.40)	106.56 (32.82)	22.54 (4.48)	12.65	3.17	28.09	5.62	17.26	38.56	2464.05 (4823.8)	30.14 (17.77)
Miaoli	119.90 (21.05)	90.63 (29.00)	110.81 (26.25)	22.61 (4.50)	12.65	3.17	23.93	6.97	21.78	38.58	2413.44 (4024.0)	26.82 (17.76)
Taichung	117.39 (17.36)	93.69 (32.07)	110.04 (31.66)	22.56 (4.48)	13.89	4.28	27.03	4.1	18.61	49.8	2129.12 (3797.7)	30.16 (18.25)
Changhua	120.35 (19.40)	93.51 (27.21)	108.11 (29.73)	22.95 (4.56)	13.89	4.28	22.03	6.73	16.89	42.02	2901.2 (5003.2)	34.37 (20.07)
Nantou	118.55 (18.71)	94.25 (27.75)	118.55 (18.71)	22.80 (4.23)	13.89	4.28	25.81	7.45	20.82	43.44	3050.15 (5041.7)	34.05 (20.55)

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Yunlin	124.53 (19.77)	99.64 (33.15)	116.99 (37.07)	22.83 (4.34)	11.47	6.48	22.04	8	22.18	50.5	2688.35 (4600.2)	37.16 (22.72)
Chiayi	126.04 (18.14)	89.91 (25.50)	116.22 (34.36)	22.73 (4.35)	11.47	6.48	23.33	7.3	17.2	51.04	2159.22 (4194.2)	40.44 (24.82)
Chiayi county	126.04 (18.14)	89.91 (25.50)	116.22 (34.36)	23.03 (4.57)	11.47	6.48	20.2	10.03	20.98	46.19	3004.08 (5538.3)	40.44 (24.82)
Tainan	121.88 (18.97)	92.43 (21.80)	115.06 (33.59)	23.00 (4.44)	11.47	6.48	22.2	4.39	17.85	45.12	1887.03 (3619.3)	39.26 (21.59)
Kaohsiung	120.63 (18.53)	94.59 (29.37)	113.13 (34.36)	23.08 (4.46)	16.06	5.63	24.01	4.17	17.46	47.18	2193.76 (3759.9)	41.09 (22.58)
Pingtung	128.38 (19.19)	98.02 (36.40)	107.34 (37.45)	23.17 (4.51)	16.06	5.63	23.79	8.62	21.09	45.69	3564.51 (1389.5)	42.95 (20.20)
Taitung	133.80 (25.64)	99.10 (30.99)	121.62 (35.52)	23.88 (4.96)	18.44	12.50	36	19.73	26.66	51.38	3794.78 (5925.6)	13.09 (8.93)
Hualien	121.56 (18.59)	105.59 (44.32)	112.74 (40.15)	23.23 (4.83)	18.44	12.50	32.42	12.72	26.32	47.85	3054.43 (6145.8)	18.38 (10.72)
Yilan	116.44 (17.69)	89.00 (18.38)	113.51 (33.59)	22.89 (4.56)	18.44	12.50	25.46	8.2	23.14	53.48	2622.83 (5151.3)	20.80 (12.23)

* mean,sd

** Prevalence for exposure, refer to Table 1 for details.

Definition of the risk factor, please refer to Table 1.

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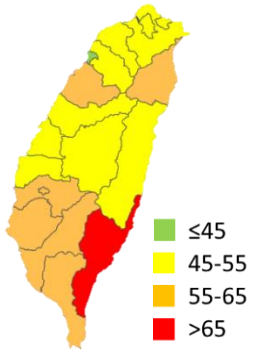
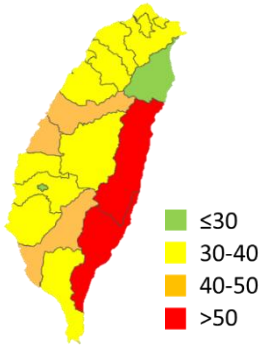
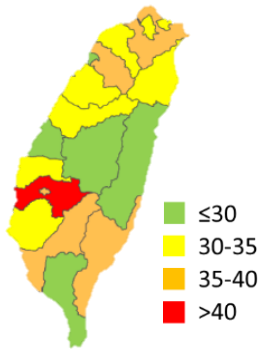
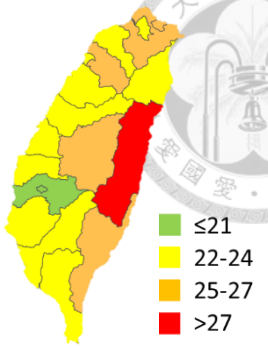
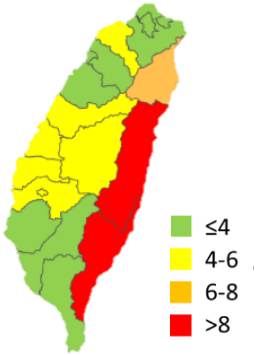
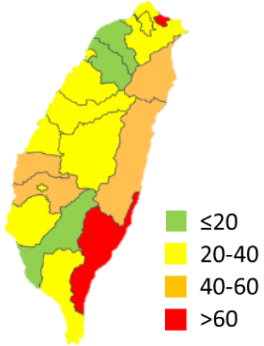
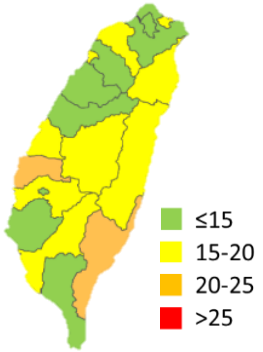
				
Risk factor	High Blood Pressure	High Fasting Blood Glucose	High Low-Density Lipoprotein	High BMI
Target disease[#]	CVD, CKD	CVD, CKD	CVD	CVD, CKD, Cancer, Neurological disorder, Respiratory diseases
				
Risk factor	Alcohol	Betel nut	Smoking	
Target disease[#]	CVD, CKD, Cancer	Cancer	CVD, CKD, Cancer, Neurological disorder, Respiratory diseases	

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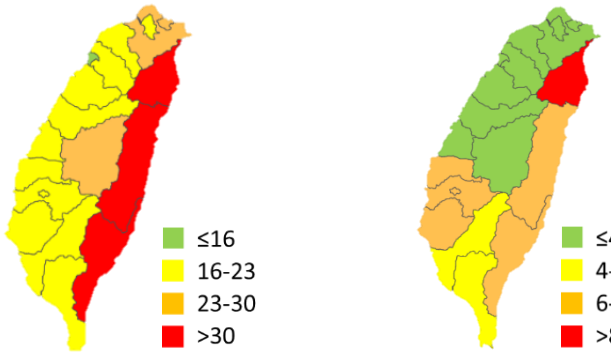
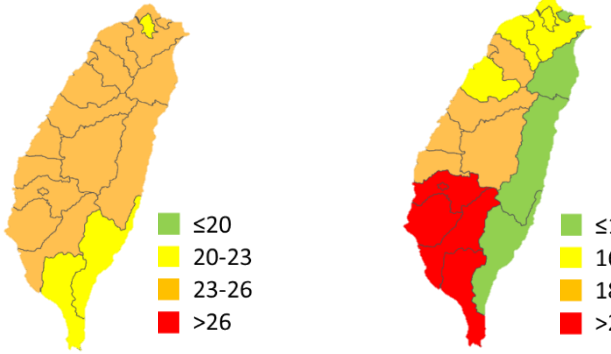
		
Risk factor Target disease[#]	HBV Cancer, Digestive system diseases	HCV Cancer, Digestive system diseases
		
Risk factor Target disease[#]	Physical Inactivity CVD, CKD, Cancer	Outdoor Air Pollution CVD, Cancer, Respiratory diseases

Figure 2 Total PAF for each risk factor at subnational level.

[#] Definition of the target disease, please refer to Table 1.

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3.3 Attributable mortality burden within subnational level

Next, we selected six administrative districts to compare the attributable mortality rate and YLL of the attributable death burden caused by its internal risk factors to further reveal the difference at health inequalities and reasons. With such results, local government can use to develop more local health policies to address the problems faced. Taipei, Taichung, Kaohsiung, Taitung are selected from the four geographical regions of Taiwan. Furthermore, after excluding six municipalities, we selected Chiayi County (oldest age structure) and Hsinchu city (the most competitive) into this study.

3.3.1 Attributable mortality rate and Years of Loss Life (YLL)

The high blood pressure, obesity, and high blood glucose are the main leading causes of attributable mortality rate at Taipei, Taichung, Hsinchu city, and Kaohsiung, but there is still a slight difference in ranking. Moreover, smoking had a second place of the ranking in Chiayi County and Taitung (figure 3.1-6).

Compare with YLL, we can find the high blood pressure is no longer the most serious problem in some administrative districts. For gender, smoking is a leading cause for males followed by obesity and high blood pressure (figure 4), meanwhile the leading cause for females are high blood pressure, high fasting blood glucose, and obesity (figure 5). (Supplement figure 1, 2).

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For Taipei, the top three attributable risk factors are the same to Taiwan and followed by outdoor air pollution and smoking. In terms of cause of death, the mainly cause of death attributed to high blood pressure death is Ischemic Heart Disease (720.64 deaths, 95% UI 617.16-851.12), Stroke (568.12 deaths, 95% UI 479.12-656.82), and Hypertensive Heart Disease (445.06 deaths, 95% UI 360.54-529.58), meanwhile 1725 (per 100,000 person-year) YLL rate. It was found that because the prevalence of smoking in Taipei was relative low (17.7%, 28.13% for males, and 6.57% for females), which led to a decline in ranking of smoking to 5th. (figure 6)

For Hsinchu city, the leading causes of attributable mortality are the same to Taiwan. Meanwhile the attributable mortality caused by high blood pressure is the lowest among the six administrative districts selected. Obesity is the main cause of YLL, also can find the YLL caused by high fasting blood glucose (1411 / 100,000) is mainly consist from Diabetes (1265 / 100,000), which means the lower age group in Hsinchu city may need to control posture and blood glucose further improve the prevalence of Diabetes. (figure 6)

For Taichung and Kaohsiung, due to the higher exposure of fasting blood glucose and number of deaths from diabetes (Taichung 1114 deaths, 95% UI 787-1441; Kaohsiung

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1282 deaths, 95% UI 973-1591), there is a higher ranking at attributable mortality for high blood glucose. Comparing with YLL, the major causes are high blood glucose (1475 / 100,000 person-year), obesity (1467 / 100,000 person-year), and high blood pressure (1408 / 100,000 person-year) at Taichung, meanwhile the obesity (1652 / 100,000 person-year), high blood pressure (1600 / 100,000 person-year), and high blood glucose (1580 / 100,000 person-year) at Kaohsiung. (figure 6)

For Chiayi county and Taitung, due to high prevalence of behavioral risk factors, smoking is just behind high blood pressure to occupy second place of attributable mortality which cause 418.33 deaths (95% UI 322.03-514.63) and 247.58 deaths (95% UI 168.68-326.48) respectively. Comparing with YLL, the leading causes are high blood pressure (2017 and 3424 / 100,000 person-year), smoking (1846 and 2590 / 100,000 person-year), and obesity (1789 and 2555 / 100,000 person-year) respectively. (figure 6)

In this way, we can find that different administrative districts need different health policy that adapt to local conditions to improve health further eliminate the health gap.

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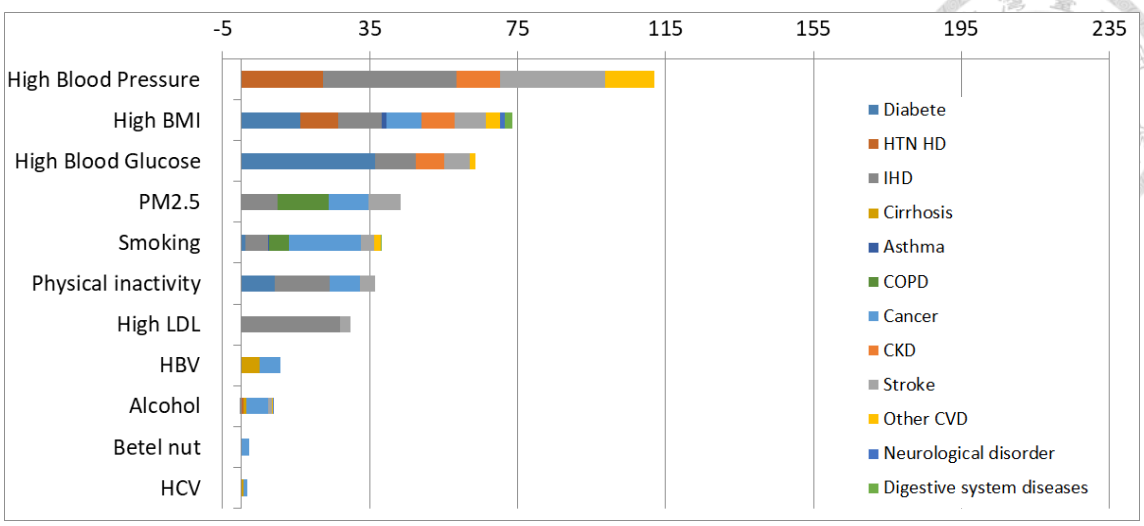

Figure 3.1 Taipei (per 100,000).

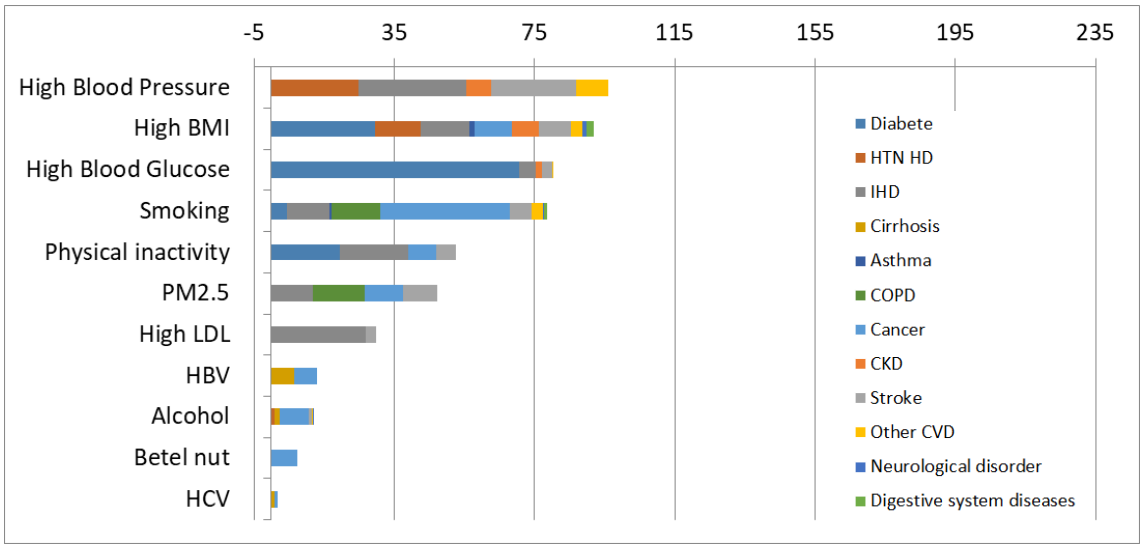

Figure 3.2 Hsinchu City (per 100,000).

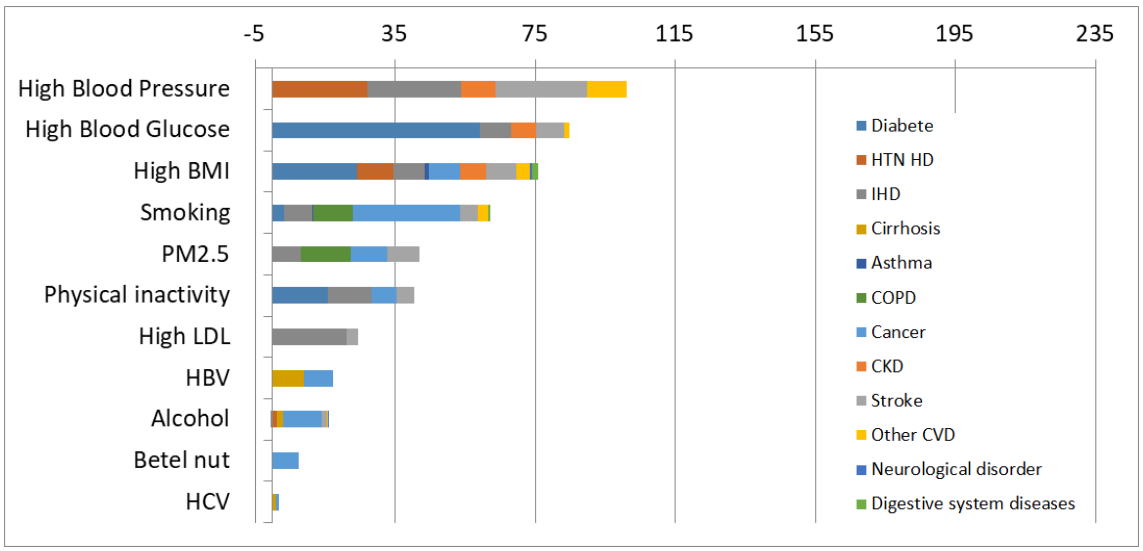

Figure 3.3 Taichung (per 100,000).

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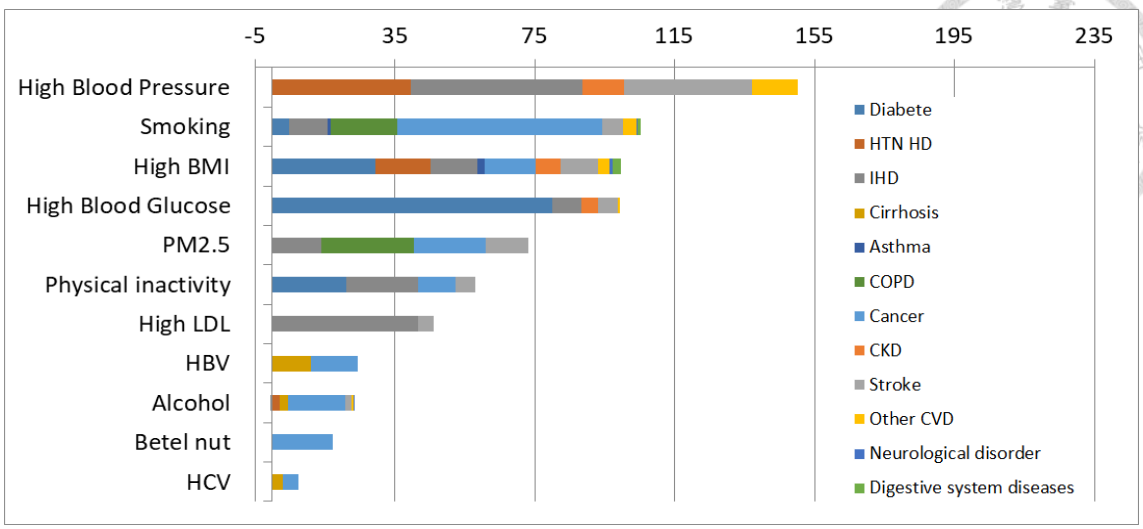

Figure 3.4 Chiayi County (per 100,000)

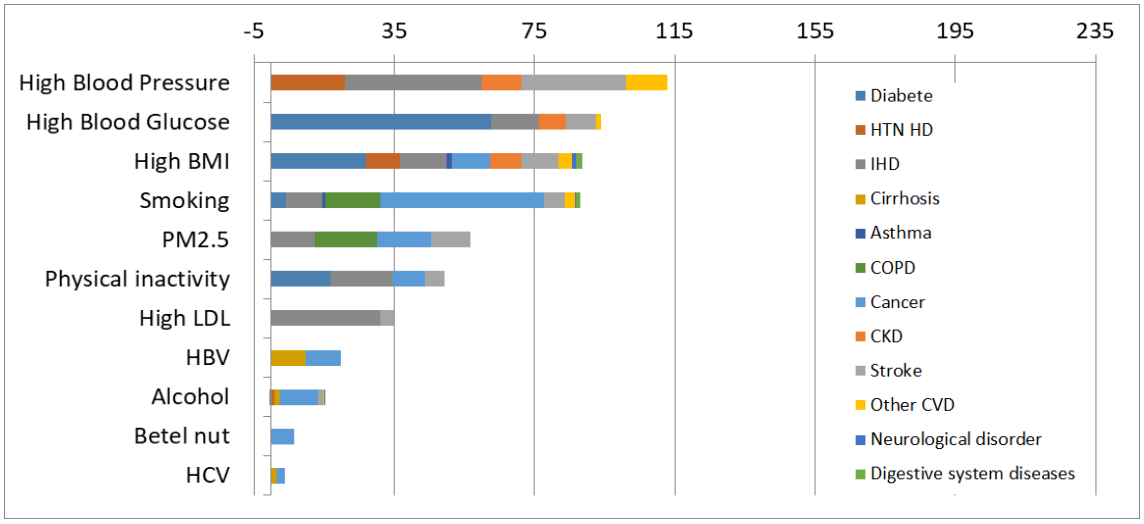

Figure 3.5 Kaohsiung (per 100,000).

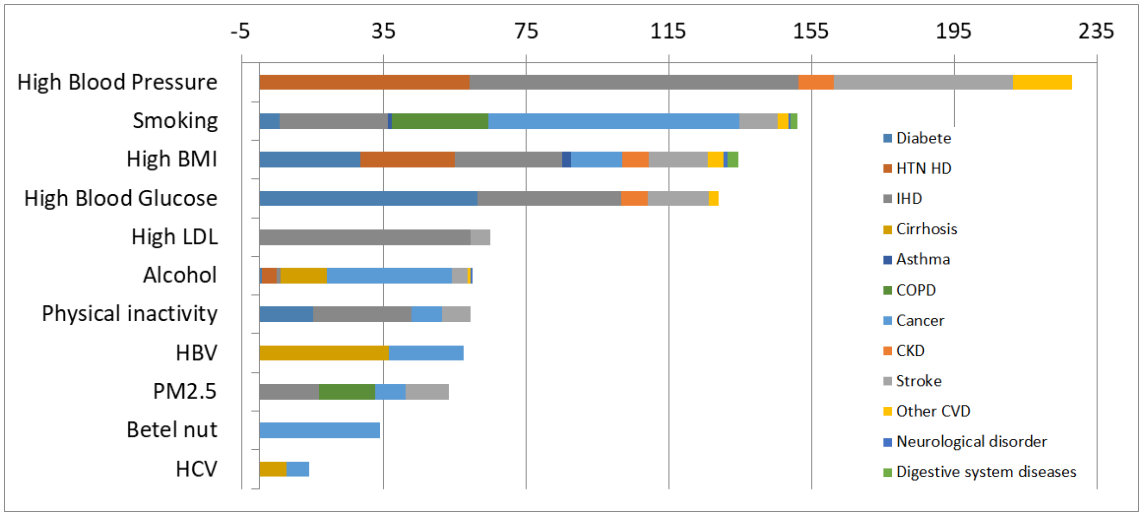

Figure 3.6 Taitung (per 100,000).

Figure 3 The attributable mortality rate ranked by risk factors.

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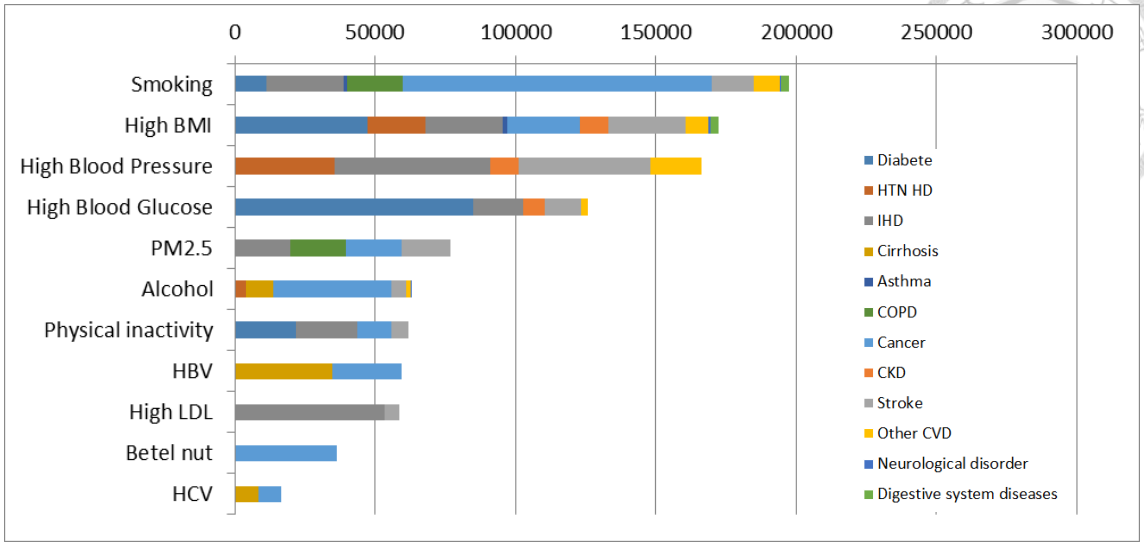

Figure 4 The attributable YLLs for male ranking by risk factors.

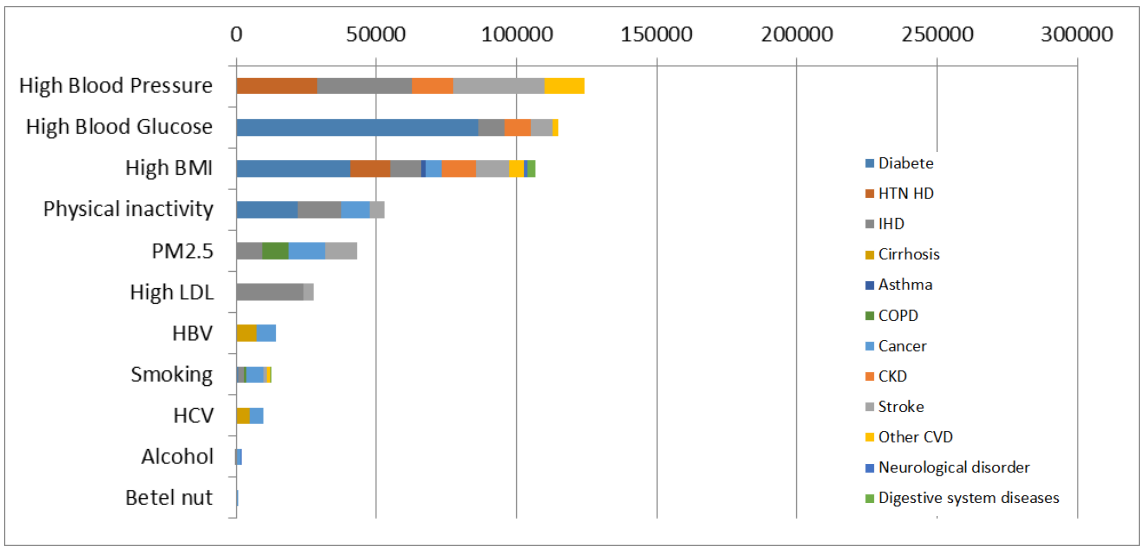

Figure 5 The attributable YLLs for female ranking by risk factors.

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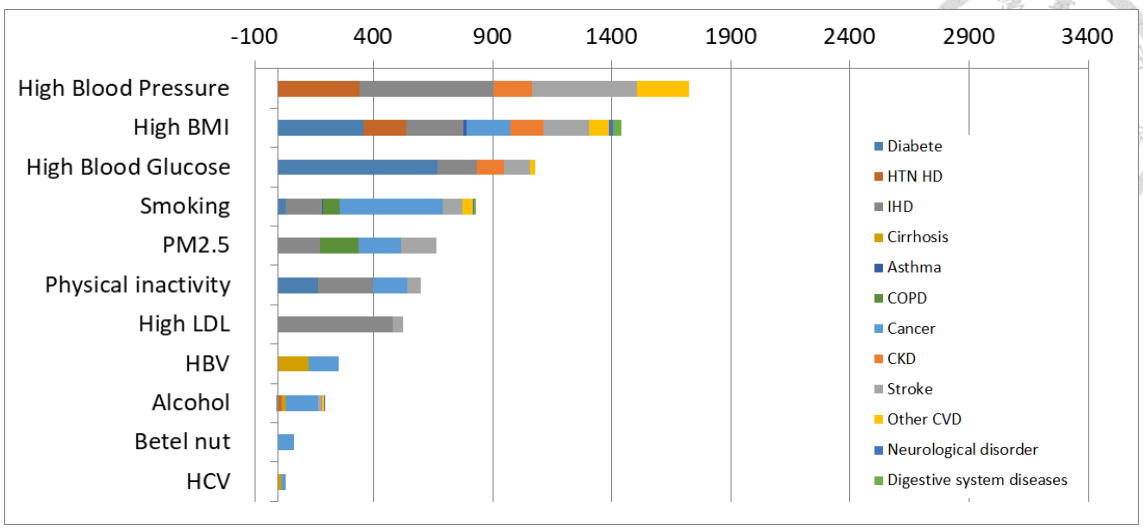

Figure 6.1 Taipei

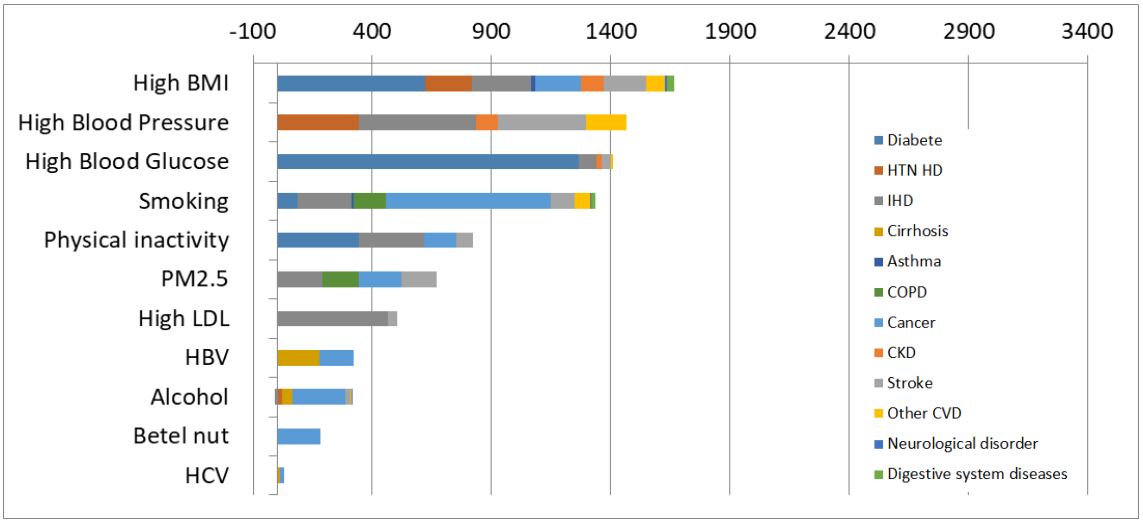

Figure 6.2 Hsinchu City

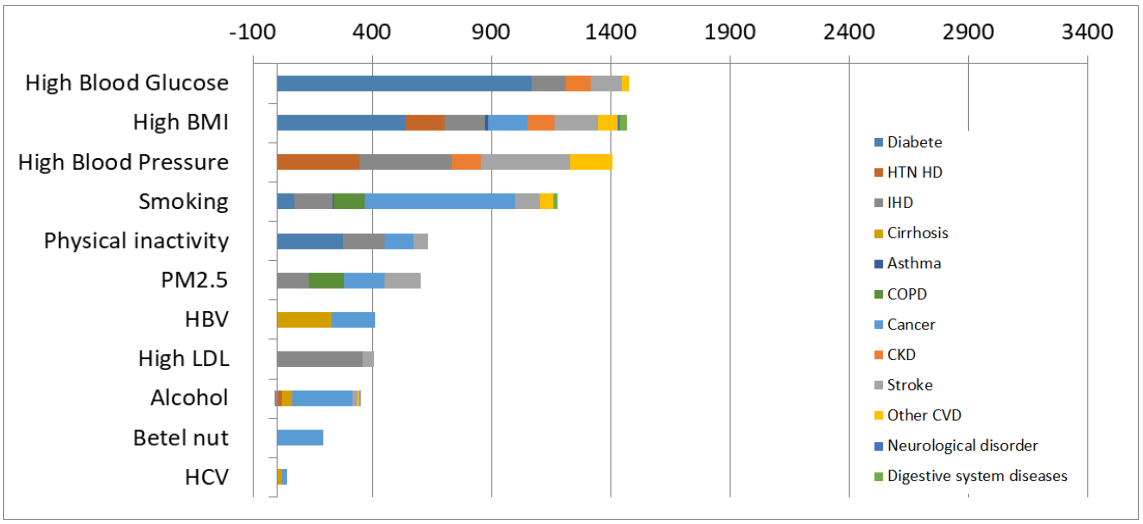

Figure 6.3 Taichung.

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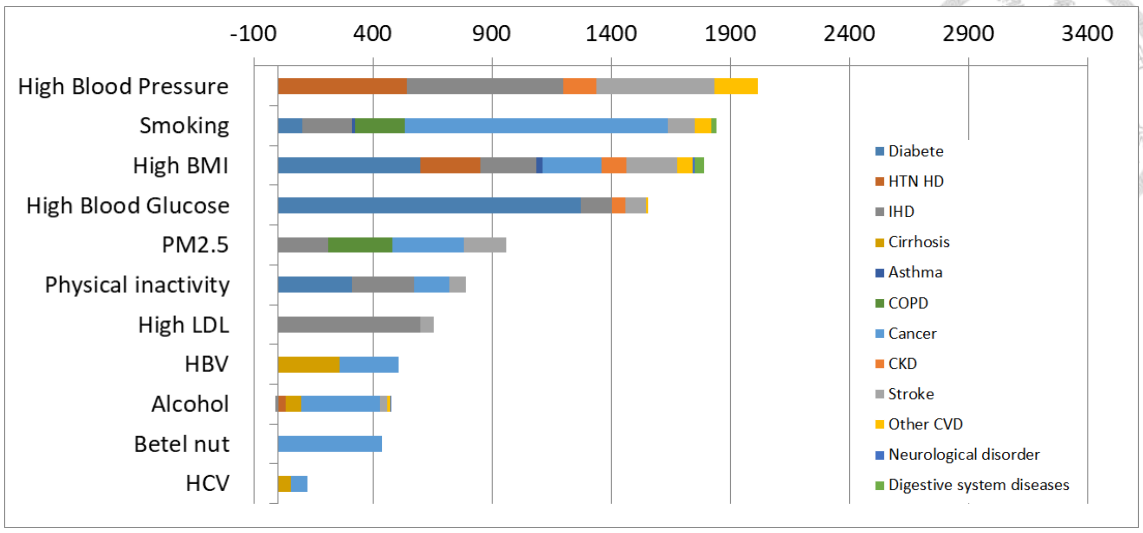

Figure 6.4 Chiayi County

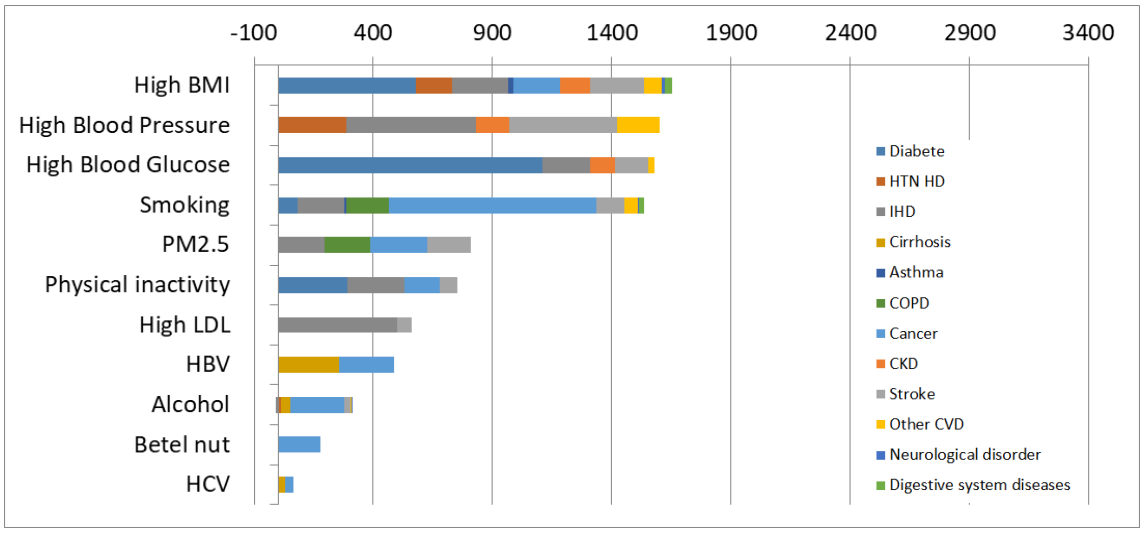

Figure 6.5 Kaohsiung.

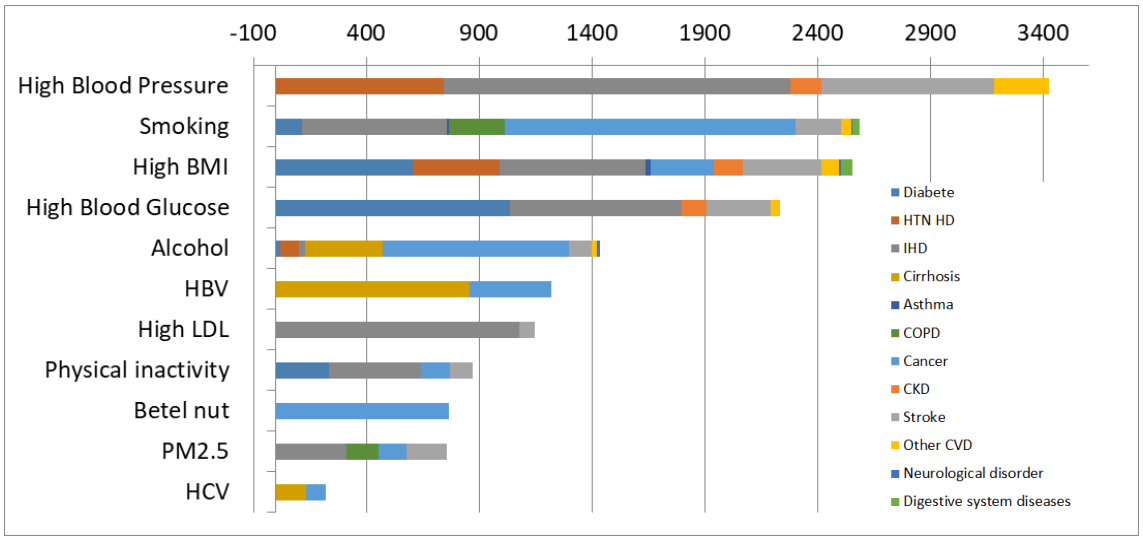

Figure 6.6 Taitung

Figure 6 The attributable YLL rate ranked by risk factors.

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3.4 Attributable mortality burden between subnational level

Compare the attributable mortality burden caused by single risk factor between counties and cities. The risk factors that cause the most serious attributable mortality burden in Taiwan are High Blood Pressure (121.2/100,000, 95%UI: 94.7-147.7), Obesity (96.9/100,000, 95%UI: 63.4-130.4), High Blood Glucose (94.5/100,000, 95%UI: 77.7-111.3), Smoking (81.7/100,000, 95%UI: 53.8-109.6), and PM2.5 (56.6/100,000, 95%UI: 70.3-42.9).

In terms of subnational level, we can find the eastern of Taiwan has a higher value which means a higher attributable mortality rate and followed by mid, southern and northern of Taiwan, and the six municipalities has a relatively low value. (figure 7)

In addition, high blood pressure is the leading cause at most administrative districts (figure 7). In Taitung, the attributable mortality (227.99/100,000) is 2.5 times than New Taipei city and Hsinchu city (95.99/100,000). The difference may cause by the high exposure of high blood pressure and further the number of deaths from cardiovascular disease are high (Ischemic heart disease: 150.85 deaths; Hypertensive heart disease: 96.55 deaths) in Taitung. (figure 7)

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Moreover, a small peak of mortality burden can be observed at mid-southern and eastern part of Taiwan which caused by high prevalence of behavioral risk factors including smoking, drinking, and chewing betel nut. Compared with other regions, mid-southern of Taiwan has a higher mortality attributed to outdoor air pollution. Eastern of Taiwan has another mortality peak caused by higher prevalence of infection-related risk factors. (figure 7)

Compare with attributable YLL rate, High BMI occupy the first place at some administrative district for attributable YLL rate. Further, the ranking of hepatitis B and alcohol drinking has reversed. In terms of subnational level, mid-southern of Taiwan has a high ranking for outdoor air pollution; meanwhile the eastern of Taiwan has a high ranking for behavioral risk factors. (figure 8)

From the above results, we can know the health effects of a single specific risk factor and even the health gap between subnational level. Such results show that there are issues of health inequality in Taiwan and further can allow the government to know which administrative districts have higher death burden and then allocate resources precisely.

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	Taiwan*	Keelung	Taipei	New Taipei	Taoyuan	Hsinchu city	Hsinchu county	Miaoli	Taichung	Changhua	Nantou	Yunlin	Chiayi city	Chiayi county	Tainan	Kaohsiung	Pingtung	Taitung	Hualien	Yilan
High Blood Pressure	1	128	112	96	112	96	121	169	101	126	134	137	156	150	141	113	170	228	167	186
High BMI	2	116	74	77	81	92	107	104	76	98	121	115	96	100	95	89	112	134	151	96
High Blood Glucose	3	98	63	63	72	81	105	111	85	103	113	102	81	99	96	94	111	129	177	60
Smoking	4	94	38	51	74	79	50	58	62	85	107	143	78	105	63	88	90	151	132	108
PM2.5	5	47	43	37	41	47	52	58	42	57	72	76	71	73	62	57	71	53	58	50
Physical inactivity	6	57	36	34	37	53	53	57	40	50	55	61	49	58	56	49	54	59	58	51
High LDL	7	39	30	27	25	30	41	40	24	31	32	38	35	46	33	35	31	65	31	45
Alcohol	8	25	11	16	13	13	13	20	17	20	28	28	23	24	18	20	26	57	41	28
HBV	9	14	8	8	21	11	11	14	15	27	28	29	23	23	16	14	21	59	53	35
Betel nut	10	6	2	8	5	7	3	12	7	15	14	17	14	17	6	7	17	34	25	10
HCV	11	3	2	2	1	2	1	2	2	2	3	8	7	8	5	4	5	14	10	8

* ranking of risk factors for attributable mortality rate

Figure 7 Heat map for mortality rate at subnational level (per 100,000)

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	Taiwan*	Keelung	Taipei	New Taipei	Taoyuan	Hsinchu city	Hsinchu county	Miaoli	Taichung	Changhua	Nantou	Yunlin	Chiayi city	Chiayi county	Tainan	Kaohsiung	Pingtung	Taitung	Hualien	Yilan
High Blood Pressure	1	1958	1725	1486	1656	1464	1672	2198	1408	1824	2011	1920	2215	2017	1909	1600	2356	3424	2399	2355
High BMI	2	2099	1441	1504	1565	1667	1959	1832	1467	1805	2063	1894	1812	1789	1722	1652	2064	2555	2776	1800
High Blood Glucose	3	1593	1079	1144	1221	1410	1734	1734	1475	1681	1825	1619	1364	1555	1581	1580	1904	2236	2730	1055
Smoking	4	1700	828	1088	1380	1335	924	1162	1178	1474	1811	2206	1352	1844	1216	1536	1764	2586	2413	1832
PM2.5	5	681	664	580	599	672	720	759	601	776	936	989	955	958	813	809	954	756	818	708
Physical inactivity	6	850	600	565	594	823	816	807	635	715	784	824	757	789	816	751	727	871	850	728
High LDL	7	626	524	481	431	507	623	552	409	513	513	616	540	657	511	560	530	1147	507	691
HBV	8	588	255	402	373	321	357	519	411	449	698	603	504	506	380	487	640	1219	918	584
Alcohol	9	311	186	198	549	311	334	339	340	524	647	555	552	468	381	301	514	1438	1244	946
Betel nut	10	132	64	207	142	182	79	335	195	375	383	399	350	439	178	178	440	766	587	266
HCV	11	53	29	33	25	29	25	38	42	46	67	144	124	127	91	67	81	219	161	110

* ranking of risk factors for attributable YLL

Figure 8 Heat map for attributable YLL at subnational level (per 100,000 person-year)

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Chapter 4 Discussion

4.1 Diseases mortality burden at subnational level in Taiwan

According to the rank of attributable death burden, we found that high blood pressure (mainly consisting of Ischemic heart disease, Hypertensive heart disease, and Stroke) is the most important risk factor for Taiwanese followed by obesity, high blood glucose, and smoking. The four major risk factors are similar to the report of GBD [13].

Further, the eastern of Taiwan has a higher tendency of attributable mortality rate and followed by mid-southern of Taiwan at most of the risk factors except for low physical activity content and outdoor air pollution. This conveys the message that subnational level in Taiwan do have an issue of health inequality.

According to the results, Taipei needs to pay efforts to control blood pressure and the posture (young and mid age population). Hsinchu city needs to focus on posture for young and mid age population. Taichung needs to pay attention to blood glucose especially for young and mid age group. With a high ranking of smoking, Chiayi County must prioritize the resource to control it. Kaohsiung needs to pay attention to posture control especially for young and mid age group. Taitung has a relative highest attributable mortality for all risk factors, which caused by a higher exposure to risk factors and even the higher mortality rate and once again reveal the health inequality in

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Taiwan and caveats the local health authority to notice the posture for young and mid age population.

From attributable mortality perspective, metabolic related risk factors are the major cause, behavioral and environmental risk factors are just behind. For subnational level, eastern Taiwan must prioritize intervention for behavioral and infection-related risk factors, meanwhile mid-southern of Taiwan need to focus on posture control, outdoor air pollution, and behavioral risk factors.

Further, outdoor air pollution is a potential problem at mid-southern of Taiwan. The higher exposure had been confirmed by the influence of local industries, including thermal power plants and petrochemical industries [38-40]. Unlike other risk factors, the effectiveness of avoiding exposure to small aerosols (PM2.5) through personal behavior is often limited. This is also an important part without time to delay to develop an integrated strategy. Therefore, different administrative districts do need to prioritize resources for different risk factors.

Referred to YLL, we can interpret higher YLL can partially explain by the fact that death occurs in a lower age group. With the estimation of YLL, we can reveal the health problems faced by middle-aged people in different administrative regions. Further to develop interventions for effectively protect the major production groups in the

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population. According to the figure 7-8 and supplement figure 1-2, BMI and smoking have the largest changes from mortality rate to YLL.

Without age standardization, the results in this study may affected by the demographic structure at subnational level. For example, relative high burden of death at Taitung may cause by the aging population. Presenting of crude mortality and YLL can reveal the true health problem and the health gap at each administrative district. With the results, local government can understand the underlying issues and health distribution and try to solve.

Despite the significant decline in the prevalence of smoking over the past decade by the *Tobacco Hazards Prevention Act 2009* and the promotion of tobacco taxation, however, the elderly population mainly contributes the downward trend. For young and mid-age group, there is still a high prevalence especially for male (about 30%). Further, the rise of emerging smoking products (for example: electronic cigarette) have become a major issue in tobacco control in the future. Explain that for future tobacco control strategies, it is also necessary to monitor the prevalence trends of different ages, genders and even the type of cigarette [41].

According to Health Promotion Administration Annual Report 2015 [42], the prevalence of overweight and obesity is 37.5% to 41.1% from 2008 to 2016 and even

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more than 50% especially for age group 35-65 of male in 2016. Demonstrate the need and urgency to reduce the prevalence of obesity by promoting adult health and combining workplace physical activity content and even promoting healthy diets.

4.2 Comparison to literature

We compared the prevalence of risk factors exposed between this study and past literatures. For metabolic risk factors, there is a high consistency between this study and the report of TW3H (Supplement table 4.) [43]. In terms of behavioral risk factors, prevalence of smoking is similar to literature but secondhand smoke is lower in this study. The reason for this is that we excluded active smokers when estimating exposure to secondhand smoke, resulting in lower prevalence [13]. The prevalence of alcohol use was lower, but the prevalence of alcohol use in Yang, 2018 was only for 18 to 64 years old [44]. If the comparison was made at the same age group (18-64 year), the prevalence of drinking in this study is about 30%. Last, the prevalence of betel nut use is slightly higher than the statistical results by Ministry of Health and Welfare. However, the age of statistical result by Ministry of Health and Welfare is for population over 12 years old [45], and our study is over 18 years old. (Supplement table 5.)

In general, there is a high consistency for estimation of risk factors between this study and literatures.

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Compared with past literature [23, 24], the main attributable risk factors are consistent, but it is slightly different in the rankings. For Taiwan in 2009, the leading causes of mortality rate are high blood glucose, smoking, high blood pressure, and obesity [23] meanwhile the ranking in this study is high blood pressure, smoking, high blood glucose, and obesity in 2013. This difference may cause by some reasons, 1) the exposure of risk factors is different between 2009 and 2013. 2) The disease outcome corresponding to the risk factors and the relative risk are different. 3) The listing of diseases and method used to redistribute the garbage code of death is different.

Signs of changes in the effects of blood pressure on attributable mortality can also be found in some articles in Taiwan. Despite being a leading cause of attributable mortality, the control rate of hypertension is generally low (21% in male, and 29% in female) [46], which further causing that the prevalence of hypertension in Taiwan is rising from 2002 to 2013. In addition, the life-time risk for hypertension is 90% so the gradual increase in age structure also increases the prevalence [46, 47]. An article published in 2010 pointed out there is a high prevalence of prehypertension at rural Taiwan, which once again stressing the issue of health inequality in Taiwan [48].

In terms of smoking, there is an analysis to estimate the prevalence of smoking. The result is the prevalence of smoking decrease significantly from 2001 (44.4%) to 2013 (34.2%) especially in old male. Highlight the effectiveness of the Tobacco Hazard Prevention Act

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(THPA) implemented in 2009. [49] Similarly, there are differences at subnational level of smoking with a higher prevalence at eastern and mid-southern of Taiwan [50, 51].

For absolute value of attributable death burden, there is a higher value for some risk factors at this study. There are two reasons that cause the difference. One is the crude mortality rate is increasing for past years. According to the report by Ministry of Health and Welfare, the crude mortality rate is change from 2009 to 2013 had changed from 616.3 to 661.3 for all cause of death (male: 748.6 to 799.2, female: 481.9 to 523.2). Another reason may cause by stratification, we use the subnational level data of exposure of risk factors and deaths that are different from the past study that use national level data. With the difference, if there is a high exposure of specific risk factor at subnational, it may affect the PAF and even attributable death burden.

Further, we also include labor to the estimate of METs, with a more complete assessment of low physical activity content. For smoking, we use the pack-year as a unit to estimate the exposure of smoking that takes duration and intensity into consideration to present a continuous exposure condition [13].

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4.3 Application and development of database

With a very diverse and complete database in Taiwan, we should make a good use of them. However, there is still fewer study analysis the distribution of health issues or the causes of them at subnational level. The current international trend is to analyze the finer geographical level called Local Burden of Disease (LBD) and to develop with the goal of precise public health [52, 53] . LBD aims to assess health outcomes across the entire area and propose solutions at a highest resolution. This analysis can even cross-administrative districts and enable resources effectively utilize in areas where health problems actually occur. However, the practice of precise public health has not yet occurred universal [54, 55].

In Taiwan, we have more diverse and detailed resources, such an analysis is bound to become the current goal to eliminate health inequalities within Taiwan. For example, the outdoor air pollution has a high exposure at mid-southern of Taiwan. However, we cannot control the fine aerosol exposure just assemble in specific administrative district. In this situation, we should cross the administrative district to solve the problem. Therefore, we expect this study to serve as a primer to provide a model for future research to develop higher resolution estimation.

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4.4 Advantages and limitations

This study includes the following advantages. First, using nationally representative health census data to assess the attributable disease burden in Taiwan. Further, the data collected from GBD (for example: RR) also systematic and representative. Second, stratification at subnational level can further rank the burden of disease death caused by attributable risk factors to reveal geographic differences. Third, we included local risk factors such as chewing betel nut, chronic hepatitis B, and chronic hepatitis C infection to providing a more complete and comprehensive assessment. Combining these advantages, our analysis provides a more comprehensive look at the impact of risk factors on attributable disease mortality burden estimation and provides a more valuable reference value for intervention strategies that can adapt to local conditions.

In terms of research limitations, the sample size may be small or missing due to stratification for subnational level, age, and gender, so the imputation of the missing data would be needed. The way we interpret is using the neighboring ages of the same county and city. The hypothesis is that it is not affected by the age group in the same county and city, the method we filled in the missing values with the following criteria:

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1) If the neighboring age group is not complete or there is no other data after the missing value appears, the previous age group data will be used to interpolate; else if it is the first data, the next age group data will be used to interpolate.
2) If adjacent age groups are complete, they will be used for interpolation.
3) If the three or more neighboring age groups are incomplete, the previous complete data will be merged with the incomplete parts and deemed to be consistent exposure.

Furthermore, there is incomplete geography coverage for database in outlying island; the Kinmen, Lianjiang, and Penghu County were excluded from our study. For some risk factors, we cannot completely rule out the possibility of measurement error in the assessment of risk factor exposure cause by self-respond data of smoking, drinking, betel nut, physical activity content, body mass index, etc.

In addition, there are shortcomings in the estimation of the attributable burden of death from chronic non-communicable diseases. The relative risk data were mostly derived from other comparative risk assessment studies, with only some risk factors including hepatitis B, hepatitis C, and betel nut are derived from local generation studies. More local long-term observational studies are necessary in the future to provide more

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appropriate relative risk estimation.

Moreover, under the restrictions of the Comparative Risk Assessment framework, this study used the data in same year for prevalence distribution of risk factors exposed and caused of death. Without considering the exposure of risk factors may change over time and ignore the induction time and latent period between exposure and disease outcome. To do so, we must assume that the risk factor maintains the same exposure during the past period. For the hypothesis of PAF, we assume that other risk factors are not affected when intervening for a specific risk factor. This is actually contrary to the actual situation.

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Chapter 5 Conclusion

Assessing the death burden of disease in population and tracing back to the attributable risk factors to further develop targeted health policies for different exposures is the key to improving health and disease prevention. Based on a well-established database and methodology, this study further assesses the subnational level. This study not only makes full use of resources, but also once again reveals the issues and distribution of health inequalities facing Taiwan.

According to the result, metabolic-related, behavioral, and environmental risk factors contribute most part of the burden of death. It further recommended that groups with lower ages should focus efforts on smoking and obesity. For subnational level, the eastern of Taiwan may invest more resources to achieve the goal of promotion of health, and strategy adapt by local issue is important. After understanding the health problems faced by each administrative district in Taiwan, how to arrange resources effectively within the limited resources for the most urgent problems is the current issue.

From a perspective of public health, prevention is the most important and highest priority for health. There are successful examples in Taiwan like Tobacco Hazard

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Prevention Act (THPA) in 2009 and universal hepatitis B virus (HBV) vaccination program for infants in 1984. In order to achieve goals to prevent health problems before they occur, population level intervention that adapts for different risk groups must be valued and popularized. Once again, the health policy that adapts to local conditions can truly achieve maximum benefits in limited resources.

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Supplement

Database for Risk Factors

National Health Interview Survey (NHIS)

In cooperation with the National Health Research Institutes (NHRI), Ministry of Health and Welfare, and Taiwan Food and Drug Administration, the main purposes of NHIS are 1) Collect and update the health status of the people, the utilization of medical insurance services, and the behavioral data. 2) provide a reference for the effectiveness evaluation of the health care policy development plan [56].

With a multi-stage stratified system sampling design, the NHIS survey covers a total of 20 counties and cities in Taiwan area. After sampling the county and city, Probability Proportional to Size (PPS) was used to ensure that the decimation rate is proportional to the unit size to further determine the weight of each unit. Method of data collection was through questionnaire, including personal basic information, personal health status, personal behavior, and utilization status of medical service. While the number of sample cases interviewed was up to 30,960, the overall completion rate was 75.2%. This study used the results of the NHIS to assess the prevalence of life-related risk factors such as body mass index(BMI), drinking alcohol, chewing betel nut, smoking, second-hand smoking and physical activity content in Taiwan.

Taiwanese Survey on Hypertension, Hyperglycemia, and Hyperlipidemia (TwHHH)

The TwHHH was a nationally representative health census survey which executed by Health promotion administration, Ministry of Health and Welfare. A total of 6,600 samples were collected in the first survey in 2002[57]. The 2007 follow-up survey was conducted to observe the relationship between disease changes and related risk factors

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and utilization status of medical service during the past five years[43].

The sampling method was the same with NHIS 2013[56]. The survey was aimed at people over the age of 15 with questionnaires, blood pressure measurements, and blood and urine collection. This study used the results of the TwHHH to assess the prevalence of metabolic related risk factors and further the infection status of HBV and HCV in Taiwan.

Taiwan Air Quality Monitoring Network (TAQMN)

The data for PM2.5 is collected from Air Quality Monitoring Network by Environmental Protection Administration, Executive Yuan which built in 1993. The network included 76 fixed air quality stations and 4 mobile stations to record hourly air quality related indicators including CO, NOx, SO2, PMx and O3[58].

Definition of exposure

life-related risk factors for BMI, alcohol use, betel nut use, smoking, second-hand smoking and physical activity content were collected from NHIS. To estimate the daily average alcohol intake cumulative concentration, we used the type of drinking to identify the alcohol concentration and further calculated it by the amount of intake and frequency. In terms of exposure of betel nut and secondhand smoke, we used the whole group as the denominator to calculate the prevalence of exposure to present. Smoking was calculated in unit of pack-year (one pack-year represents the equivalent of smoking one pack of cigarettes (assuming a 20 cigarette pack) per day for one year) [13]. There was also the record of physical activity habits of respondents, and we quantified it based on the standardized method metabolic equivalent (MET) by Arizona State University Healthy Lifestyle Research Center[59]. The type, frequency, and duration in all domains of life (leisure/recreation, work/household and transport) were used to calculate MET, which was a simple indicator of intensity and estimated calorie expenditure at unit of weekly. The meaning of the representative is the ratio of the rate of calorie consumption during

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physical activity content the rate of calorie expenditure during sitting and rest. The MET equivalent of 1 unit was defined as 3.5 ml of oxygen per minute per kilogram of body weight, which was roughly equivalent to the oxygen consumption per minute when one person is sitting in a quiet state without any activity[60].

For blood pressure, the measuring machine was Microlife Electronic Blood Pressure Monitor BP3AC1-1 and take the average of the two times for measurements as a record (if the two measurements differ above 10 mmHg, may need to measure the third time). Fasting 12-hour venous blood was collected and then saved at minus 20 degrees until been used to estimate blood sugar, blood lipids, HBsAg and hepatitis C antigen-antibody. For testing method, Hexokinase was used for blood sugar and direct measure was used for low density cholesterol (LDL).

The annual average fine aerosol (PM2.5) exposure data was collected from the Taiwan Air Quality Monitoring Network. Since the establishment of the air quality station was based on population density and road use, not the county and municipal administrative area, so we selected the data of the station with a population density of more than 10,000 people per square kilometer, and integrate the calculations to estimate the PM2.5 exposure of the county. For the counties and cities with limited station data, the station data of the county and city metropolitan area as the estimation result[26].

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Figure S1. Attributable mortality rate at subnational level ranked by risk factors (per 100,000).

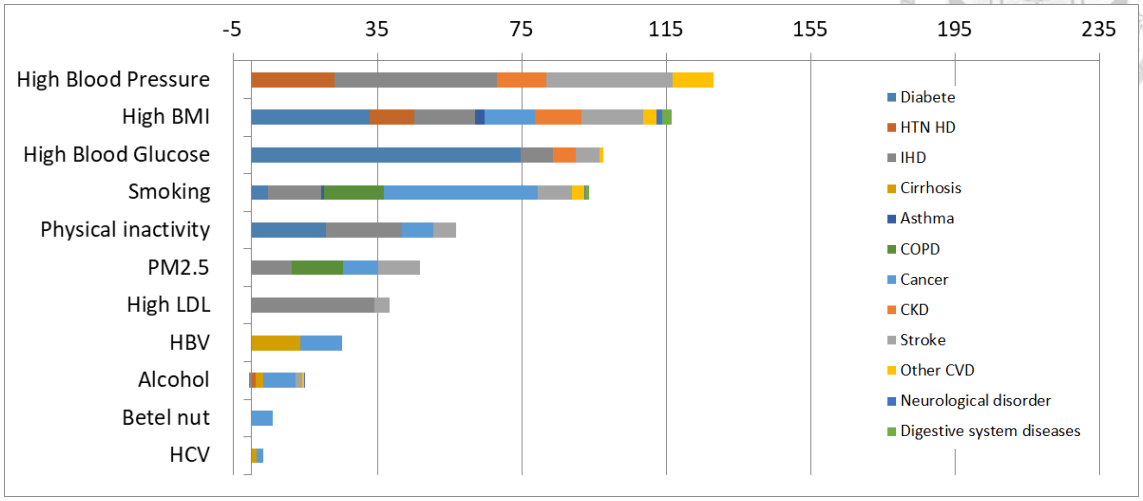

Figure S1.1 Keelung

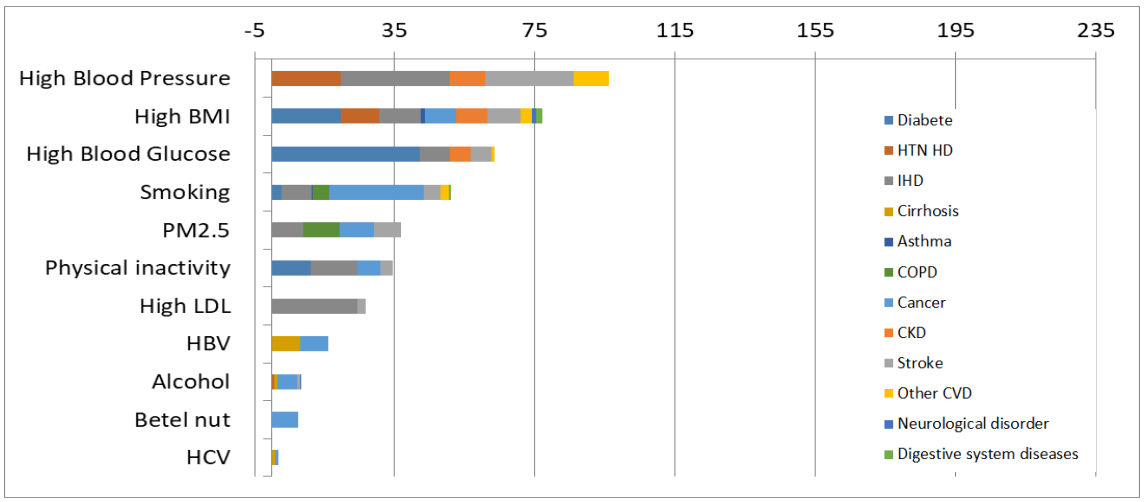

Figure S1.2 New Taipei

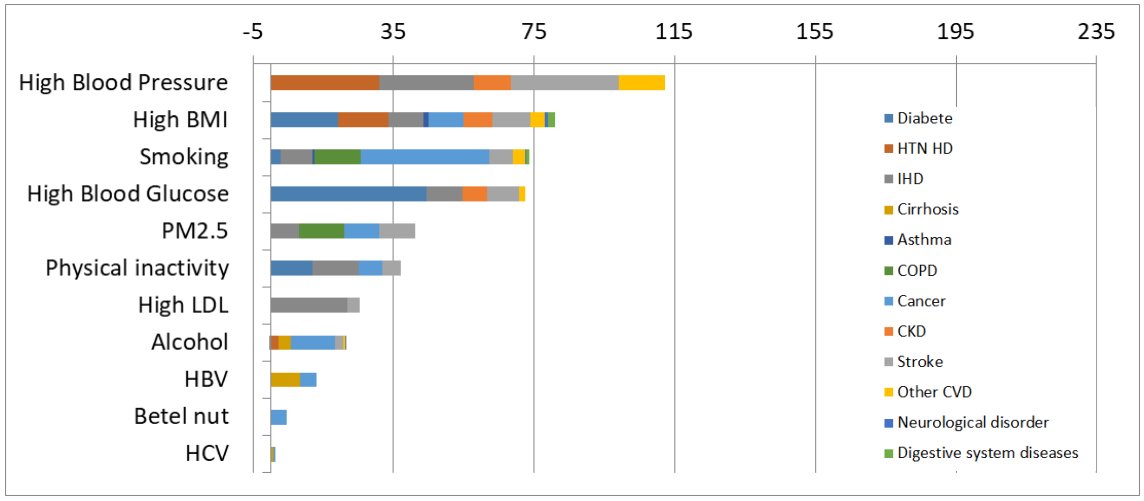

Figure S1.3 Taoyuan

doi:10.6342/NTU201903237

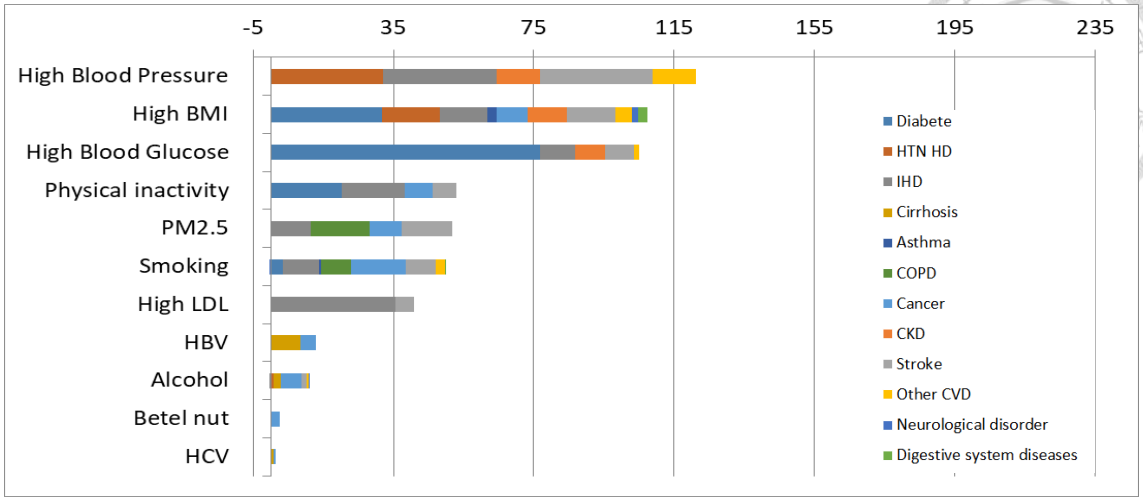

Figure S1.4 Hsinchu County

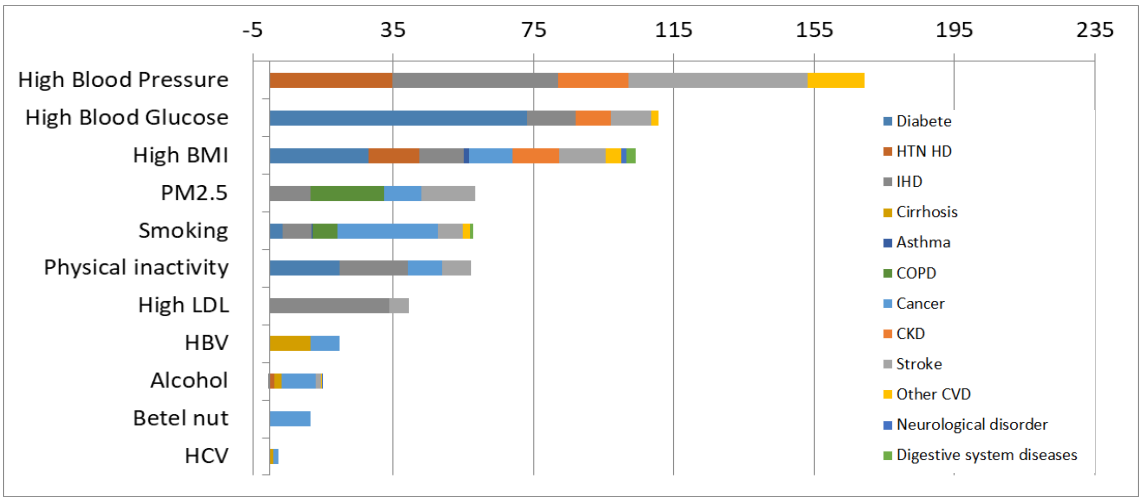

Figure S1.5 Miaoli

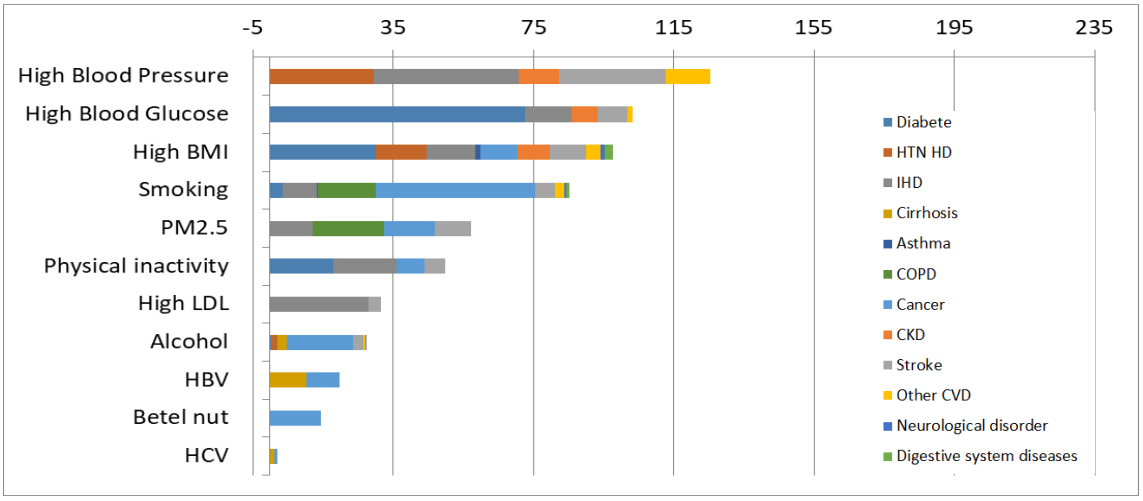

Figure S1.6 Changhua

doi:10.6342/NTU201903237

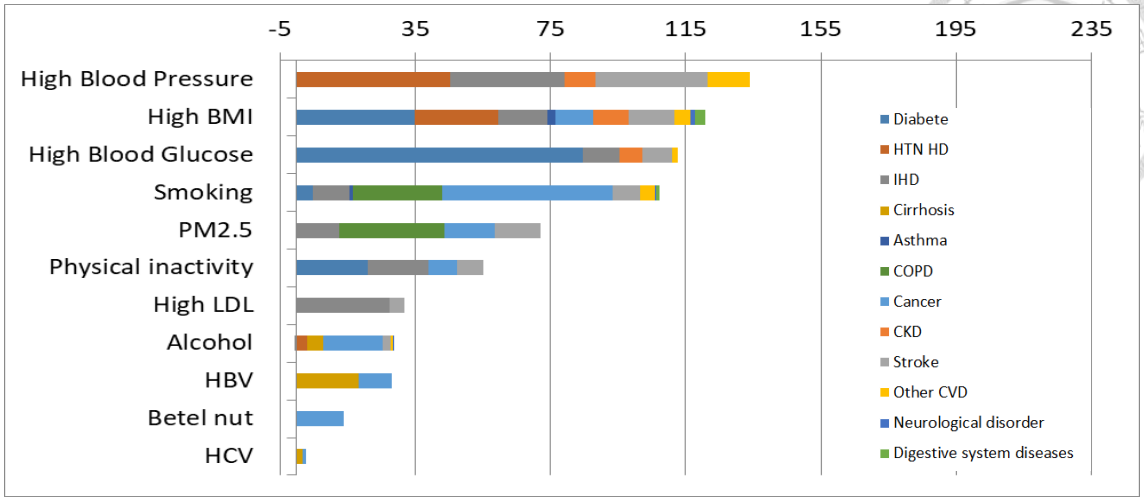

Figure S1.7 Nantou

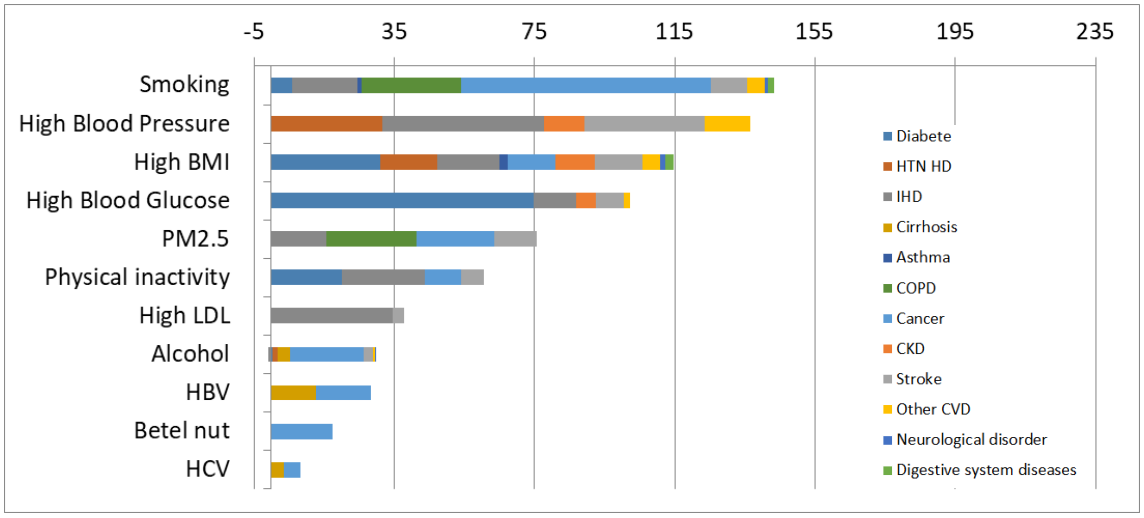

Figure S1.8 Yunlin

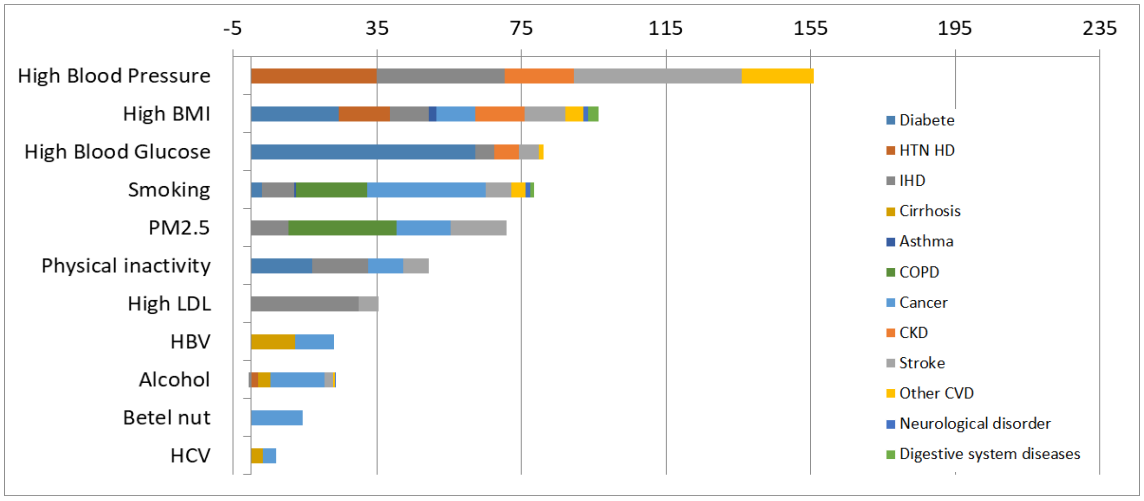

Figure S1.9 Chiayi City

doi:10.6342/NTU201903237

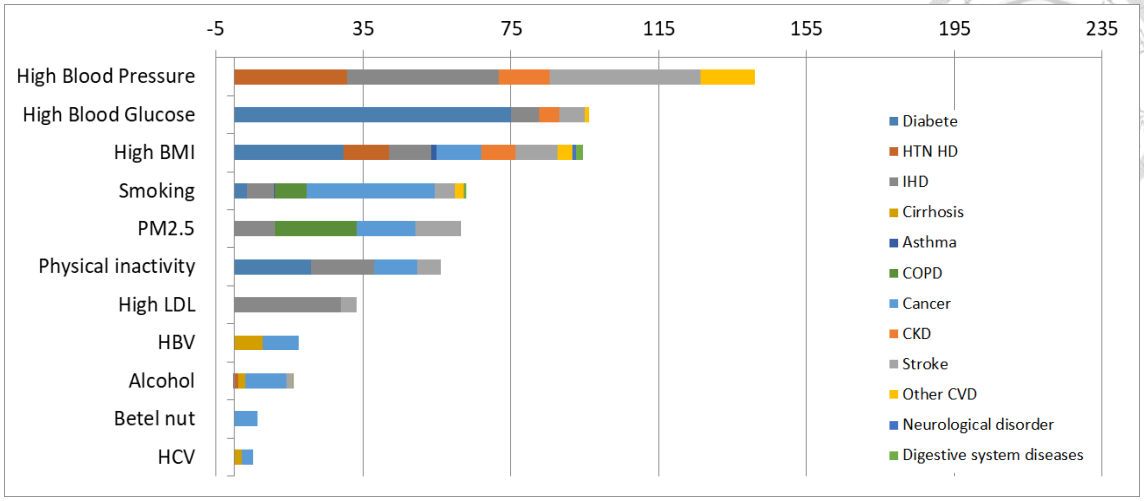

Figure S1.10 Tainan

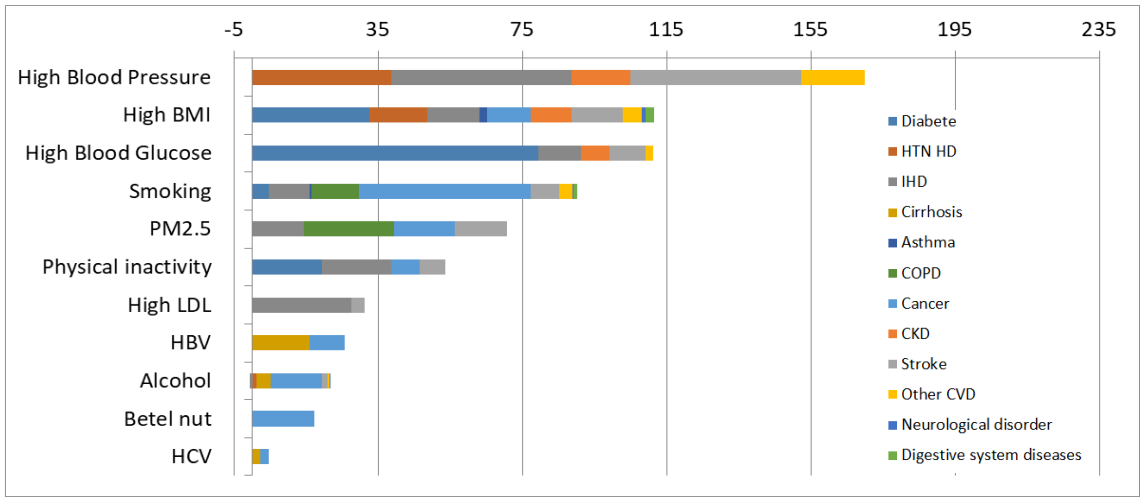

Figure S1.11 Pingtung

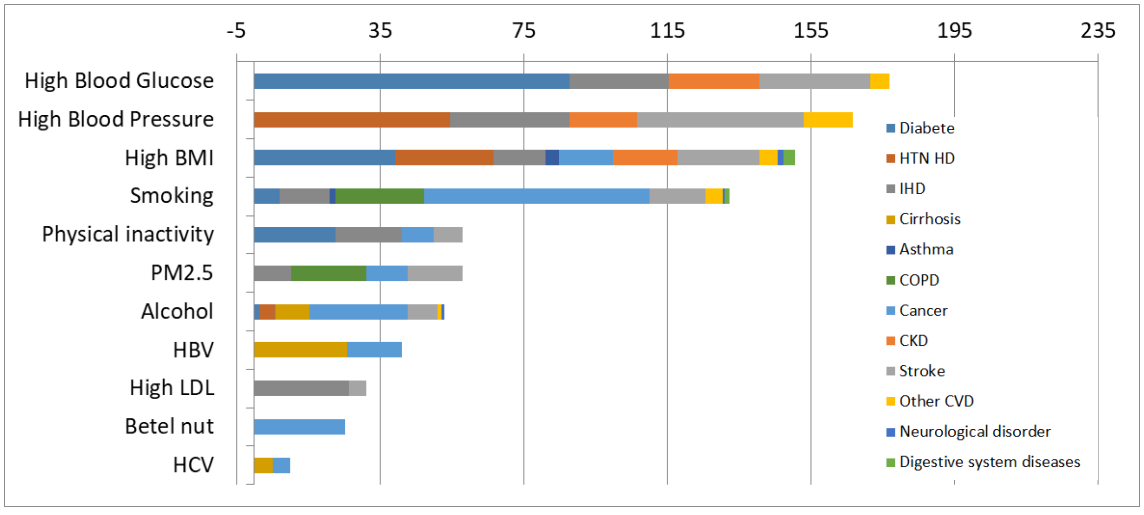

Figure S1.12 Hualien

doi:10.6342/NTU201903237

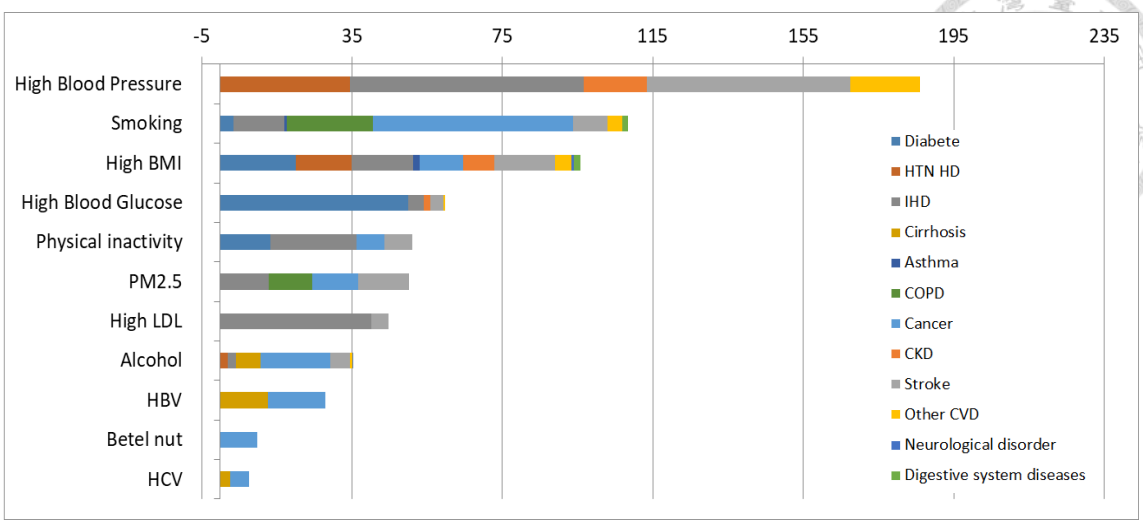

Figure S1.13 Yilan

doi:10.6342/NTU201903237

Figure S2. The attributable YLL rate at subnational level ranked by risk factors.

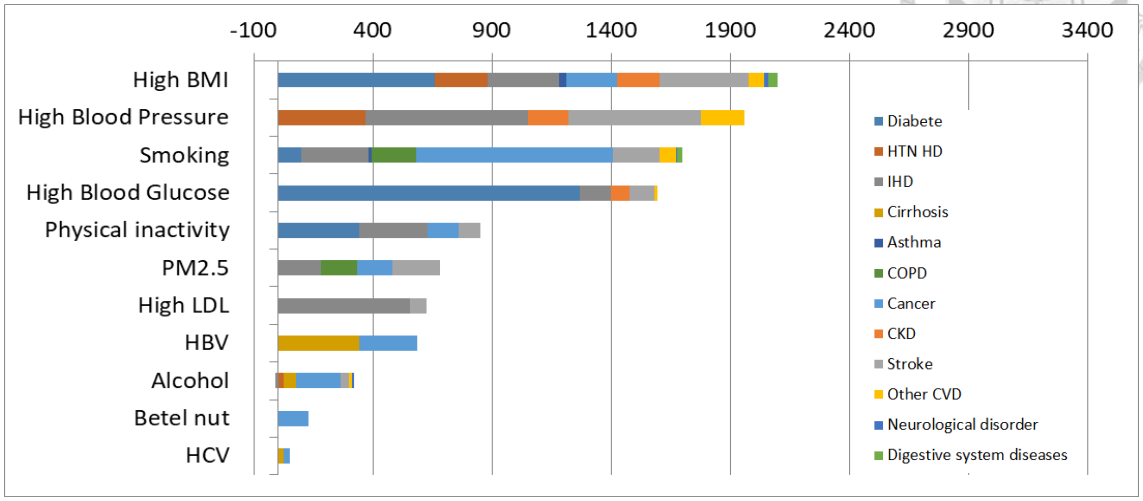

Figure S2.1 Keelung

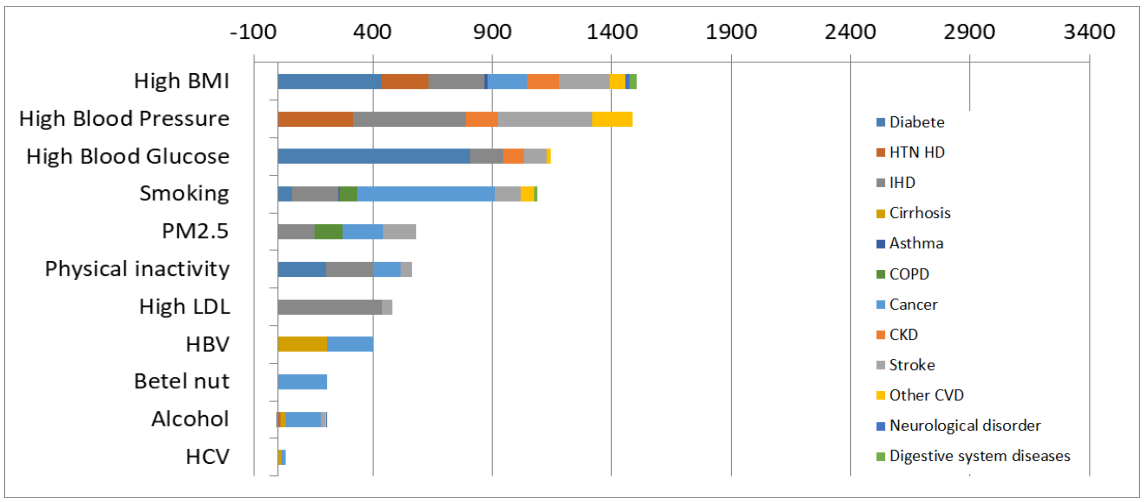

Figure S2.2 New Taipei

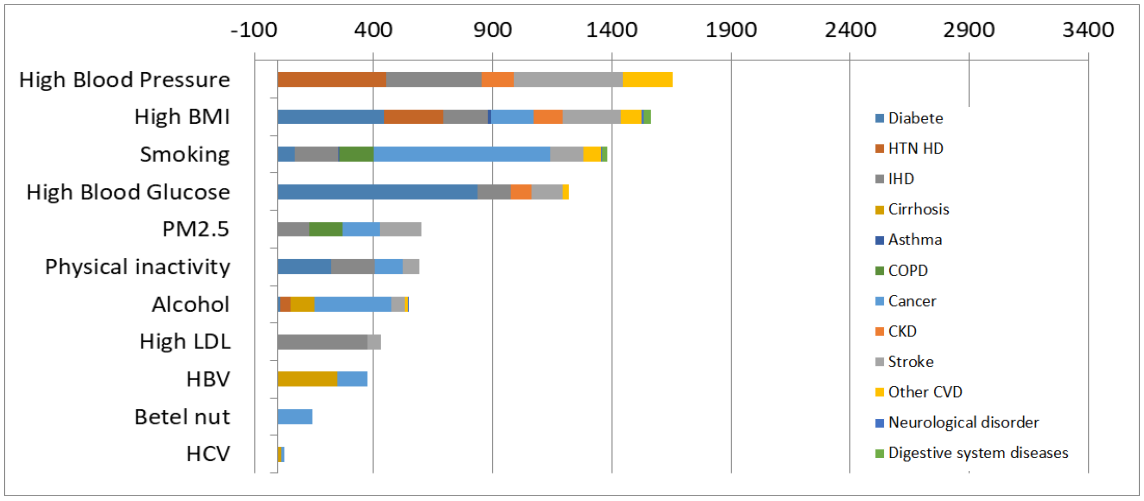

Figure S2.3 Taoyuan

doi:10.6342/NTU201903237

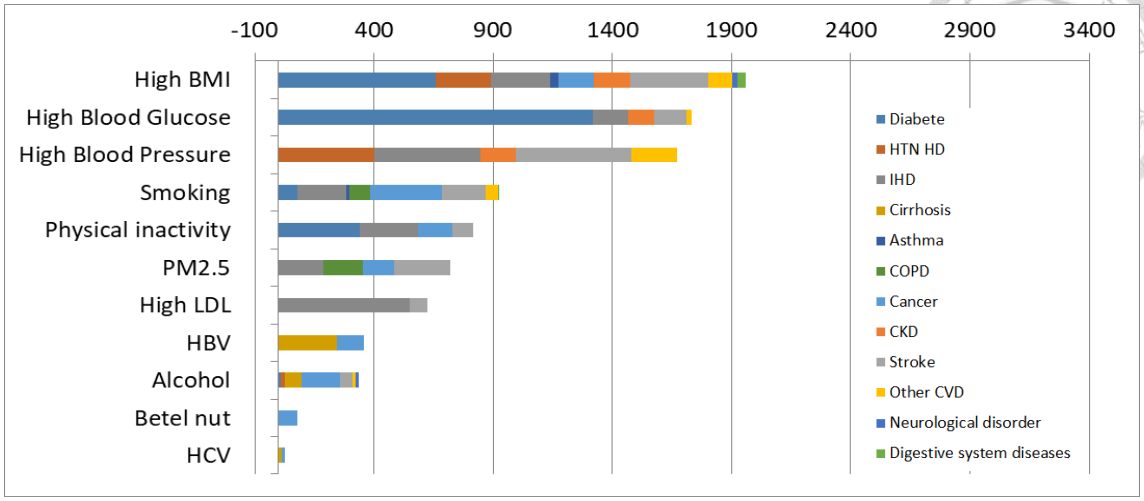

Figure S2.4 Hsinchu County

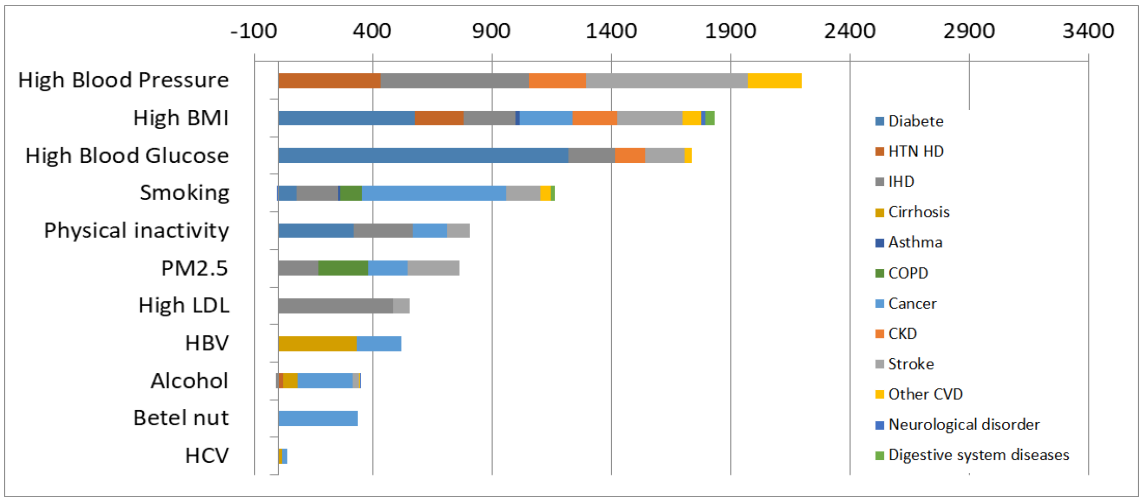

Figure S2.5 Miaoli

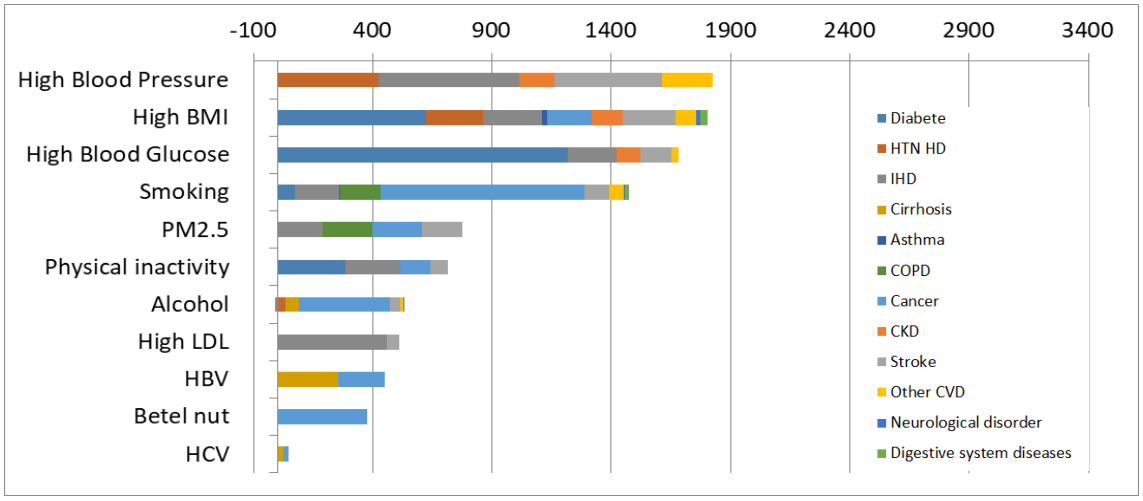

Figure S2.6 Changhua

doi:10.6342/NTU201903237

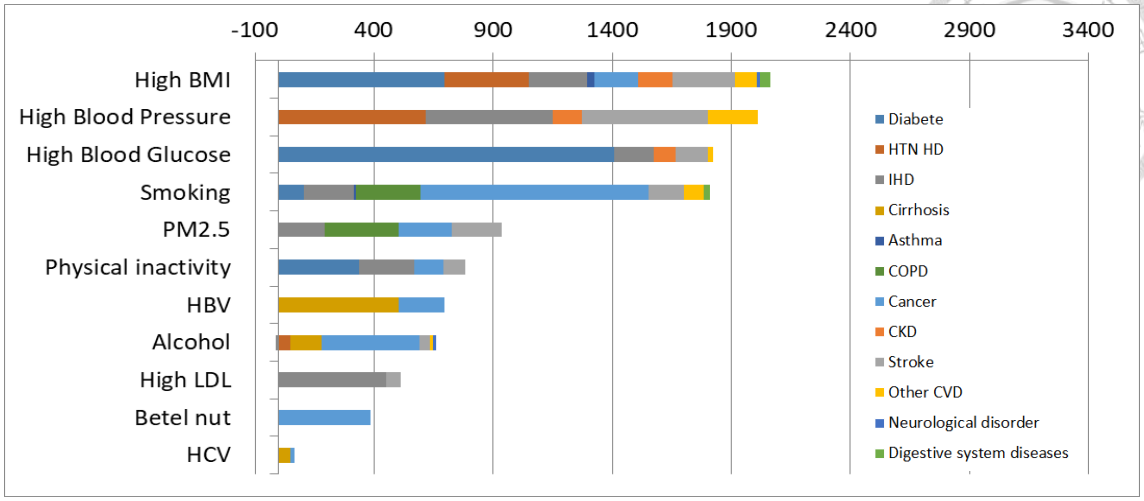

Figure S2.7 Nantou

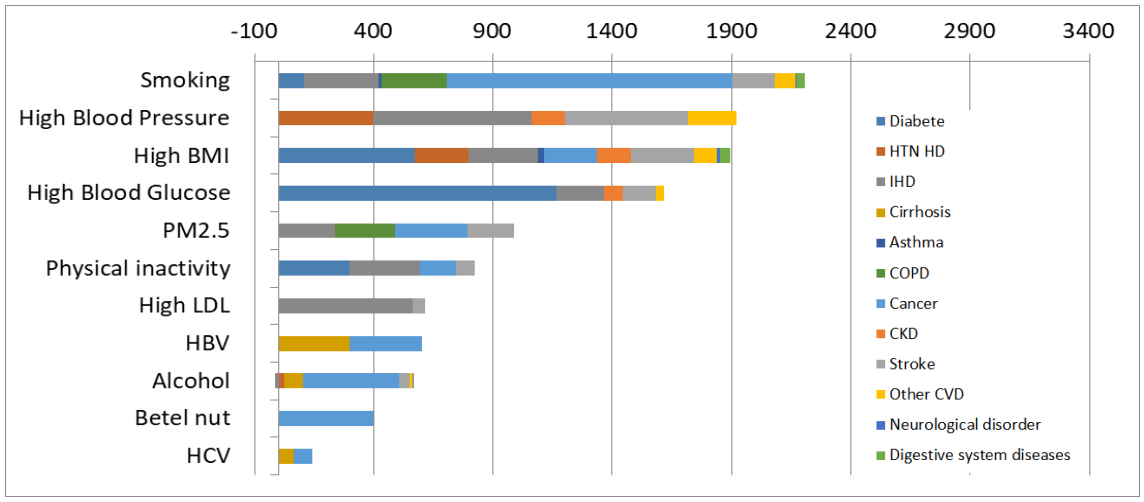

Figure S2.8 Yunlin

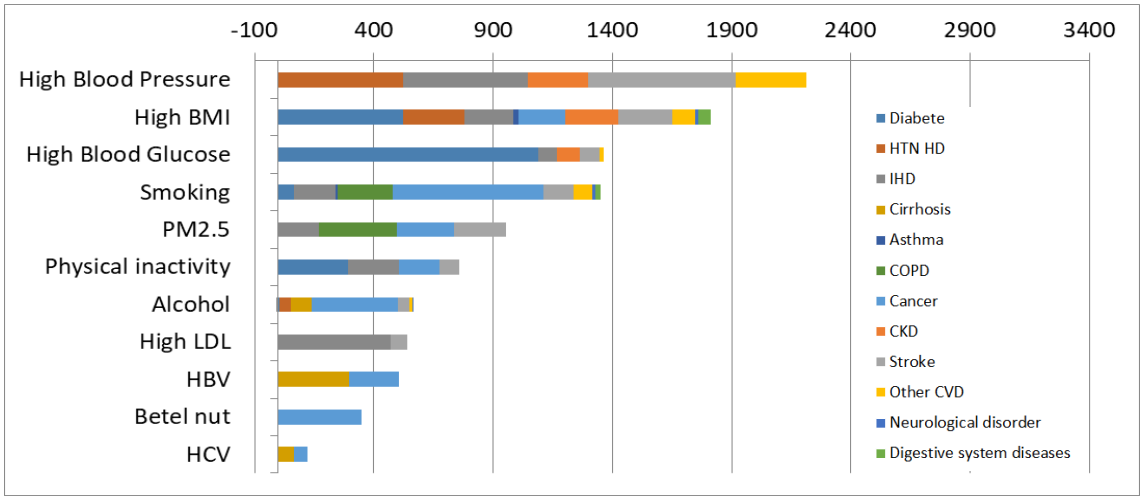

Figure S2.9 Chiayi City

doi:10.6342/NTU201903237

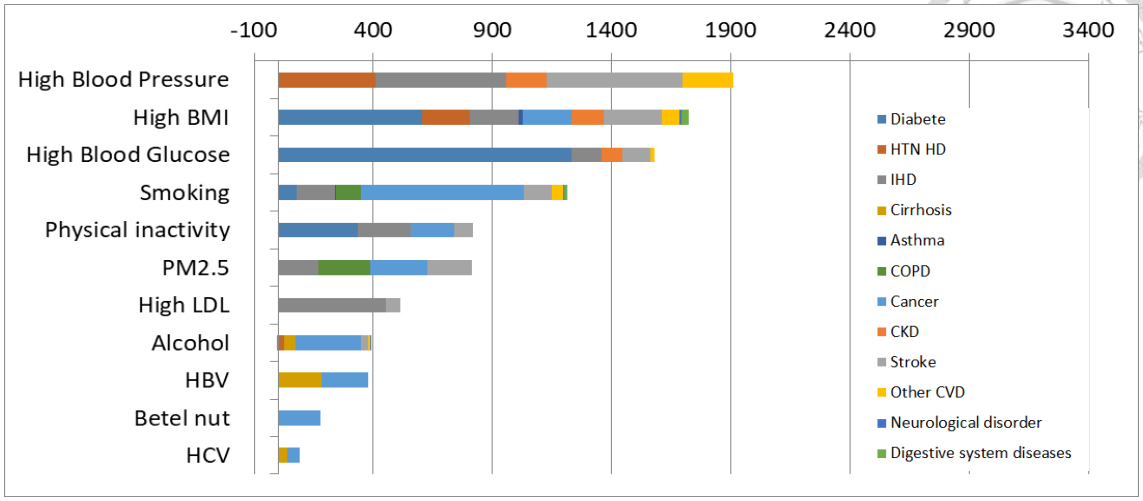

Figure S2.10 Tainan

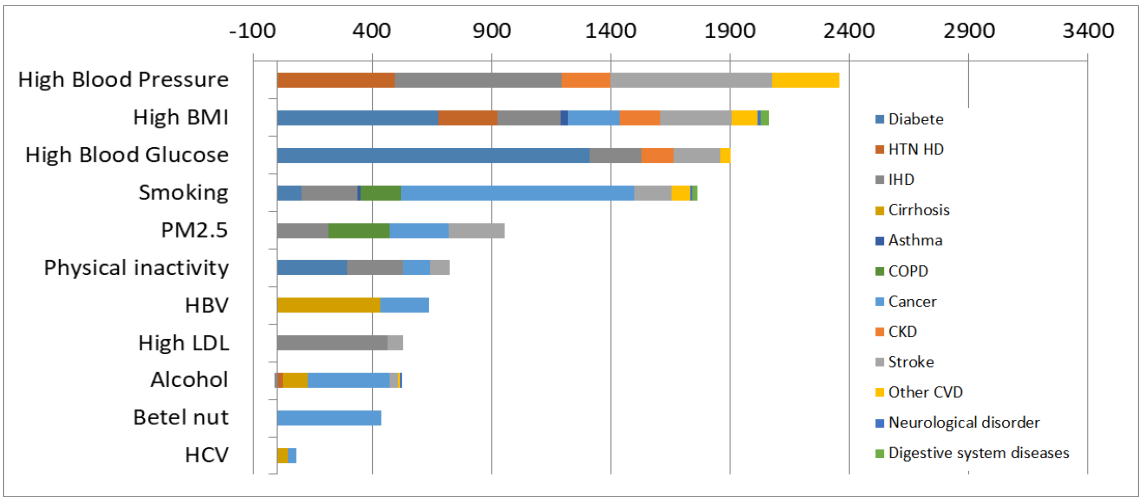

Figure S2.11 Pingtung

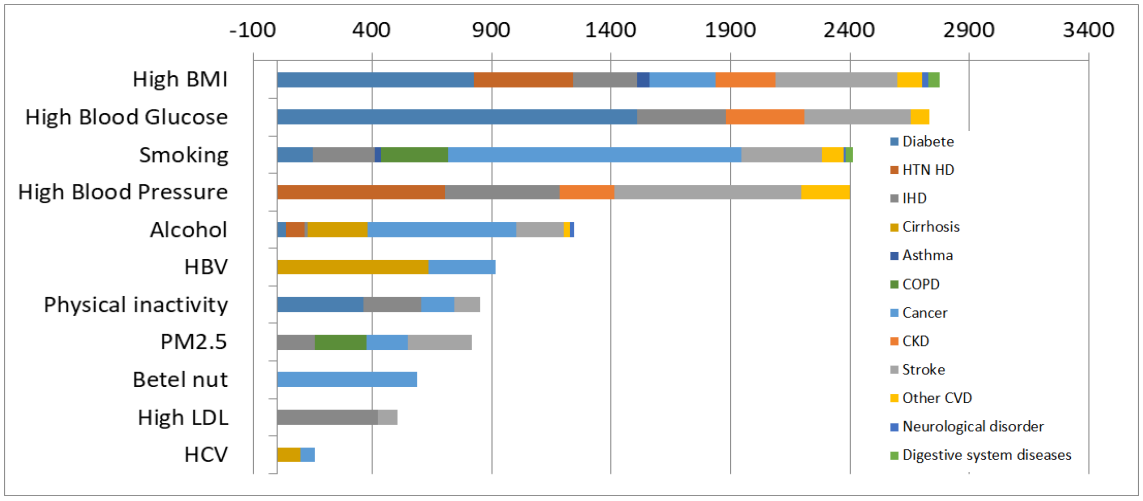

Figure S2.12 Hualien

doi:10.6342/NTU201903237

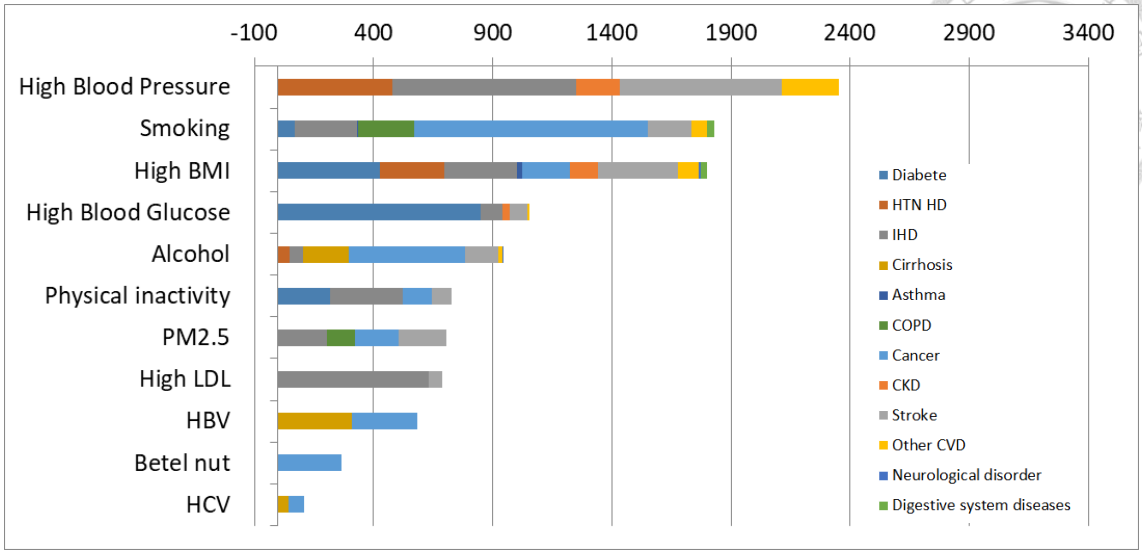

Figure S2.13 Yilan

doi:10.6342/NTU201903237

Table S1. Relative risk for risk factors and disease outcome by age group

Table S1.1 High fasting plasma glucose (per mmol/L increase)

Risk factor / Disease outcome	Sex	RR for age group											
		25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Ischemic heart disease	both	1.471	1.373	1.274	1.22	1.211	1.201	1.192	1.182	1.173	1.168	1.168	1.169
Ischemic stroke	both	1.526	1.4	1.275	1.21	1.204	1.199	1.194	1.188	1.183	1.174	1.162	1.133
Intracerebral hemorrhage	both	1.506	1.382	1.258	1.196	1.193	1.191	1.189	1.187	1.184	1.175	1.158	1.116
Subarachnoid hemorrhage	both	1.506	1.382	1.258	1.196	1.193	1.191	1.189	1.187	1.184	1.175	1.158	1.116
Chronic kidney disease due to hypertension	both	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388
Chronic kidney disease due to glomerulonephritis	both	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388
Chronic kidney disease due to other and unspecified causes	both	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388	1.388

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Table S1.2 High systolic blood pressure (per 10 mmHg increase)

Risk factor / Disease outcome	Sex	RR for age group											
		25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Rheumatic heart disease	both	1.631	1.474	1.317	1.229	1.211	1.193	1.175	1.157	1.139	1.127	1.12	1.104
Ischemic heart disease	both	1.972	1.818	1.665	1.568	1.527	1.487	1.446	1.405	1.364	1.33	1.303	1.266
Ischemic stroke	both	1.854	1.774	1.694	1.628	1.574	1.521	1.468	1.414	1.361	1.318	1.284	1.201
Intracerebral hemorrhage	both	2.134	2.05	1.966	1.874	1.775	1.676	1.577	1.478	1.379	1.323	1.311	1.279
Subarachnoid hemorrhage	both	2.134	2.05	1.966	1.874	1.775	1.676	1.577	1.478	1.379	1.323	1.311	1.279
Hypertensive heart disease	both	2.862	2.838	2.814	2.703	2.504	2.304	2.105	1.905	1.706	1.619	1.644	1.708
Non-rheumatic calcific aortic valve disease	both	1.755	1.605	1.455	1.365	1.335	1.306	1.276	1.247	1.217	1.193	1.175	1.128
Other cardiomyopathy	both	1.755	1.605	1.455	1.365	1.335	1.306	1.276	1.247	1.217	1.193	1.175	1.128
Atrial fibrillation and flutter	both	1.76	1.631	1.503	1.423	1.392	1.361	1.33	1.299	1.268	1.237	1.208	1.134
Aortic aneurysm	both	1.544	1.469	1.394	1.345	1.321	1.296	1.272	1.248	1.223	1.2	1.177	1.119
Peripheral vascular disease	both	1.728	1.491	1.254	1.138	1.142	1.146	1.15	1.154	1.159	1.152	1.136	1.095
Endocarditis	both	1.755	1.605	1.455	1.365	1.335	1.306	1.276	1.247	1.217	1.193	1.175	1.128
Other cardiovascular and circulatory diseases	both	1.744	1.624	1.504	1.427	1.395	1.363	1.33	1.298	1.265	1.235	1.207	1.137
Chronic kidney disease due to diabetes mellitus type 1	both	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283
Chronic kidney disease due to diabetes mellitus type 2	both	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283	1.283
Chronic kidney disease due to hypertension	both	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281
Chronic kidney disease due to glomerulonephritis	both	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281	1.281
Chronic kidney disease due to other and unspecified causes	both	1.282	1.282	1.282	1.282	1.282	1.282	1.282	1.282	1.282	1.282	1.282	1.282

doi:10.6342/NTU201903237

Table S1.3 High LDL cholesterol (per mmol/L increase)

Risk factor / Disease outcome	Sex	RR for age group											
		25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Ischemic heart disease	both	2.016	2.027	2.038	1.971	1.828	1.685	1.541	1.398	1.254	1.193	1.213	1.262
Ischemic stroke	both	1.67	1.626	1.583	1.518	1.434	1.35	1.265	1.181	1.096	1.062	1.077	1.116

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Table S1.4 High body-mass index (per 5 kg/m2 increase)

Risk factor / Disease outcome	Sex	RR for age group											
		25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Esophageal cancer	male	1.391	1.391	1.391	1.391	1.391	1.391	1.391	1.391	1.391	1.391	1.391	1.391
	female	1.351	1.351	1.351	1.351	1.351	1.351	1.351	1.351	1.351	1.351	1.351	1.351
Colon and rectum cancer	male	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177
	female	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059	1.059
Liver cancer due to hepatitis B	male	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289
	female	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176
Liver cancer due to hepatitis C	male	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289
	female	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176
Liver cancer due to alcohol use	male	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289
	female	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176
Liver cancer due to other causes	male	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289	1.289
	female	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176	1.176
Gallbladder and biliary tract cancer	male	1.155	1.155	1.155	1.155	1.155	1.155	1.155	1.155	1.155	1.155	1.155	1.155
	female	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344
Pancreatic cancer	male	1.071	1.071	1.071	1.071	1.071	1.071	1.071	1.071	1.071	1.071	1.071	1.071
	female	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092
Uterine cancer	male	1.613	1.613	1.613	1.613	1.613	1.613	1.613	1.613	1.613	1.613	1.613	1.613
Ovarian cancer	female	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038	1.038
Kidney cancer	male	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24	1.24

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	female	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32	1.32
Thyroid cancer	male	1.221	1.221	1.221	1.221	1.221	1.221	1.221	1.221	1.221	1.221	1.221	1.221
	female	1.136	1.136	1.136	1.136	1.136	1.136	1.136	1.136	1.136	1.136	1.136	1.136
Non-Hodgkin's lymphoma	male	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089
	female	1.068	1.068	1.068	1.068	1.068	1.068	1.068	1.068	1.068	1.068	1.068	1.068
Multiple myeloma	male	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089	1.089
	female	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092	1.092
Acute lymphoid leukemia	male	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086
	female	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131
Chronic lymphoid leukemia	male	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086
	female	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131
Acute myeloid leukemia	male	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086
	female	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131
Chronic myeloid leukemia	male	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086
	female	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131
Other leukemia	male	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086	1.086
	female	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131	1.131
Ischemic heart disease	both	2.274	2.274	2.018	1.724	1.599	1.567	1.52	1.466	1.414	1.414	1.414	1.414
Ischemic stroke	both	2.472	2.472	2.235	1.979	1.826	1.733	1.635	1.543	1.455	1.455	1.455	1.455
Intracerebral hemorrhage	both	3.066	3.066	2.913	2.597	2.389	2.199	1.996	1.805	1.665	1.665	1.665	1.665
Subarachnoid hemorrhage	both	3.066	3.066	2.913	2.597	2.389	2.199	1.996	1.805	1.665	1.665	1.665	1.665
Hypertensive heart disease	both	3.122	3.122	3	2.769	2.573	2.407	2.281	2.159	2.035	2.035	2.035	2.035
Atrial fibrillation and flutter	male	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344	1.344

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	female	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346	1.346
Asthma	male	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409	1.409
	female	1.402	1.402	1.402	1.402	1.402	1.402	1.402	1.402	1.402	1.402	1.402	1.402
Gallbladder and biliary diseases	male	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464	1.464
	female	1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729	1.729
Alzheimer's disease and other dementias	male	1.218	1.218	1.218	1.218	1.218	1.218	1.218	1.218	1.218	1.218	1.218	1.218
	female	1.214	1.214	1.214	1.214	1.214	1.214	1.214	1.214	1.214	1.214	1.214	1.214
Diabetes mellitus type 2	both	3.547	3.547	3.455	3.349	3.16	2.864	2.624	2.417	2.215	2.215	2.215	2.215
Chronic kidney disease due to diabetes mellitus type 2	both	-	-	-	1.746	1.746	1.746	1.746	1.746	2.036	2.036	2.036	2.036
Chronic kidney disease due to hypertension	both	-	-	-	1.763	1.763	1.763	1.763	1.763	2.044	2.044	2.044	2.044
Chronic kidney disease due to glomerulonephritis	both	-	-	-	1.742	1.742	1.742	1.742	1.742	2.044	2.044	2.044	2.044
Chronic kidney disease due to other and unspecified causes	both	-	-	-	1.732	1.732	1.732	1.732	1.732	2.032	2.032	2.032	2.032
Cataract	male	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
	female	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104	1.104
Gout	male	1.628	1.628	1.628	1.628	1.628	1.628	1.628	1.628	1.628	1.628	1.628	1.628
	female	1.493	1.493	1.493	1.493	1.493	1.493	1.493	1.493	1.493	1.493	1.493	1.493

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Table S1.4 betel nut use, chronic hepatitis B, C, and Second-hand smoke

Risk factor / Disease outcome	Sex	RR
betel nut use		
Lip and oral cavity cancer	both	10.98
Larynx cancer	both	6.24
Esophageal cancer	both	5.64
chronic hepatitis B		
Liver cancer	both	8.69
Cirrhosis and other chronic liver diseases	both	6.63
chronic hepatitis C		
Liver cancer	both	8.46
Cirrhosis and other chronic liver diseases	both	1.8
Second-hand smoke		
Breast cancer	both	1.072
Asthma	both	1.97
Lung cancer	both	1.43
Stroke	both	1.22
Chronic obstructive pulmonary disease	both	1.55
Ischemic heart disease	both	1.27

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Table S1.5 smoking(pack-year)

Risk factor / Disease outcome	Sex	Unit	RR										
			30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Lip and oral cavity cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	17.7	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19	3.19
	both	35.4	3.754	3.754	3.754	3.754	3.754	3.754	3.754	3.754	3.754	3.754	3.754
	both	53.1	4.017	4.017	4.017	4.017	4.017	4.017	4.017	4.017	4.017	4.017	4.017
	both	70.8	5.517	5.517	5.517	5.517	5.517	5.517	5.517	5.517	5.517	5.517	5.517
Nasopharynx cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	10.7	1.879	1.879	1.879	1.879	1.879	1.879	1.879	1.879	1.879	1.879	1.879
	both	21.4	1.992	1.992	1.992	1.992	1.992	1.992	1.992	1.992	1.992	1.992	1.992
	both	32.1	2.297	2.297	2.297	2.297	2.297	2.297	2.297	2.297	2.297	2.297	2.297
	both	42.9	2.662	2.662	2.662	2.662	2.662	2.662	2.662	2.662	2.662	2.662	2.662
	both	53.6	3.377	3.377	3.377	3.377	3.377	3.377	3.377	3.377	3.377	3.377	3.377
	both	64.3	4.466	4.466	4.466	4.466	4.466	4.466	4.466	4.466	4.466	4.466	4.466
Other pharynx cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	17.7	4.792	4.792	4.792	4.792	4.792	4.792	4.792	4.792	4.792	4.792	4.792
	both	35.4	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255
	both	53.1	6.588	6.588	6.588	6.588	6.588	6.588	6.588	6.588	6.588	6.588	6.588
	both	70.8	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21	7.21
	both	88.5	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15	11.15
Esophageal cancer	both	0	1	1	1	1	1	1	1	1	1	1	1

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	both	15	3.038	3.038	3.038	3.038	3.038	3.038	3.038	3.038	3.038	3.038	3.038
	both	30	2.778	2.778	2.778	2.778	2.778	2.778	2.778	2.778	2.778	2.778	2.778
	both	45	4.471	4.471	4.471	4.471	4.471	4.471	4.471	4.471	4.471	4.471	4.471
	both	60	5.327	5.327	5.327	5.327	5.327	5.327	5.327	5.327	5.327	5.327	5.327
	both	75	7.326	7.326	7.326	7.326	7.326	7.326	7.326	7.326	7.326	7.326	7.326
	both	90	9.593	9.593	9.593	9.593	9.593	9.593	9.593	9.593	9.593	9.593	9.593
Stomach cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	12.5	1.427	1.427	1.427	1.427	1.427	1.427	1.427	1.427	1.427	1.427	1.427
	both	25	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607
	both	37.5	1.907	1.907	1.907	1.907	1.907	1.907	1.907	1.907	1.907	1.907	1.907
	both	50	2.055	2.055	2.055	2.055	2.055	2.055	2.055	2.055	2.055	2.055	2.055
	both	75	2.122	2.122	2.122	2.122	2.122	2.122	2.122	2.122	2.122	2.122	2.122
Colon and rectum cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	18.8	1.505	1.505	1.505	1.505	1.505	1.505	1.505	1.505	1.505	1.505	1.505
	both	37.5	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607	1.607
	both	56.2	1.583	1.583	1.583	1.583	1.583	1.583	1.583	1.583	1.583	1.583	1.583
Liver cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	14.6	1.512	1.512	1.512	1.512	1.512	1.512	1.512	1.512	1.512	1.512	1.512
	both	29.2	1.638	1.638	1.638	1.638	1.638	1.638	1.638	1.638	1.638	1.638	1.638
	both	43.8	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83	1.83
	both	58.3	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786	1.786
	both	72.9	1.937	1.937	1.937	1.937	1.937	1.937	1.937	1.937	1.937	1.937	1.937
Pancreatic cancer	male	0	1	1	1	1	1	1	1	1	1	1	1

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	female	0	1	1	1	1	1	1	1	1	1	1	1
	male	15.8	1.653	1.653	1.653	1.653	1.653	1.653	1.653	1.653	1.653	1.653	1.653
	female	15.8	2.361	2.361	2.361	2.361	2.361	2.361	2.361	2.361	2.361	2.361	2.361
	male	31.5	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799	1.799
	female	31.5	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745	2.745
	male	47.3	2.173	2.173	2.173	2.173	2.173	2.173	2.173	2.173	2.173	2.173	2.173
	female	47.3	3.281	3.281	3.281	3.281	3.281	3.281	3.281	3.281	3.281	3.281	3.281
	male	63	2.429	2.429	2.429	2.429	2.429	2.429	2.429	2.429	2.429	2.429	2.429
	female	63	3.843	3.843	3.843	3.843	3.843	3.843	3.843	3.843	3.843	3.843	3.843
Larynx cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	15	4.593	4.593	4.593	4.593	4.593	4.593	4.593	4.593	4.593	4.593	4.593
	both	30	8.448	8.448	8.448	8.448	8.448	8.448	8.448	8.448	8.448	8.448	8.448
	both	45	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16	16.16
	both	60	21.95	21.95	21.95	21.95	21.95	21.95	21.95	21.95	21.95	21.95	21.95
	both	75	26.15	26.15	26.15	26.15	26.15	26.15	26.15	26.15	26.15	26.15	26.15
Tracheal, bronchus, and lung cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	5	1.758	1.758	1.758	1.758	1.758	1.758	1.758	1.758	1.758	1.758	1.758
	both	14.3	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86	4.86
	both	28.6	8.899	8.899	8.899	8.899	8.899	8.899	8.899	8.899	8.899	8.899	8.899
	both	42.9	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51	13.51
	both	57.1	14.83	14.83	14.83	14.83	14.83	14.83	14.83	14.83	14.83	14.83	14.83
	both	71.4	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64	18.64
	both	85.7	21.53	21.53	21.53	21.53	21.53	21.53	21.53	21.53	21.53	21.53	21.53

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Breast cancer	female	0	1	1	1	1	1	1	1	1	1	1	1
	female	12.8	1.207	1.207	1.207	1.207	1.207	1.207	1.207	1.207	1.207	1.207	1.207
	female	25.5	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31	1.31
	female	38.2	1.242	1.242	1.242	1.242	1.242	1.242	1.242	1.242	1.242	1.242	1.242
	female	63.8	1.274	1.274	1.274	1.274	1.274	1.274	1.274	1.274	1.274	1.274	1.274
Cervical cancer	female	0	1	1	1	1	1	1	1	1	1	1	1
	female	5	1.785	1.785	1.785	1.785	1.785	1.785	1.785	1.785	1.785	1.785	1.785
	female	7.4	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941	1.941
	female	14.8	2.245	2.245	2.245	2.245	2.245	2.245	2.245	2.245	2.245	2.245	2.245
	female	22.1	3.355	3.355	3.355	3.355	3.355	3.355	3.355	3.355	3.355	3.355	3.355
	female	29.5	4.207	4.207	4.207	4.207	4.207	4.207	4.207	4.207	4.207	4.207	4.207
Kidney cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	12.3	1.366	1.366	1.366	1.366	1.366	1.366	1.366	1.366	1.366	1.366	1.366
	both	24.6	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73	1.73
	both	36.9	1.757	1.757	1.757	1.757	1.757	1.757	1.757	1.757	1.757	1.757	1.757
	both	49.2	1.892	1.892	1.892	1.892	1.892	1.892	1.892	1.892	1.892	1.892	1.892
	both	61.5	2.006	2.006	2.006	2.006	2.006	2.006	2.006	2.006	2.006	2.006	2.006
Bladder cancer	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	15	2.804	2.804	2.804	2.804	2.804	2.804	2.804	2.804	2.804	2.804	2.804
	both	30	3.328	3.328	3.328	3.328	3.328	3.328	3.328	3.328	3.328	3.328	3.328
	both	45	4.239	4.239	4.239	4.239	4.239	4.239	4.239	4.239	4.239	4.239	4.239
	both	60	4.553	4.553	4.553	4.553	4.553	4.553	4.553	4.553	4.553	4.553	4.553
Other leukemia	both	0	1	1	1	1	1	1	1	1	1	1	1

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	both	12.4	2.011	2.011	2.011	2.011	2.011	2.011	2.011	2.011	2.011	2.011	2.011
	both	24.8	2.253	2.253	2.253	2.253	2.253	2.253	2.253	2.253	2.253	2.253	2.253
	both	37.1	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64
Chronic obstructive pulmonary disease	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	10	2.512	2.512	2.512	2.512	2.512	2.512	2.512	2.512	2.512	2.512	2.512
	both	20	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942	3.942
	both	30	4.619	4.619	4.619	4.619	4.619	4.619	4.619	4.619	4.619	4.619	4.619
	both	40	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255	5.255
	both	50	5.967	5.967	5.967	5.967	5.967	5.967	5.967	5.967	5.967	5.967	5.967
	both	60	6.995	6.995	6.995	6.995	6.995	6.995	6.995	6.995	6.995	6.995	6.995
	both	70	8.274	8.274	8.274	8.274	8.274	8.274	8.274	8.274	8.274	8.274	8.274
	both	80	9.838	9.838	9.838	9.838	9.838	9.838	9.838	9.838	9.838	9.838	9.838
	both	90	12.91	12.91	12.91	12.91	12.91	12.91	12.91	12.91	12.91	12.91	12.91
Prostate cancer	male	0	1	1	1	1	1	1	1	1	1	1	1
	male	7.5	1.192	1.192	1.192	1.192	1.192	1.192	1.192	1.192	1.192	1.192	1.192
	male	15	1.173	1.173	1.173	1.173	1.173	1.173	1.173	1.173	1.173	1.173	1.173
	male	22.5	1.166	1.166	1.166	1.166	1.166	1.166	1.166	1.166	1.166	1.166	1.166
	male	30	1.235	1.235	1.235	1.235	1.235	1.235	1.235	1.235	1.235	1.235	1.235
	male	37.5	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
Ischemic heart disease	male	0	1	1	1	1	1	1	1	1	1	1	1
	female	0	1	1	1	1	1	1	1	1	1	1	1
	male	11.2	2.965	2.965	2.965	2.526	2.526	2.125	2.125	1.773	1.773	1.46	1.46
	female	11.2	3.783	3.783	3.783	3.183	3.183	2.608	2.608	2.131	2.131	1.68	1.68

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	male	22.5	3.29	3.29	3.29	2.671	2.671	2.188	2.188	1.784	1.784	1.457	1.457
	female	22.5	6.684	6.684	6.684	4.917	4.917	3.569	3.569	2.572	2.572	1.85	1.85
	male	33.8	4.276	4.276	4.276	3.388	3.388	2.634	2.634	2.054	2.054	1.599	1.599
	female	33.8	9.744	9.744	9.744	6.798	6.798	4.678	4.678	3.246	3.246	2.178	2.178
	male	45	5.45	5.45	5.45	4.139	4.139	3.075	3.075	2.325	2.325	1.737	1.737
	female	45	11.77	11.77	11.77	7.729	7.729	5.097	5.097	3.414	3.414	2.239	2.239
	male	56.2	5.574	5.574	5.574	4.182	4.182	3.016	3.016	2.227	2.227	1.647	1.647
	female	56.2	13.64	13.64	13.64	8.813	8.813	5.612	5.612	3.69	3.69	2.405	2.405
Ischemic stroke	male	0	1	1	1	1	1	1	1	1	1	1	1
	female	0	1	1	1	1	1	1	1	1	1	1	1
	male	10	2.363	2.363	2.363	2.112	2.112	1.843	1.843	1.606	1.606	1.386	1.386
	female	10	2.334	2.334	2.334	2.101	2.101	1.916	1.916	1.721	1.721	1.479	1.479
	male	20	2.319	2.319	2.319	1.971	1.971	1.662	1.662	1.415	1.415	1.222	1.222
	female	20	3.737	3.737	3.737	3.04	3.04	2.443	2.443	1.94	1.94	1.527	1.527
	male	30	3.178	3.178	3.178	2.666	2.666	2.224	2.224	1.849	1.849	1.518	1.518
	female	30	5.491	5.491	5.491	4.206	4.206	3.136	3.136	2.3	2.3	1.721	1.721
	male	40	3.431	3.431	3.431	2.734	2.734	2.117	2.117	1.659	1.659	1.337	1.337
	female	40	7.127	7.127	7.127	5.103	5.103	3.636	3.636	2.593	2.593	1.781	1.781
	male	50	4.456	4.456	4.456	3.491	3.491	2.659	2.659	2.048	2.048	1.579	1.579
	female	50	9.851	9.851	9.851	6.922	6.922	5	5	3.569	3.569	2.352	2.352
	male	60	5.317	5.317	5.317	4.155	4.155	3.175	3.175	2.395	2.395	1.844	1.844
	female	60	11.72	11.72	11.72	8.28	8.28	5.942	5.942	4.286	4.286	2.783	2.783
Intracerebral hemorrhage	male	0	1	1	1	1	1	1	1	1	1	1	1

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	female	0	1	1	1	1	1	1	1	1	1	1	1
	male	10	2.363	2.363	2.363	2.112	2.112	1.843	1.843	1.606	1.606	1.386	1.386
	female	10	2.334	2.334	2.334	2.101	2.101	1.916	1.916	1.721	1.721	1.479	1.479
	male	20	2.319	2.319	2.319	1.971	1.971	1.662	1.662	1.415	1.415	1.222	1.222
	female	20	3.737	3.737	3.737	3.04	3.04	2.443	2.443	1.94	1.94	1.527	1.527
	male	30	3.178	3.178	3.178	2.666	2.666	2.224	2.224	1.849	1.849	1.518	1.518
	female	30	5.491	5.491	5.491	4.206	4.206	3.136	3.136	2.3	2.3	1.721	1.721
	male	40	3.431	3.431	3.431	2.734	2.734	2.117	2.117	1.659	1.659	1.337	1.337
	female	40	7.127	7.127	7.127	5.103	5.103	3.636	3.636	2.593	2.593	1.781	1.781
	male	50	4.456	4.456	4.456	3.491	3.491	2.659	2.659	2.048	2.048	1.579	1.579
	female	50	9.851	9.851	9.851	6.922	6.922	5	5	3.569	3.569	2.352	2.352
	male	60	5.317	5.317	5.317	4.155	4.155	3.175	3.175	2.395	2.395	1.844	1.844
	female	60	11.72	11.72	11.72	8.28	8.28	5.942	5.942	4.286	4.286	2.783	2.783
Subarachnoid hemorrhage	male	0	1	1	1	1	1	1	1	1	1	1	1
	female	0	1	1	1	1	1	1	1	1	1	1	1
	male	10	2.363	2.363	2.363	2.112	2.112	1.843	1.843	1.606	1.606	1.386	1.386
	female	10	2.334	2.334	2.334	2.101	2.101	1.916	1.916	1.721	1.721	1.479	1.479
	male	20	2.319	2.319	2.319	1.971	1.971	1.662	1.662	1.415	1.415	1.222	1.222
	female	20	3.737	3.737	3.737	3.04	3.04	2.443	2.443	1.94	1.94	1.527	1.527
	male	30	3.178	3.178	3.178	2.666	2.666	2.224	2.224	1.849	1.849	1.518	1.518
	female	30	5.491	5.491	5.491	4.206	4.206	3.136	3.136	2.3	2.3	1.721	1.721
	male	40	3.431	3.431	3.431	2.734	2.734	2.117	2.117	1.659	1.659	1.337	1.337
	female	40	7.127	7.127	7.127	5.103	5.103	3.636	3.636	2.593	2.593	1.781	1.781

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	male	50	4.456	4.456	4.456	3.491	3.491	2.659	2.659	2.048	2.048	1.579	1.579
	female	50	9.851	9.851	9.851	6.922	6.922	5	5	3.569	3.569	2.352	2.352
	male	60	5.317	5.317	5.317	4.155	4.155	3.175	3.175	2.395	2.395	1.844	1.844
	female	60	11.72	11.72	11.72	8.28	8.28	5.942	5.942	4.286	4.286	2.783	2.783
Atrial fibrillation and flutter	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	6.3	1.532	1.532	1.532	1.507	1.507	1.474	1.474	1.429	1.429	1.324	1.324
	both	12.6	1.895	1.895	1.895	1.774	1.774	1.632	1.632	1.459	1.459	1.283	1.283
	both	18.9	2.222	2.222	2.222	1.997	1.997	1.766	1.766	1.518	1.518	1.299	1.299
	both	25.2	2.588	2.588	2.588	2.261	2.261	1.952	1.952	1.629	1.629	1.37	1.37
Aortic aneurysm	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	12	5.046	5.046	5.046	4.201	4.201	3.404	3.404	2.669	2.669	2.014	2.014
	both	24	9.532	9.532	9.532	6.722	6.722	4.62	4.62	3.116	3.116	2.076	2.076
	both	36	12.382	12.382	12.382	8.505	8.505	5.626	5.626	3.697	3.697	2.455	2.455
	both	48	14.479	14.479	14.479	9.77	9.77	6.258	6.258	3.954	3.954	2.503	2.503
Peripheral vascular disease	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	9.3	3.033	3.033	3.033	2.78	2.78	3.077	3.077	2.978	2.978	2.194	2.194
	both	18.6	6.374	6.374	6.374	5.44	5.44	5.689	5.689	4.868	4.868	3.01	3.01
	both	27.9	8.997	8.997	8.997	7.43	7.43	7.069	7.069	5.123	5.123	2.877	2.877
	both	37.2	10.787	10.787	10.787	8.838	8.838	8.201	8.201	5.967	5.967	3.335	3.335
	both	46.5	11.975	11.975	11.975	9.778	9.778	9.03	9.03	6.528	6.528	3.629	3.629
Asthma	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	2.5	1.236	1.236	1.236	1.236	1.236	1.236	1.236	1.236	1.236	1.236	1.236
	both	7.5	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659	1.659

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	both	15	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85	1.85
	both	22.5	1.987	1.987	1.987	1.987	1.987	1.987	1.987	1.987	1.987	1.987	1.987
	both	30	2.366	2.366	2.366	2.366	2.366	2.366	2.366	2.366	2.366	2.366	2.366
Peptic ulcer disease	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	6.5	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824	1.824
	both	13	2.156	2.156	2.156	2.156	2.156	2.156	2.156	2.156	2.156	2.156	2.156
	both	19.5	2.519	2.519	2.519	2.519	2.519	2.519	2.519	2.519	2.519	2.519	2.519
	both	26	2.552	2.552	2.552	2.552	2.552	2.552	2.552	2.552	2.552	2.552	2.552
	both	32.5	2.888	2.888	2.888	2.888	2.888	2.888	2.888	2.888	2.888	2.888	2.888
Gallbladder and biliary diseases	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	8.8	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
	both	17.5	1.303	1.303	1.303	1.303	1.303	1.303	1.303	1.303	1.303	1.303	1.303
	both	26.2	1.398	1.398	1.398	1.398	1.398	1.398	1.398	1.398	1.398	1.398	1.398
	both	35	1.612	1.612	1.612	1.612	1.612	1.612	1.612	1.612	1.612	1.612	1.612
	both	43.8	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81	1.81
Alzheimer's disease and other dementias	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	12	2.078	2.078	2.078	2.078	2.078	2.078	2.078	2.078	2.078	2.078	2.078
	both	24	2.936	2.936	2.936	2.936	2.936	2.936	2.936	2.936	2.936	2.936	2.936
	both	36	3.737	3.737	3.737	3.737	3.737	3.737	3.737	3.737	3.737	3.737	3.737
	both	48	4.103	4.103	4.103	4.103	4.103	4.103	4.103	4.103	4.103	4.103	4.103
Parkinson's disease	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	7.5	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835	0.835
	both	15	0.689	0.689	0.689	0.689	0.689	0.689	0.689	0.689	0.689	0.689	0.689

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	both	22.5	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604	0.604
	both	30	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52
	both	37.5	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432	0.432
	both	45	0.323	0.323	0.323	0.323	0.323	0.323	0.323	0.323	0.323	0.323	0.323
Multiple sclerosis	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	5.6	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377	1.377
	both	11.2	1.756	1.756	1.756	1.756	1.756	1.756	1.756	1.756	1.756	1.756	1.756
	both	16.9	1.965	1.965	1.965	1.965	1.965	1.965	1.965	1.965	1.965	1.965	1.965
	both	22.5	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04	2.04
Diabetes mellitus type 2	both	0	1	1	1	1	1	1	1	1	1	1	1
	both	6.5	1.439	1.439	1.439	1.439	1.439	1.439	1.439	1.439	1.439	1.439	1.439
	both	12.9	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43	1.43
	both	19.4	1.637	1.637	1.637	1.637	1.637	1.637	1.637	1.637	1.637	1.637	1.637
	both	25.8	1.665	1.665	1.665	1.665	1.665	1.665	1.665	1.665	1.665	1.665	1.665
	both	32.3	1.841	1.841	1.841	1.841	1.841	1.841	1.841	1.841	1.841	1.841	1.841
	both	38.8	2.163	2.163	2.163	2.163	2.163	2.163	2.163	2.163	2.163	2.163	2.163

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Table S1.6 Low physical activity content

Risk factor / Disease outcome	Sex	Unit	RR	RR	RR	RR	RR
		METs	Colon and rectum cancer	Breast cancer	Ischemic heart disease	Ischemic stroke	Diabetes mellitus type 2
	both	0	1	1	1	1	1
	both	600	0.978	0.987	0.909	0.91	0.98
	both	1200	0.956	0.974	0.819	0.819	0.961
	both	1800	0.833	0.96	0.808	0.802	0.921
	both	2400	0.883	0.957	0.796	0.785	0.882
	both	3000	0.833	0.953	0.776	0.784	0.834
	both	3600	0.831	0.949	0.756	0.783	0.786
	both	4200	0.829	0.946	0.736	0.782	0.737
	both	4800	0.827	0.942	0.736	0.779	0.736
	both	5400	0.825	0.938	0.735	0.776	0.735
	both	6000	0.824	0.935	0.734	0.774	0.734
	both	6600	0.822	0.931	0.734	0.771	0.733
	both	7200	0.82	0.928	0.733	0.768	0.732
	both	7800	0.818	0.924	0.733	0.765	0.731
	both	8400	0.816	0.92	0.732	0.762	0.73
	both	9000	0.815	0.917	0.731	0.759	0.729
	both	9600	0.813	0.912	0.731	0.756	0.728
	both	10200	0.811	0.908	0.73	0.753	0.727

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both	10800	0.809	0.904	0.73	75	0.726
both	11400	0.807	0.9	0.729	0.747	0.725
both	12000	0.805	0.895	0.728	0.744	0.723
both	12600	0.804	0.891	0.728	0.741	0.722
both	13200	0.802	0.887	0.727	0.738	0.721
both	13800	0.8	0.883	0.727	0.735	0.72
both	14400	0.798	0.879	0.726	0.732	0.719
both	15000	0.796	0.874	0.725	0.729	0.718
both	15600	0.795	0.872	0.725	0.727	0.717
both	16200	0.793	0.87	0.725	0.724	0.716
both	16800	0.791	0.868	0.724	0.721	0.715
both	17400	0.789	0.865	0.723	0.718	0.714
both	18000	0.787	0.863	0.722	0.715	0.713
both	18600	0.786	0.861	0.722	0.712	0.712
both	19200	0.784	0.859	0.721	0.709	0.711
both	19800	0.782	0.856	0.721	0.706	0.709
both	20400	0.78	0.854	0.72	0.703	0.708
both	21000	0.778	0.852	0.72	0.7	0.707
both	21600	0.777	0.85	0.719	0.697	0.706
both	22200	0.775	0.847	0.718	0.694	0.705
both	22800	0.773	0.845	0.718	0.691	0.704
both	23400	0.771	0.843	0.717	0.688	0.703
both	24000	0.883	0.841	0.717	0.685	0.702

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both	24600	0.769	0.839	0.716	0.682	0.701
both	25200	0.767	0.836	0.715	0.679	0.7
both	25800	0.766	0.834	0.715	0.677	0.699
both	26400	0.764	0.832	0.714	0.674	0.698
both	27000	0.762	0.83	0.714	0.671	0.697
both	27600	0.76	0.827	0.713	0.668	0.696
both	28200	0.757	0.825	0.712	0.665	0.694
both	28800	0.755	0.823	0.712	0.662	0.693
both	29400	0.753	0.821	0.712	0.659	0.692
both	30000	0.751	0.818	0.711	0.656	0.691
both	30600	0.749	0.816	0.71	0.653	0.69
both	31200	0.748	0.814	0.709	0.65	0.689
both	31800	0.746	0.812	0.709	0.647	0.688
both	32400	0.744	0.809	0.708	0.644	0.687
both	33000	0.743	0.808	0.708	0.643	0.686

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Table S1.7 Alcohol use

Risk factor / Disease outcome	Sex	Unit	RR
Esophageal cancer	both	72	2.669
	both	60	2.452
	both	48	2.202
	both	36	1.815
	both	24	1.466
	both	12	1.212
	both	0	1
Liver cancer	both	72	1.424
	both	60	1.372
	both	48	1.31
	both	36	1.225
	both	24	1.14
	both	12	1.067
	both	0	1
Larynx cancer	both	72	2.461
	both	60	2.144
	both	48	1.813
	both	36	1.531
	both	24	1.304

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	both	12	1.12
	both	0	1
Breast cancer	both	72	1.476
	both	60	1.452
	both	48	1.443
	both	36	1.433
	both	24	1.329
	both	12	1.17
	both	0	1
Colon and rectum cancer	both	72	1.616
	both	60	1.468
	both	48	1.323
	both	36	1.237
	both	24	1.156
	both	12	1.078
	both	0	1
Lip and oral cavity cancer	both	72	4.848
	both	60	3.766
	both	48	2.991
	both	36	2.311
	both	24	1.738
	both	12	1.293
	both	0	1

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Nasopharynx cancer	both	72	4.545
	both	60	3.803
	both	48	3.062
	both	36	2.385
	both	24	1.839
	both	12	1.371
	both	0	1
Other pharynx cancer	both	72	4.764
	both	60	3.972
	both	48	3.199
	both	36	2.519
	both	24	1.943
	both	12	1.472
	both	0	1
Ischemic heart disease	male	72	1.091
	male	60	0.993
	male	48	0.906
	male	36	0.871
	male	24	0.857
	male	12	0.865
	male	0	1
	female	72	1.107
	female	60	1.012

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	female	48	0.932
	female	36	0.882
	female	24	0.846
	female	12	0.823
	female	0	1
Ischemic stroke	male	72	1.451
	male	60	1.312
	male	48	1.159
	male	36	1.05
	male	24	0.97
	male	12	0.938
	male	0	1
	female	72	1.43
	female	60	1.3
	female	48	1.145
	female	36	0.985
	female	24	0.85
	female	12	0.824
	female	0	1
Intracerebral hemorrhage	male	72	1.971
	male	60	1.705
	male	48	1.458
	male	36	1.31

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	male	24	1.162
	male	12	1.068
	male	0	1
	female	72	2.276
	female	60	1.964
	female	48	1.614
	female	36	1.337
	female	24	1.11
	female	12	1.031
	female	0	1
Hypertensive heart disease	both	72	1.86
	both	60	1.705
	both	48	1.614
	both	36	1.479
	both	24	1.315
	both	12	1.046
	both	0	1
Atrial fibrillation and flutter	both	72	1.535
	both	60	1.411
	both	48	1.312
	both	36	1.214
	both	24	1.131
	both	12	1.066

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	both	0	1
Cirrhosis and other chronic liver diseases	both	72	9.427
	both	60	6.274
	both	48	4.673
	both	36	3.274
	both	24	2.055
	both	12	1.243
	both	0	1
Pancreatitis	both	72	3.298
	both	60	2.217
	both	48	1.717
	both	36	1.471
	both	24	1.228
	both	12	1.073
	both	0	1
Epilepsy	both	72	2.48
	both	60	2.186
	both	48	1.872
	both	36	1.585
	both	24	1.353
	both	12	1.177
	both	0	1
Diabetes mellitus	male	72	1.198

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male	60	1.165
male	48	1.084
male	36	1
male	24	0.932
male	12	0.921
male	0	1
female	72	1.172
female	60	1.074
female	48	0.945
female	36	0.836
female	24	0.76
female	12	0.733
female	0	1

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Table S1.8 Outdoor air pollution

Risk factor / Disease outcome	Sex	Unit	RR for age group											
			25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80+
Tracheal, bronchus, and lung cancer	both	600	2.541	2.541	2.541	2.541	2.541	2.541	2.541	2.541	2.541	2.541	2.541	2.541
	both	500	2.369	2.369	2.369	2.369	2.369	2.369	2.369	2.369	2.369	2.369	2.369	2.369
	both	400	2.185	2.185	2.185	2.185	2.185	2.185	2.185	2.185	2.185	2.185	2.185	2.185
	both	300	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982	1.982
	both	200	1.753	1.753	1.753	1.753	1.753	1.753	1.753	1.753	1.753	1.753	1.753	1.753
	both	150	1.622	1.622	1.622	1.622	1.622	1.622	1.622	1.622	1.622	1.622	1.622	1.622
	both	135	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58	1.58
	both	120	1.536	1.536	1.536	1.536	1.536	1.536	1.536	1.536	1.536	1.536	1.536	1.536
	both	105	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49	1.49
	both	90	1.442	1.442	1.442	1.442	1.442	1.442	1.442	1.442	1.442	1.442	1.442	1.442
	both	75	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39	1.39
	both	60	1.335	1.335	1.335	1.335	1.335	1.335	1.335	1.335	1.335	1.335	1.335	1.335
	both	45	1.273	1.273	1.273	1.273	1.273	1.273	1.273	1.273	1.273	1.273	1.273	1.273
	both	30	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203	1.203
	both	25	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177	1.177
	both	20	1.148	1.148	1.148	1.148	1.148	1.148	1.148	1.148	1.148	1.148	1.148	1.148
	both	15	1.116	1.116	1.116	1.116	1.116	1.116	1.116	1.116	1.116	1.116	1.116	1.116
	both	10	1.077	1.077	1.077	1.077	1.077	1.077	1.077	1.077	1.077	1.077	1.077	1.077
	both	5	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02	1.02

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	both	0	1	1	1	1	1	1	1	1	1	1	1	1
Ischemic heart disease	both	600	2.244	2.142	2.033	1.917	1.831	1.743	1.661	1.583	1.506	1.434	1.371	1.307
	both	500	2.166	2.073	1.971	1.863	1.783	1.701	1.624	1.551	1.479	1.412	1.352	1.292
	both	400	2.076	1.993	1.901	1.8	1.727	1.652	1.582	1.515	1.448	1.386	1.331	1.274
	both	300	1.941	1.898	1.816	1.725	1.662	1.594	1.532	1.471	1.41	1.354	1.304	1.253
	both	200	1.838	1.779	1.71	1.631	1.579	1.521	1.467	1.416	1.363	1.314	1.271	1.225
	both	150	1.754	1.703	1.643	1.572	1.526	1.474	1.426	1.38	1.332	1.288	1.249	1.207
	both	135	1.726	1.677	1.62	1.551	1.507	1.457	1.412	1.367	1.321	1.279	1.241	1.204
	both	120	1.695	1.649	1.595	1.529	1.487	1.44	1.396	1.354	1.31	1.269	1.233	1.194
	both	105	1.661	1.619	1.567	1.505	1.466	1.421	1.38	1.339	1.297	1.258	1.224	1.187
	both	90	1.624	1.585	1.537	1.478	1.442	1.399	1.361	1.323	1.283	1.246	1.214	1.179
	both	75	1.583	1.547	1.503	1.448	1.415	1.376	1.34	1.305	1.267	1.233	1.202	1.169
	both	60	1.535	1.504	1.464	1.413	1.384	1.348	1.315	1.283	1.249	1.217	1.189	1.158
	both	45	1.479	1.452	1.417	1.372	1.347	1.314	1.286	1.257	1.226	1.198	1.173	1.145
	both	30	1.406	1.385	1.357	1.318	1.229	1.271	1.247	1.224	1.197	1.173	1.152	1.128
	both	25	1.376	1.357	1.332	1.296	1.278	1.253	1.231	1.209	1.185	1.163	1.143	1.12
	both	20	1.341	1.324	1.303	1.27	1.254	1.232	1.212	1.192	1.17	1.15	1.132	1.111
	both	15	1.298	1.284	1.266	1.237	1.225	1.205	1.188	1.171	1.152	1.134	1.118	1.1
	both	10	1.238	1.229	1.245	1.192	1.183	1.168	1.155	1.141	1.125	1.112	1.099	1.084
	both	5	1.097	1.095	1.088	1.079	1.077	1.071	1.067	1.062	1.055	1.049	1.045	1.038
	both	0	1	1	1	1	1	1	1	1	1	1	1	1
Stroke	both	600	1.704	1.641	1.587	1.535	1.481	1.436	1.39	1.347	1.306	1.267	1.228	1.191
	both	500	1.664	1.606	1.555	1.506	1.455	1.413	1.37	1.329	1.291	1.254	1.216	1.181

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	both	400	1.619	1.565	1.518	1.472	1.426	1.387	1.346	1.308	1.273	1.238	1.203	1.171
	both	300	1.565	1.516	1.474	1.432	1.39	1.355	1.318	1.283	1.251	1.22	1.187	1.157
	both	200	1.496	1.454	1.418	1.381	1.345	1.314	1.282	1.251	1.223	1.196	1.167	1.14
	both	150	1.453	1415	1.382	1.348	1.315	1.288	1.259	1.231	1.205	1.181	1.154	1.13
	both	135	1.438	1.401	1.37	1.337	1.305	1.279	1.261	1.221	1.199	1.175	1.15	1.126
	both	120	1.421	1.386	1.357	1.325	1.295	1.269	1.243	1.216	1.192	1.169	1.145	1.122
	both	105	1.404	1.37	1.342	1.312	1.283	1.258	1.233	1.208	1.185	1.163	1.139	1.117
	both	90	1.384	1.352	1.326	1.297	1.269	1.246	1.222	1.198	1.177	1.156	1.133	1.112
	both	75	1.362	1.332	1.307	1.28	1.254	1.233	1.211	1.188	1.167	1.148	1.126	1.106
	both	60	1.336	1.309	1.286	1.261	1.237	1.217	1.197	1.175	1.157	1.138	1.118	1.1
	both	45	1.305	1.281	1.261	1.237	1.216	1.198	1.18	1.161	1.144	1.127	1.109	1.091
	both	30	1.265	1.244	1.227	1.207	1.189	1.174	1.158	1.141	1.126	1.112	1.096	1.081
	both	25	1.248	1.229	1.213	1.194	1.177	1.163	1.149	1.133	1.119	1.106	1.091	1.076
	both	20	1.227	1.211	1.196	1.179	1.164	1.151	1.137	1.123	1.11	1.098	1.084	1.071
	both	15	1.202	1.188	1.176	1.16	1.146	1.135	1.123	1.11	1.099	1.088	1.076	1.064
	both	10	1.167	1.155	1.146	1.133	1.122	1.113	1.104	1.093	1.083	1.075	1.064	1.054
	both	5	1.073	1.069	1.066	1.059	1.054	1.051	1.046	1.043	1.039	1.035	1.03	1.025
	both	0	1	1	1	1	1	1	1	1	1	1	1	1
Chronic obstructive pulmonary disease	both	600	2.335	2.335	2.335	2.335	2.335	2.335	2.335	2.335	2.335	2.335	2.335	2.335
	both	500	2.231	2.231	2.231	2.231	2.231	2.231	2.231	2.231	2.231	2.231	2.231	2.231
	both	400	2.114	2.114	2.114	2.114	2.114	2.114	2.114	2.114	2.114	2.114	2.114	2.114
	both	300	1.979	1.979	1.979	1.979	1.979	1.979	1.979	1.979	1.979	1.979	1.979	1.979
	both	200	1.815	1.815	1.815	1.815	1.815	1.815	1.815	1.815	1.815	1.815	1.815	1.815

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both	150	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714	1.714
both	135	1.681	1.681	1.681	1.681	1.681	1.681	1.681	1.681	1.681	1.681	1.681	1.681
both	120	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645	1.645
both	105	1.606	1.606	1.606	1.606	1.606	1.606	1.606	1.606	1.606	1.606	1.606	1.606
both	90	1.564	1.564	1.564	1.564	1.564	1.564	1.564	1.564	1.564	1.564	1.564	1.564
both	75	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518	1.518
both	60	1.466	1.466	1.466	1.466	1.466	1.466	1.466	1.466	1.466	1.466	1.466	1.466
both	45	1.405	1.405	1.405	1.405	1.405	1.405	1.405	1.405	1.405	1.405	1.405	1.405
both	30	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33	1.33
both	25	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
both	20	1.266	1.266	1.266	1.266	1.266	1.266	1.266	1.266	1.266	1.266	1.266	1.266
both	15	1.224	1.224	1.224	1.224	1.224	1.224	1.224	1.224	1.224	1.224	1.224	1.224
both	10	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17	1.17
both	5	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06	1.06
both	0	1	1	1	1	1	1	1	1	1	1	1	1

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Table S2. Garbage code and ICD-10 code

code	disease	ICD-10
GC01	correction for hidden of HIV	A31, A42-44, B37-46, B49, B55, B58-59, D80-84, D89
GC02	hypertension and Atherosclerosis	I10, I15, I6-7
GC03	ill defined death in urogenital and kidney diseases chapter	N32-33, N35, N37, N39, N42-44, N46-48, N50-53, N61-64, N48, N91, N95-97
GC04	ill defined death in Blood, endocrine chapter	D68, E15-19, E37-39, E47-50, E62, E64,E69
GC05	ill defined death in digestive diseases chapter	K00-K30
GC06	ill defined death in disorders of nervous system chapter	G32, G43-44, G47, G50-65, G89, G99
GC07	ill defined death in infectious disease chapter	A59, A71, A74, A97, B07, B30, B35-36, B68, B73-81, B85-88, B94
GC08	ill defined death in Mental disorder chapter	F06-09, F17, F20-99
GC09	ill defined death in musculoskeletal disorders chapter	M10-M99
GC10	ill defined death in R chapter	R07-R99
GC11	ill defined death in sense organ diseases chapter	H00-H99
GC12	ill defined death in skin diseases chapter	L20-L99
GC13	ill defined death in Z and U chapter	U05-U99, Z00-99, ZA1-8, ZB0
GC14	Immediate cause	D65, I46
GC15	injury with undetermined intent	W76, X47, Y10-Y33
GC16	Injury with unknown factor or intend	X59, Y34, Y86-92
GC17	inter-Heart Failur , pulmonary embolisim	I26-28, I50-51
GC18	intermediate - central nervous system	F04, G06-08, G92-93
GC19	intermediate - digestive system	K65-66, K71-75
GC20	intermediate - fluid, electrolyte	E86-87
GC21	intermediate - other	E85, R50, R56-57, R63-65
GC22	intermediate - other CVD	I31, I42-49, I74-76, I96
GC23	intermediate - respiratory	J69, J80-81, J85-86, J90-98
GC24	intermediate - septicemia	A4
GC25	intermediate -in musculoskeletal disorders	M86, M97-98
GC26	Intermediate Kidny and urolology	N13, N17, N19, N32, N82
GC27	special signs	F05, G8-9, I95, K92, N92-95, R00-63
GC28	stroke unspecified	I64, I67-69
GC29	unspecified cause in Mental and nervous	F06-08, F50, G00-09, G15-19,

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	system disorders chapter	G27-29, G33-34, G38-39, G42-49, G66-69, G74-98
GC30	unspecified cause in Cancer chapter	C14, C26-29, C35-36, C39, C42, C46, C55-99, D00-54
GC31	unspecified cause in cardiovascular and circulatory diseases chapter	I00-04, I14-19, I29, I51-59, I9,ID59
GC32	unspecified cause in congenital and neonatal diseases chapter	P06, P16-18, P30-34, P40-49, P62-89, P97-99, Q08-10, Q19, Q29, Q36, Q46-49, Q88-89, Q94, Q99
GC33	unspecified cause in digestive diseases chapter	K31-34, K39, K47-49, K53-54, K63, K69, K75, K78-79, K84, K87-89, K92-93, K96-99
GC34	unspecified cause in infectious disease chapter	A01, A149, A29-30, A45-49, A61-64, A72-73, A76, A99, B08-14, B28-34, B54-55, B61-64, B82-84, B89, B92-99, N70-74, P37
GC35	unspecified cause in injuries chapter	S00-99, SO69, T00-98, TO7, V87-89, V99, W47-48, W63, W71-72, W82, W95-98, X07, X40-44, X49, X55-56, Y09, Y85, Y92-99
GC36	unspecified cause in maternal diseases chapter	O08, O17-19, O27, O37-39, O49-59, O78-79, O93-95
GC37	unspecified cause in musculoskeletal disorders chapter	M04, M28-29, M37-39, M52, M55-59, M64, M69, M74, M78
GC38	unspecified cause in Nutritional, metabolic, endocrine and blood disorder chapter	D50, D59, D62-64, D69, D75, D79, D85, D87-99, E07-08, E12-14, E34-35, E9, R73
GC39	unspecified cause in respiratory diseases chapter	J00-08, J15, J17-19, J22-29, J40, J47-59, J64, J71-79, J83, J85, J87-90, J93, J97-99, P23
GC40	unspecified cause in Skin diseases chapter	L06-07, L09, L15-19, L31-39, L69, L77-79, M44
GC41	unspecified cause in urogenital and kidney diseases chapter	N09, N24, N28, N38, N40, N54-59, N66-69, N78-79, N84-90

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Table S3. Distribution of prevalence of risk factors between subnational levels

		Taiwan	Keelung	Taipei	New Taipei	Taoyuan	Hsinchu	Hsinchu county	Miaoli	Taichung	Changhua	Nantou	Yunlin	Chiayi	Chiayi county	Tainan	Kaohsiung	Pingtung	Taitung	Hualien	Yilan
SBP (mean, sd)	Both	120.63	123.79	120.18	118.56	119.08	119.56	113.97	119.90	117.39	120.35	118.55	124.53	126.04	126.04	121.88	120.63	128.38	133.80	121.56	116.44
		(19.03)	(17.91)	(19.44)	(18.19)	(17.75)	(15.93)	(19.98)	(21.05)	(17.36)	(19.40)	(18.71)	(19.77)	(18.14)	(18.14)	(18.97)	(18.53)	(19.19)	(25.64)	(18.59)	(17.69)
	Male	124.18	131.48	123.08	121.85	122.4	122.88	115.10	122.13	121.17	123.50	124.08	127.65	129.47	129.47	127.43	124.11	131.01	142.80	119.88	120.99
		(17.09)	(15.73)	(16.44)	(16.49)	(16.45)	(13.06)	(11.81)	(18.68)	(16.88)	(16.30)	(17.64)	(18.73)	(17.07)	(17.07)	(17.17)	(16.93)	(16.94)	(22.65)	(16.14)	(15.85)
	Female	117.56	116.11	117.73	115.77	116.27	116.23	113.02	117.95	113.72	117.46	113.98	121.69	122.93	122.93	117.38	117.78	125.87	126.98	123.12	113.06
		(20.06)	(16.89)	(21.37)	(19.09)	(18.37)	(18.00)	(24.93)	(22.95)	(17.09)	(21.49)	(18.43)	(20.36)	(10.74)	(10.74)	(19.20)	(19.32)	(20.88)	(26.02)	(20.80)	(18.34)
FPG (mean, sd)	Both	92.43	94.59	90.09	89.00	91.71	84.68	91.17	90.63	93.69	93.51	94.25	99.64	89.91	89.91	92.43	94.59	98.02	99.10	105.59	89.00
		(27.20)	(23.60)	(25.95)	(23.42)	(26.13)	(10.81)	(16.40)	(29.00)	(32.07)	(27.21)	(27.75)	(33.15)	(25.50)	(25.50)	(21.80)	(29.37)	(36.40)	(30.99)	(44.32)	(18.38)
	Male	93.51	96.04	89.55	90.09	91.71	88.11	93.87	94.77	92.07	94.24	97.30	98.38	89.19	89.19	95.50	95.68	100.72	100.72	103.96	92.79
		(27.93)	(29.73)	(19.64)	(25.05)	(21.80)	(10.45)	(20.90)	(40.18)	(28.65)	(29.19)	(33.87)	(25.22)	(19.82)	(19.82)	(27.03)	(29.37)	(42.34)	(38.02)	(45.41)	(26.49)
	Female	91.71	92.97	90.63	88.29	90.09	81.26	88.83	86.67	95.14	92.97	91.35	100.90	90.63	90.63	89.91	93.87	95.68	97.66	107.03	107.03
		(26.49)	(15.86)	(30.27)	(22.16)	(29.55)	(4.68)	(11.53)	(10.63)	(35.14)	(25.23)	(21.44)	(39.46)	(28.29)	(28.29)	(15.86)	(29.55)	(25.59)	(25.59)	(44.14)	(44.14)
LDL (mean, sd)	Both	110.81	110.81	110.04	109.27	108.49	105.41	106.56	110.81	110.04	108.11	106.56	116.99	116.22	116.22	115.06	113.13	107.34	121.62	112.74	113.51
		(32.82)	(30.89)	(31.27)	(32.05)	(32.82)	(28.19)	(32.82)	(26.25)	(31.66)	(29.73)	(33.59)	(37.07)	(34.36)	(34.36)	(33.59)	(34.36)	(37.45)	(35.52)	(40.15)	(33.59)
	Male	112.74	111.97	113.13	113.9	111.97	105.79	110.81	111.58	113.13	107.72	112.36	112.74	117.76	117.76	117.38	115.44	103.09	111.97	104.63	118.53
		(33.20)	(28.57)	(31.27)	(32.05)	(34.36)	(30.12)	(35.91)	(26.64)	(32.05)	(29.34)	(35.14)	(35.52)	(33.59)	(33.59)	(33.59)	(32.43)	(41.70)	(34.36)	(42.08)	(34.75)
	Female	109.27	109.65	107.72	105.79	105.79	105.02	103.09	110.43	107.34	108.88	102.32	120.85	115.06	115.06	113.13	111.58	111.58	129.73	120.85	109.27
		(32.43)	(33.20)	(30.89)	(32.05)	(31.27)	(26.25)	(30.12)	(26.64)	(30.89)	(30.12)	(32.05)	(38.22)	(34.75)	(34.75)	(33.59)	(35.90)	(32.82)	(34.75)	(37.07)	(32.43)
BMI (mean, sd)	Both	22.88	23.20	22.48	22.88	22.96	22.34	22.54	22.61	22.56	22.95	22.80	22.83	22.73	23.03	23.00	23.08	23.17	23.88	23.23	22.89
		(4.49)	(4.40)	(4.21)	(4.62)	(4.53)	(4.43)	(4.48)	(4.50)	(4.48)	(4.56)	(4.23)	(4.34)	(4.35)	(4.57)	(4.44)	(4.46)	(4.51)	(4.96)	(4.83)	(4.56)
	Male	23.58	23.77	23.37	23.68	23.60	23.15	22.37	23.24	23.22	23.40	23.19	23.44	23.58	23.63	23.78	23.77	23.64	24.65	23.71	23.90
		(4.55)	(4.44)	(4.22)	(4.88)	(4.57)	(4.51)	(4.55)	(4.61)	(4.48)	(4.62)	(4.38)	(4.19)	(4.41)	(4.59)	(4.38)	(4.58)	(4.48)	(5.30)	(4.76)	(4.54)
	Female	22.16	22.62	21.64	22.07	22.69	21.53	21.66	21.90	21.90	22.49	22.40	22.14	21.92	22.36	22.20	22.39	22.67	23.05	22.73	21.82
		(4.32)	(4.03)	(4.03)	(4.20)	(4.39)	(4.20)	(4.24)	(4.37)	(4.37)	(4.45)	(4.05)	(4.41)	(4.14)	(4.46)	(4.38)	(4.21)	(4.49)	(4.46)	(4.85)	(4.33)
HBV (%)	Both	14.21	16.87	12.51	16.87	12.65	12.65	12.65	12.65	13.89	13.89	13.89	11.47	11.47	11.47	11.47	16.06	16.06	18.44	18.44	18.44
	Male	17.01	20.73	15.24	20.73	16.48	16.48	16.48	16.48	17.51	17.51	17.51	12.33	12.33	12.33	12.33	18.62	18.62	20.29	20.29	20.29
	Female	11.59	12.96	10.04	12.96	9.29	9.29	9.29	9.29	10.42	10.42	10.42	10.7	10.7	10.7	10.7	13.7	13.7	16.67	16.67	16.67

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HCV (%)	Both	4.91	3.81	2.94	3.81	3.17	3.17	3.17	3.17	4.28	4.28	4.28	6.48	6.48	6.48	6.48	5.63	5.63	12.50	12.50	12.50
	Male	4.01	1.85	2.25	1.85	1.07	1.07	1.07	1.07	4.08	4.08	4.08	6.71	6.71	6.71	6.71	5.15	5.15	8.63	8.63	8.63
	Female	5.71	5.52	3.53	5.52	4.99	4.99	4.99	4.99	4.46	4.46	4.46	6.28	6.28	6.28	6.28	6.04	6.04	15.57	15.57	15.57
Alcohol (%)	Both	26.31	30.89	32.67	32.36	29.92	23.64	28.09	23.93	27.03	22.03	25.81	22.04	23.33	20.2	22.2	24.01	23.79	36	32.42	25.46
	Male	36.09	41.49	40.61	38.54	40.02	31.89	36.21	36.38	34.87	34.26	36.87	35.51	35.49	32.27	29.28	32.6	34.35	46.66	45.91	35.51
	Female	16.3	20.31	25.4	26.01	18.97	15.15	19.92	10.9	19.21	9.36	14.42	7.18	11.93	7.66	15.02	15.18	12.76	24.21	18.56	14.74
Betel nut (%)	Both	6.53	4.37	3.22	6.16	6.07	4.37	5.62	6.97	4.1	6.73	7.45	8	7.3	10.03	4.39	4.17	8.62	19.73	12.72	8.2
	Male	11.77	8.06	6.43	11.05	9.85	8.2	11.2	13.38	8.22	12.82	14.12	15.04	15.07	19.19	8.36	7.96	13.48	25.17	21.13	15.64
	Female	1.18	0.69	0.28	1.12	1.97	0.42	0	0.28	0	0.4	0.6	0.23	0	0.53	0.38	0.27	3.54	13.68	4.07	0.28
Smoking (%)	Both	19.76	25.24	17.17	21.68	23.85	17.94	17.26	21.78	18.61	16.89	20.82	22.18	17.2	20.98	17.85	17.46	21.09	26.66	26.32	23.14
	Male	34.27	37.56	28.13	35.23	38.56	32.37	30.56	36.93	31.79	30.59	37.41	38.58	31.46	37.4	30.37	29.9	36.66	40.63	43.09	38.07
	Female	4.89	11.57	6.57	7.13	7.58	3.08	3.36	2.93	4.77	2.23	3.03	3.82	2.17	2.91	4.17	3.33	4.27	9	8.63	6.32
Secondhand smoke (%)	Both	46.99	50.47	46.86	56.14	50.15	41.85	38.56	38.58	49.8	42.02	43.44	50.5	51.04	46.19	45.12	47.18	45.69	51.38	47.85	53.48
	Male	49.66	51.94	51.06	59.25	51.92	46.93	40.79	39.66	51.3	44.26	43.39	56.99	54.23	50.52	47.03	51.37	50.04	54.22	45.15	55.14
	Female	45	49.38	43.73	53.81	48.81	37.92	36.87	37.77	48.66	40.25	43.48	45.74	48.77	43.1	43.66	43.91	42.49	49.23	49.73	52.23
Physical activity content (mean, sd)	Both	2521.7 (5343.5)	2191.74 (4459.9)	2411.25 (3707.8)	2640.85 (4520.5)	2019.39 (3695.9)	2004 (5445.9)	2464.05 (4823.8)	2413.44 (4024.0)	2129.12 (3797.7)	2901.2 (5003.2)	3050.15 (5041.7)	2688.35 (4600.2)	2159.22 (4194.2)	3004.08 (5538.3)	1887.03 (3619.3)	2193.76 (3759.9)	3564.51 (1389.5)	3794.78 (5925.6)	3054.43 (6145.8)	2622.83 (5151.3)
	Male	3302.85 (5423.5)	285272 (4976.5)	2878.73 (4041.6)	3382.27 (5582.2)	2699.27 (4568.6)	2811.26 (7233.7)	3261.95 (5708.3)	3149.73 (4790.2)	2811.5 (4543.8)	3744.1 (5759.9)	4294.91 (6362.0)	3704.79 (5558.3)	3172.15 (5504.6)	3981.46 (6621.9)	2420.83 (4220.6)	2828.7 (4233.7)	3932.42 (5925.6)	4841.59 (6977.7)	4207.8 (6643.5)	3486.9 (6036.7)
	Female	1721.7 (5137.1)	1532.21 (3745.6)	1983.66 (3285.8)	1877.64 (2979.3)	1282.04 (2172.5)	1172.86 (2138.7)	1661.99 (3557.7)	1642.77 (2752.9)	1449.37 (2659.2)	2027.72 (3809.4)	1767.66 (3008.6)	1567.34 (2987.6)	1208.44 (1843.6)	1989.73 (3902.8)	1345.41 (2793.3)	1540.59 (3050.5)	3180.04 (1903.5)	2636.32 (4318.8)	1868.88 (5313.2)	1701.01 (3797.5)
PM2.5 (mean, sd)	Both	30.07 (20.25)	18.4 (12.67)	25.55 (15.74)	28.17 (16.75)	25.68 (17.61)	30.14 (17.77)	30.14 (17.77)	26.82 (17.76)	30.16 (18.25)	34.37 (20.07)	34.05 (20.55)	37.16 (22.72)	40.44 (24.82)	40.44 (24.82)	39.26 (21.59)	41.09 (22.58)	42.95 (20.20)	13.09 (8.93)	18.38 (10.72)	20.80 (12.23)

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Table S4. Comparison of prevalence of metabolic risk factors

		TW3H 2007*	This study
SBP (mean, sd)			
	Male	125.18 (16.99)	124.18 (17.09)
	Female	118.49 (20.09)	117.56 (20.06)
FPG (mean, sd)			
	Male	93.44 (28.34)	93.51 (27.93)
	Female	91.61 (26.56)	91.71 (26.49)
LDL (mean, sd)			
	Male	112.81 (33.27)	112.74 (33.20)
	Female	109.37 (32.54)	109.27 (32.43)

*Report of hypertension, hyperglycemia and hyperlipidemia in Taiwan, Ministry of Health and Welfare, 2007

Table S5. Comparison of prevalence of behavioral risk factors

		Literature Review	This study
Smoking (%)[1]			
	Male	34	34.3
	Female	4.8	4.9
Secondhand smoke (%)[1]	Male	62	50
	Female	51	45
Alcohol (%)[2]			
	Both	32	26
Betel nut (%)[3]			
	Male	10	11.7
	Female	0.7	1.1

[1]A population study on the time trend of cigarette smoking, cessation, and exposure to secondhand smoking from 2001 to 2013 in Taiwan, Chi-Yung Chiang, 2016

[2] 台灣成年族群飲酒型態與事故傷害、酒駕之關係探討, 楊涵纖, 2018

[3] https://olap.hpa.gov.tw/index.aspx , Ministry of Health and Welfare, 2019

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