Country Health Profile:

NON-COMMUNICABLE DISEASES IN SINGAPORE

BSc Global Health
Module 2 In-Course Assessment 1

Word Count: 2521

Non-communicable diseases in Singapore

ABSTRACT

Background

Singapore is undergoing the epidemiologic transition, in which the burden of disease has changed from that of infectious diseases to non-communicable diseases (NCDs). This narrative review explores the rise of main chronic NCDs in Singapore in terms of its epidemiology, and looks at the changes in modifiable risk factors associated with NCDs.

Methods

A MEDLINE literature search was performed using MeSH terms such as “chronic disease”, “cardiovascular disease”, “coronary disease”, “hypertension”, “diabetes mellitus”, “obesity”, “cancer”, “high/elevated blood pressure” and “Singapore” to obtain relevant articles. Key reports were downloaded directly from the Ministry of Health (MOH) and Department of Statistics websites.

Results

The leading causes of mortality and disease burdens in Singapore today are mostly NCDs, including cancers, cardiovascular diseases (CVDs) and diabetes mellitus. In terms of risk factors, there are improvements in hypertension, smoking and physical activity, whereas the prevalence of obesity and unhealthy diets have continued to rise.

Conclusion

The rise of some cancers, diabetes and CVDs can be attributed to increases in the prevalence of modifiable risk factors. Nonetheless, effective health promotion strategies have reversed some of these trends, demonstrating the need for future prevention strategies to be informed by a sound evidence-base.

THE EPIDEMIOLOGICAL TRANSITION

The Republic of Singapore is a small city-state with a population exceeding 5 million and a total land area of about 712.4 square kilometres,[1] making it one the most densely populated countries in the world (Table 1). From the fishing village several decades ago to the modern first world country today, Singapore's economic growth and rate of urbanization has been phenomenal. A corollary of such rapid industrialization is the epidemiologic transition, in which the main disease burden has shifted from infectious diseases and nutritional deficiencies (Group I causes) to chronic non-communicable diseases (Group II causes).

Demographic trends

Figure 1 shows a rapidly ageing population in Singapore. Rapid reductions in fertility and mortality rates and increases in life expectancy contributed to this phenomenon. Life expectancy at birth and infant mortality rate have visibly improved, whereas crude mortality rate in Singapore has fallen slightly (Table 1).[2]

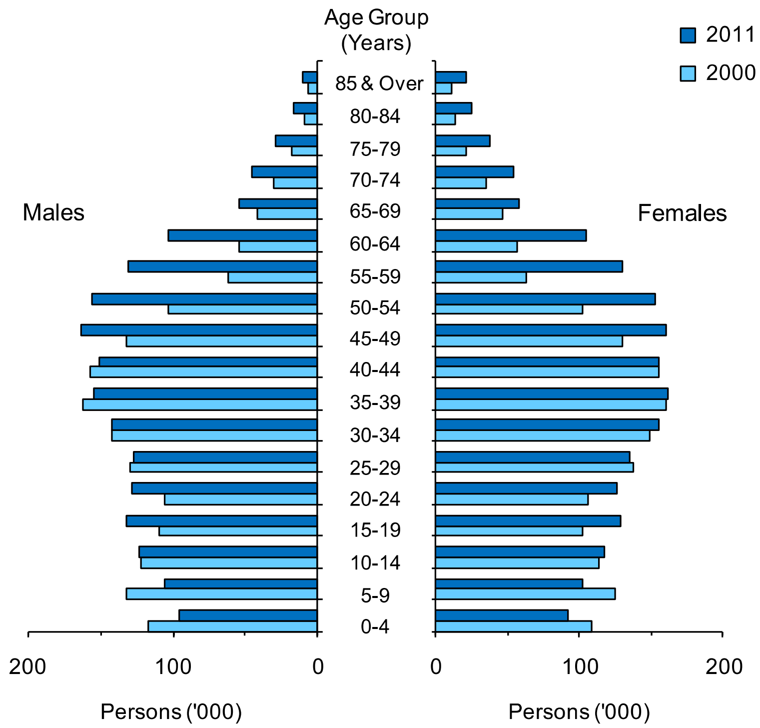

Fig 1. Age pyramid of Singapore's resident population.[2]

As Singapore undergoes the epidemiologic transition, the pattern of mortality shifts from Group I causes at younger ages to Group II causes (NCDs) at older ages (Table 2).[3]

Table 1. Summary of demographic trends and selected key health indicators in Singapore, 1970-2010.[2]

Indicator	1970	1980	1990	2000	2010
Population					
Total Population ('000s)	2,074.5	2,413.9	3,047.1	4,027.9	5,076.7
Population density (total population per sq km)	3,538	3,907	4,814	5,900	7,126
Old-Age Support Ratio[a]	17.0	13.8	11.8	9.9	8.2
Mortality					
Total Deaths	10,717	12,505	13,891	15,693	17,610
Crude Death Rate (per 1000 residents)	5.2	4.9	4.7	4.5	4.4
Infant Mortality Rate (per 1000 resident live-births)	20.5	8.0	6.6	2.5	2.0
Life Expectancy at Birth (years)	65.8	72.1	75.3	78.0	81.8

[a]Number aged 15-64 years per elderly aged ≥65 years.

Table 2. Principle causes of death in Singapore.[3]

Causes of mortality[a]	2007	2008	2009
	Percentage of total deaths		
1. Cancer	27.7	29.3	29.3
2. Ischaemic heart disease	19.8	20.1	19.2
3. Pneumonia	13.9	13.9	15.3
4. Cerebrovascular disease (including stroke)	8.7	8.3	8.0
5. Accidents, poisoning and violence	6.0	5.8	5.7
6. Other heart diseases	4.3	4.0	4.4
7. Urinary tract infections	2.2	2.1	2.5
8. Chronic obstructive lung disease	2.6	2.5	2.4
9. Nephritis, nephrotic syndrome and nephrosis	2.0	2.1	2.3
10. Diabetes mellitus	3.6	2.7	1.7

[a]Based on International Classification of Diseases 9 (ICD 9).

Changing burden of disease

Applying methods used by the WHO's Global Burden of Disease (GBD) Study 2004, the Singapore Burden of Disease Study 2004 was conducted to quantify disease burden in terms of disability-adjusted life years (DALYs).[4] The results, grouped by major disease categories (Figure 2a) and specific leading causes of death (Figure 2b), shows how Singapore's disease burden profile broadly matches that of a high-income country, where majority of the burden comes from chronic conditions. Five of the top fifteen causes of disease burdens—diabetes mellitus, ischaemic/coronary heart disease (IHD/CHD), stroke, lung cancer and Alzheimer's disease and other dementias—were also featured in the top ten leading causes of death for high-income countries based on the WHO's GBD Study.[5]

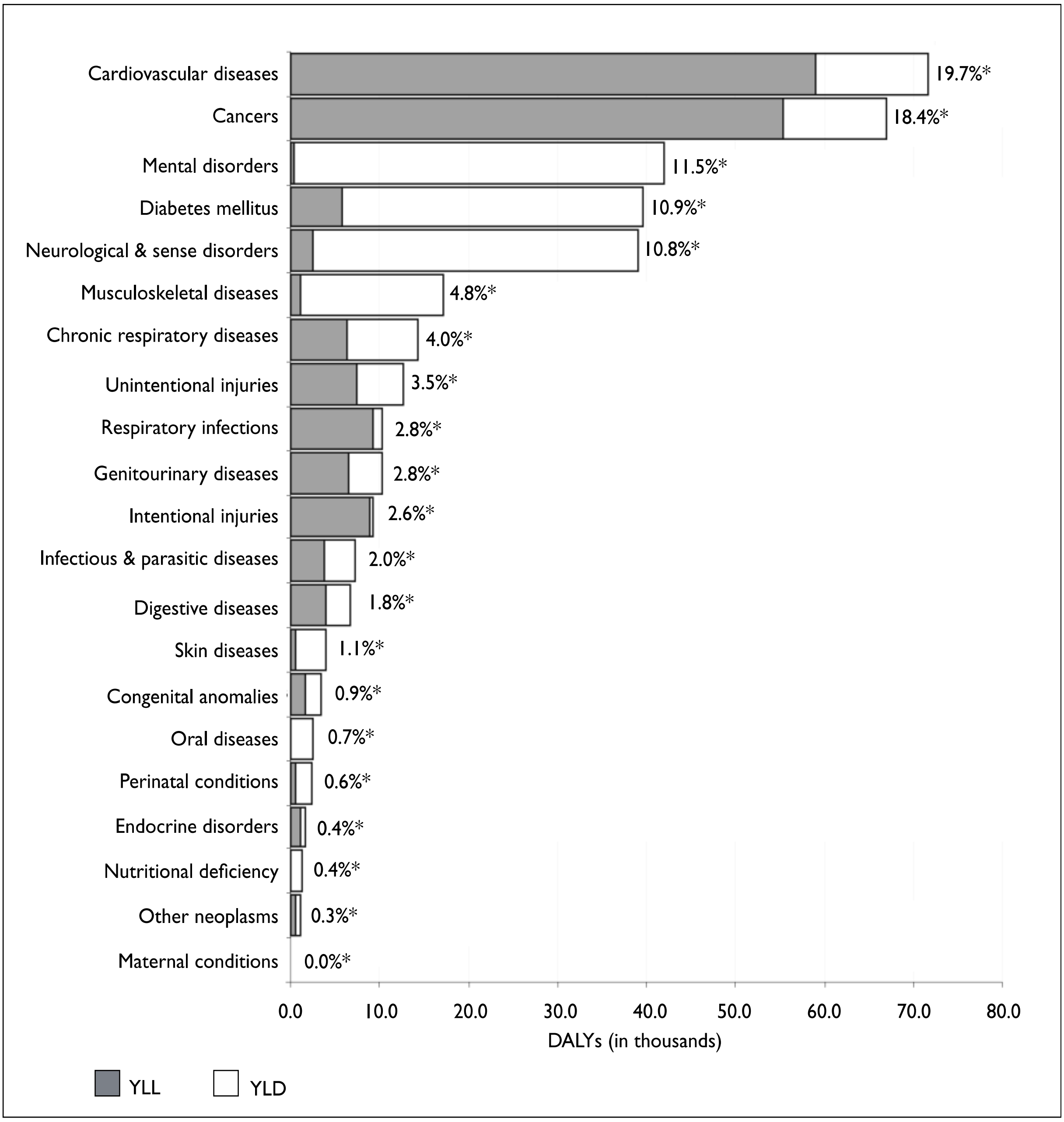

Fig 2a. Burden of disease by major disease categories in Singapore 2004.[4] The DALY is computed as the sum of YLL and YLD.

*values refer to percentage of DALYs for each disease category

[YLL, years of life lost due to premature death; YLD, years of life lost due to disability]

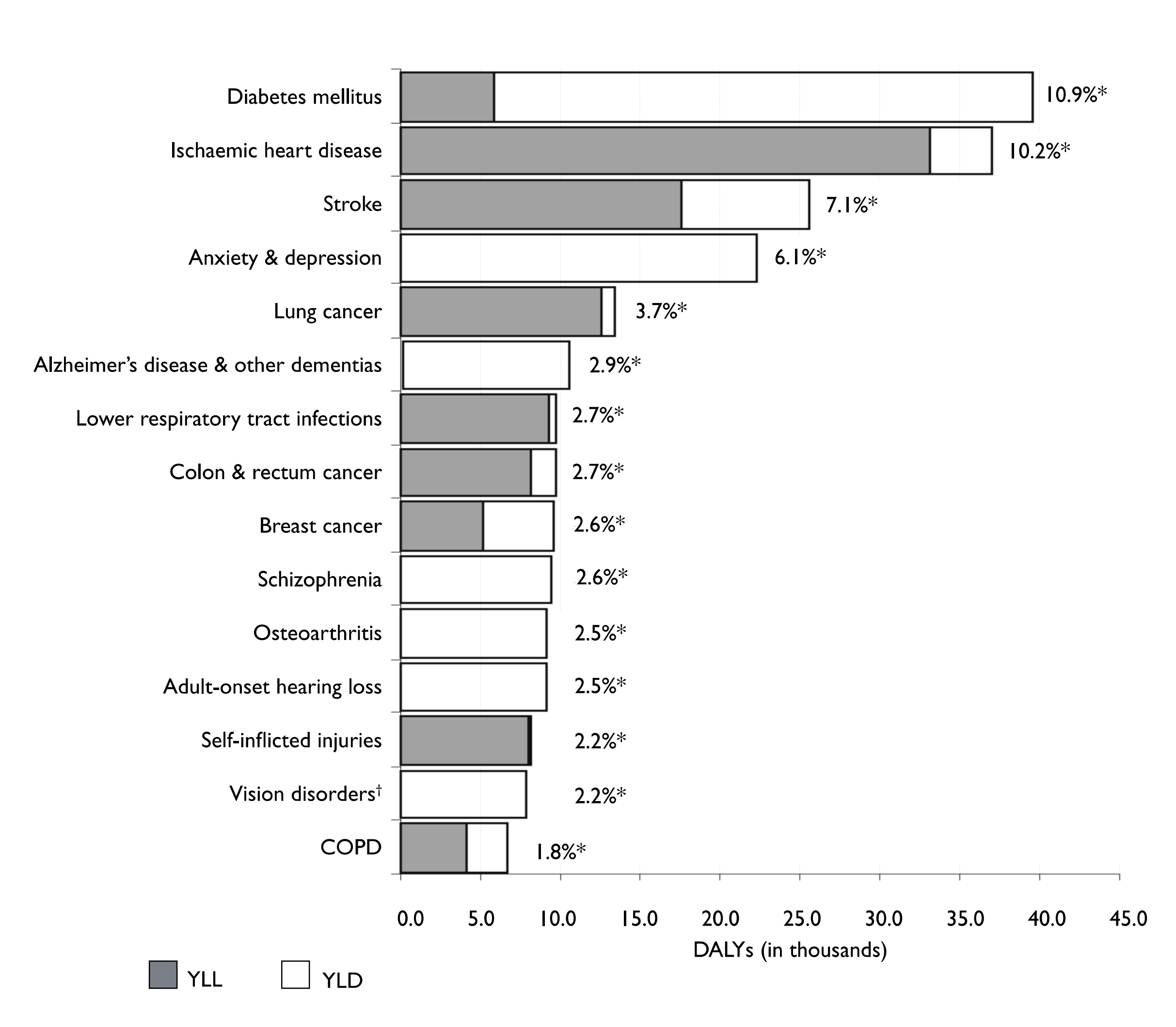

Fig 2b. Burden of disease for top 15 leading causes of death in Singapore 2004.[4]
[COPD, chronic obstructive pulmonary disease]

EPIDEMIOLOGY OF CHRONIC NON-COMMUNICABLE DISEASES

Table 3 gives the WHO's 2008 estimates of age-standardized death rates for NCDs in Singapore.[6] Globally this might not be considered high, but compared to her regional neighbours in southeast Asia, Singapore has a considerably higher proportion (about 80%) of total deaths attributable to NCDs.[7]

Table 3. Age-standardized death rates due to NCDs in Singapore, 2008, by gender.[6]

	Age-standardised death rates per 100,000 population			
	All NCDs	**Cancers**	**Cardiovascular diseases & Diabetes mellitus**	**Chronic respiratory diseases**
Gender				
Males	372.1	141.6	171.2	22.6
Females	238.8	90.2	108.9	7.2

Cancers

The Singapore Cancer Registry (SCR) has been collecting data on cancer incidence and survival trends since 1968. By 2009, cancer has become the number one killer in Singapore.[3] Table 4 compares the incidence and mortality rates of all cancers in Singapore and selected regions.[8]

Table 4. Age-standardised rates of incidence and mortality of all cancers in Singapore, southeast Asia and developed regions, 2008. Data obtained from GLOBOCAN 2008, International Agency for Research on Cancer (IARC).[8]

REGION / GENDER	Incidence		Mortality	
	ASIR[a]	**Risk of getting cancer before age 75 (%)[b]**	**ASMR[a]**	**Risk of dying from cancer before age 75 (%)[b]**
Developed regions	**255.8**	**25.7**	**111.1**	**11.8**
Males	299.2	30.0	143.1	14.9
Females	226.3	22.1	87.2	9.1
Southeast Asia	**141.4**	**14.6**	**99.5**	**10.6**
Males	143.9	15.2	112.3	12.0
Females	141.6	14.2	89.4	9.4
Singapore	**196.0**	**19.6**	**90.1**	**9.4**
Males	208.2	21.0	110.0	11.5
Females	188.4	18.4	73.3	7.6

[a]Age-standardised rates for incidence (ASIR) or mortality (ASMR) are calculated based on new cases or deaths per 100,000 person-years respectively, using the world standard population as the standard age structure.

[b]Probability of individuals getting or dying from cancer before the age of 75; expressed as a percentage of the number of new born children (out of 100) who would be expected to develop or die from cancer before the age of 75 if they had the corresponding cancer rates (in the absence of other causes of death).

Compared to southeast Asia, Singapore had a higher ASIR for all cancers and a higher risk of developing cancer. Although this might reflect better diagnostic capabilities in Singapore, it is still worrying that the incidence rates are rapidly approaching those of developed regions. Furthermore, from 1998-2002, the cancer incidence rates for Singaporean Chinese are almost comparable to developed economies in parts of Europe and Asia.[9]

Figures 3a and 3b show the ten most common cancers for males and females in Singapore respectively,[10] whereas Figures 4a and 4b show the time trends of selected cancers in both sexes from 1968 to 2007.[11]

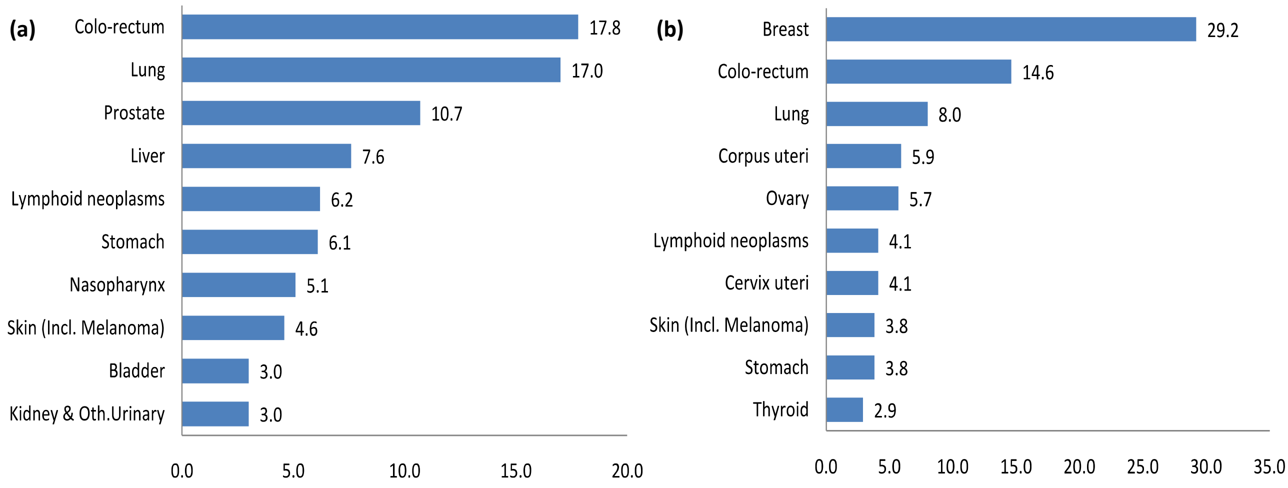

Fig 3. Ten most frequent cancers (%) in Singaporean **(a)** males and **(b)** females, 2004-2008.[10]

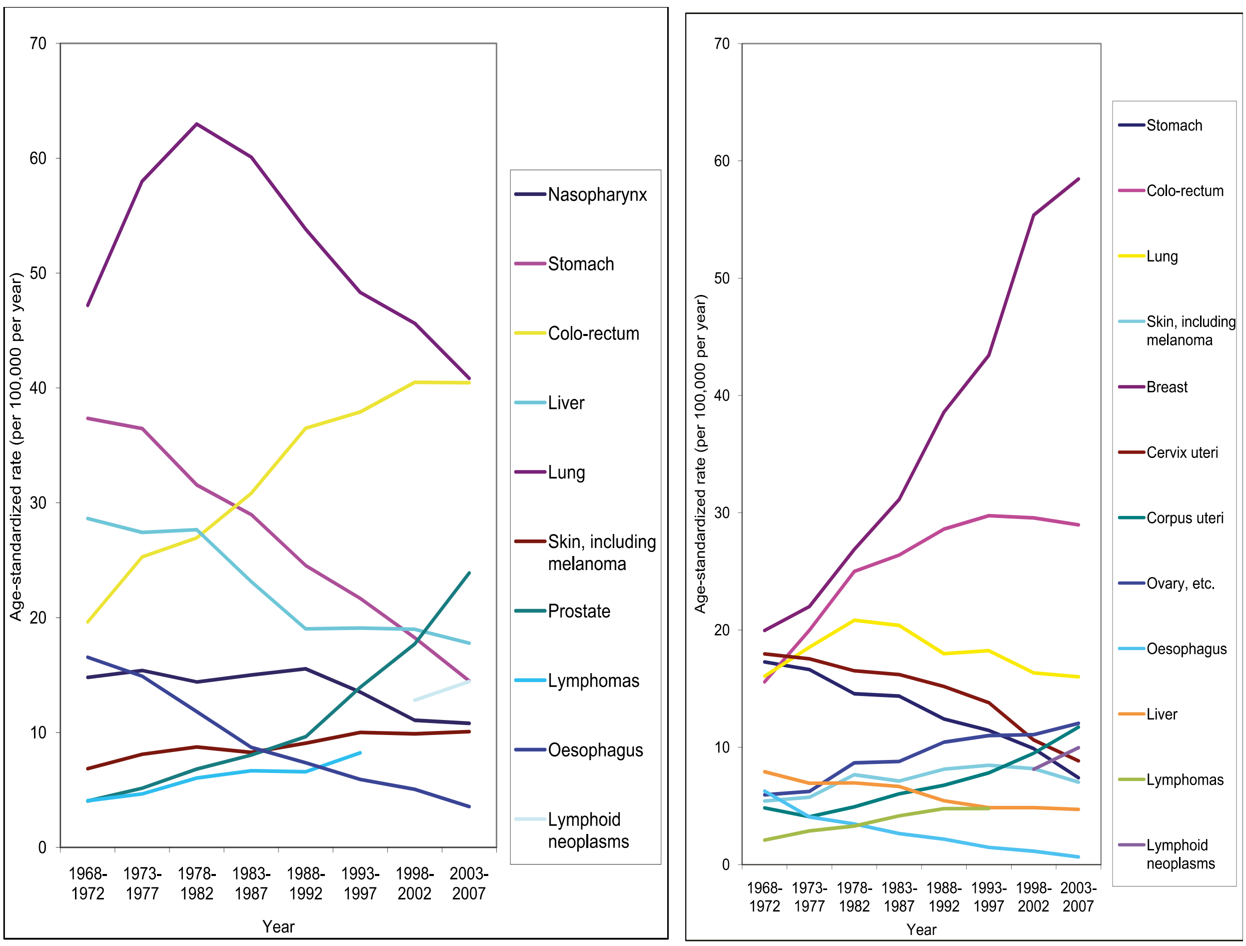

Fig 4. Trends in age-standardised incidence rates of selected cancers in Singaporean males (left) and females (right), 1968-2007.[11]

Colorectal cancer is most common in adult Singaporean males, particularly those in their most productive years (working-age group: 15-64 years).[11] The incidence rate for colorectal cancer in 2008 was 41.6 per 100,000 person-years, almost comparable to the average for Europe and higher than the average for North America.[8]

The downward trend in lung cancer incidences belies the severity of lung cancer as a public health issue for Singapore. The close gap between the incidence and mortality rates for lung cancer (Figure 5a and 5b) suggests a high case-fatality ratio.[11] Despite an upward trend in survival, the 5-year relative survival ratio stood at less than 10% for Singaporean males, suggesting a poorer prognosis than most other cancers.

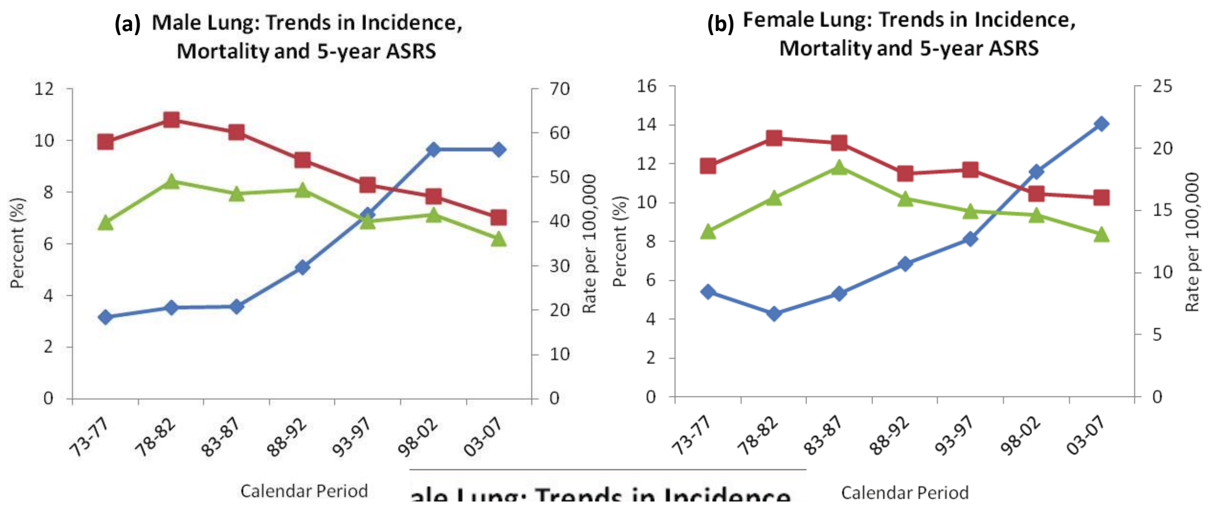

Fig 5. Trends in age-standardized relative survival ratio (ASRS), age-standardised incidence rate (ASIR) and age-standardised mortality rate (ASMR) of lung cancer in Singapore **(a)** males and **(b)** females, 1968-2007.[11]

Breast cancer has the highest incidence in females regardless of ethnicity. This was attributed, in part, to the increased use of mammographic screening especially for women above 50 years old.[12] There is increasing evidence that improvements in socioeconomic conditions have contributed to the increase in risk factors for developing breast cancer, such as lower parity and delaying of childbirth until a later age.[13,14]

Diabetes mellitus

Type 2 diabetes (T2D), characterized by insulin resistance and hyperinsulinaemia, has significantly increased in prevalence as Singapore undergoes rapid urbanization.[15] T2D was the largest single cause of disease burden in 2004.[4] In 2010, one in nine (11.3%) Singaporeans were diabetic, an increase from the 9.0% in 2004. Diabetes was more prevalent in males, amongst Malays and in older age groups.[16]

The Singapore Chinese Health Study (SCHS), a prospective cohort study of 63,257 ethnic Chinese in Singapore, found that diabetics had a 50% higher risk of developing colorectal cancer than non-diabetics, after adjustment for age, sex, dialect group, education level, body mass index (BMI), tobacco and alcohol use, and familial history of colorectal cancer.[17] Using data from the 1992 NHS, Lim *et al.* showed that insulin-resistant overweight/obese individuals had a higher burden of cardiovascular dysmetabolic syndrome compared with those who were insulin-sensitive.[18] Several earlier studies support the higher prevalence of diabetes in ethnic minorities. Amongst them, Ang *et al.* found that hyperinsulinaemia was significantly associated with elevated blood pressure only in Malay women;[19] although another prospective cohort study found that diabetes was associated with a higher risk of IHD in Asian Indians compared to Chinese and Malays.[20]

Cardiovascular diseases

Diabetes is also an established risk factor for some cardiovascular diseases (CVDs),[21] the category of NCDs that collectively accounts for the largest disease burden in 2004.[4] Together, CVD and diabetes account for about 46% of the total death rate attributable to NCDs in both males and females.[6] By 2009, one in three Singaporeans will die of a heart disease or stroke.[3]

As early as 1987, the rising trend of CVD mortality has been documented in Singapore.[22] The Singapore Cardiovascular Cohort Study (SCCS) is a large prospective cohort study combining data from 3 previous cross-sectional surveys that looked at incidence and mortality due to CHD and stroke, the two main CVDs in Singapore. After adjustment for age and all other risk factors, Indian males were found to be three times more likely to develop CHD than their Chinese (hazard ratio [HR] = 3.1, 95% confidence interval [CI] 2.0-4.8) and Malays (HR = 3.4, 95% CI 1.8-3.3) counterparts.[23]

Several studies have noted the need for an Asian perspective when assessing the risk of CVD mortality. Chan *et al*. found that the Global Registry of Acute Coronary Events (GRACE) risk score, which was developed based on a largely European cohort, underestimated the in-hospital mortality across all ethnic groups in Singapore.[24] Other studies highlighted the need for a re-assessment of the international cut-off values for cardiovascular risk factors in Asian populations.[25,26] Even within Asia, differences exist and dietary fat and hypercholesterolaemia have been hypothesized to contribute to the early rise in CHD in Singapore compared to Hong Kong and mainland China.[27]

RISK FACTORS FOR CHRONIC NCDs

Odegaard *et al.* found that regardless of whether participants had a history of CVD or diabetes at baseline, a combination of 6 different modifiable risk factors (diet, physical activity, sleep, BMI, alcohol and tobacco use) produced a graded, inverse association with CVD mortality.[28] In 1992, the Ministry of Health conducted the National Health Survey (NHS) to monitor lifestyle-related health risk factors amongst Singaporeans. Compared to the NHS 2004, results from the NHS 2010 in a random sample of 7,695 Singaporeans aged 18-79 years showed significant increases in the prevalence of obesity, smoking and diabetes mellitus.[16]

Hypertension

From 1980 to 2008, the systolic blood pressures (SBP) for males and females have declined in high-income countries in Asia-Pacific.[29] Encouraging results from international studies

(Figure 6) and national surveys (Table 5) both show that the prevalence of hypertension in Singapore has declined. Nevertheless, Singaporean men and women aged 15 years and above still had the highest and second highest age-adjusted estimated mean SBP, respectively, amongst countries in southeast Asia.[7]

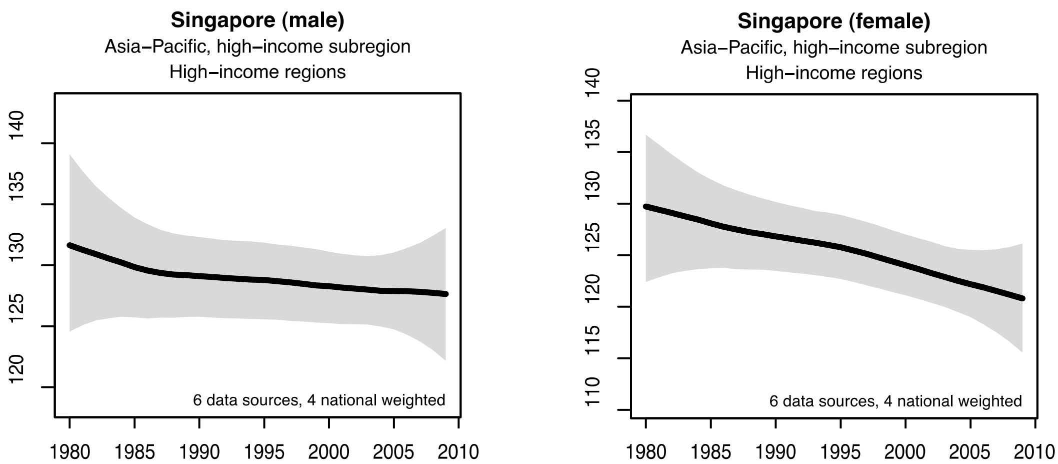

Fig 6. Trends in age-standardized mean SBP for Singapore between 1980 and 2008. The solid line represents the posterior mean trend estimate and the shaded area the uncertainty interval.[29]

Table 5. Trends in age-standardised prevalence (%) of hypertension by gender and ethnic group. Data obtained from National Health Survey 2010.[16]

GENDER / ETHNICITY	Age-standardised prevalence (%)			
	1992	**1998**	**2004**	**2010**
TOTAL	**27.7**	**32.5**	**26.8**	**23.5**
Gender				
Males	31.4	35.3	25.9	26.4
Females	24.0	29.6	22.3	20.7
Ethnic Group				
Chinese	27.5	31.7	27.1	23.4
Malays	31.1	40.5	25.1	28.0
Indians	24.5	29.4	24.1	19.3

Data from the SCCS found that hypertensive individuals, with or without CVD risk factors, were at an increased risk of all-cause and CVD mortality,[30] with a dose-response relationship between the number of CVD risk factors and the risk of mortality. Pre-hypertension, whilst not independently associated with CVD mortality, was associated with an increase in all-cause or CVD mortality in the presence of diabetes, smoking or personal history of CVD.[31]

Gan *et al.* using data from military conscripts (males aged 17-23 years old) demonstrated a strong association between hypertension (independent of white-coat hypertension) and obesity, suggesting that the problem of hypertension in young adults may be underestimated.[32] This is supported by studies showing that younger individuals with hypertension were more likely to be unaware of their BP status.[33]

Diet

A consequence of the nutrition transition is the shift towards energy dense diets that are rich in saturated fats, animal protein, sugars and processed food.[34] The National Nutrition Survey (NNS) found that the proportion of Singaporeans with an excess intake of energy, total fat, saturated fat and cholesterol increased from 1998 to 2004.[35] A higher dietary intake of saturated fats and cholesterol has been found in Singaporean Chinese compared to Hong Kong Chinese, potentially accounting for the higher CVD mortality in Singapore.[27,36] In 2010, 39% of total dietary fat consumed by the average Singaporean was saturated fat – this was 1.3 times the recommended proportion. The Salt Intake Study 2010 found that individual salt intake rose to 8.3 g/day, almost 1.7 times the recommended level of less than 5 g/day.[37] Younger and working adults had the highest rates of salt intake (Figure 7).

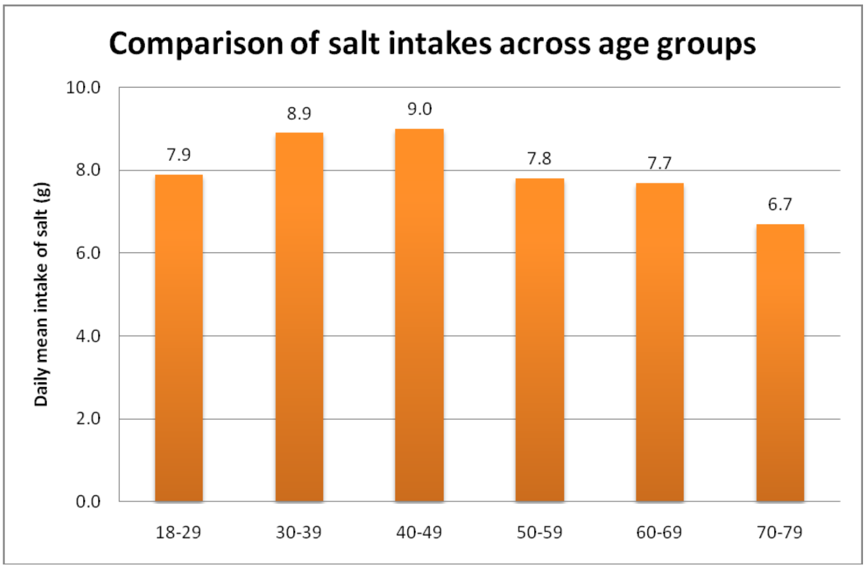

Fig 7. Salt intakes by age group amongst Singaporeans, Salt Intake Study, National Nutrition Survey 2010.[37]

Seow *et al.* found that a higher intake of red meat and lower intake of vegetables were independently associated with an increased risk of colorectal carcinoma.[38] Marine n-3 polyunsaturated fatty acid intake was also positively associated with an increased risk of advanced colorectal cancer.[39] Muella *et al.* found that consuming 2 or more sugar-sweetened carbonated beverage was significantly associated with an increased risk of pancreatic cancer.[40] Principal component analysis of data from the SCHS found two major dietary patterns in Singaporean Chinese: the VFS pattern that is rich in vegetables, fruits and soy was inversely associated with risk of T2D; whereas the DSM pattern rich in dim sum, processed meat, sweetened and fried food was positively associated with risk of T2D.[41]

Obesity

Obesity is a well-known risk factor for CVD, T2D and some cancers. International comparisons show that Singaporean males had one of the lowest BMI amongst high-income countries,[42] and local school-based programs to tackle childhood obesity have proven to be successful.[43] However, data from the NHS 2010 still found an increasing prevalence of obesity,[16,44] notably in males and Malays (Table 6). Because BMI does not take into account body composition, abdominal fatness was also measured.

Table 6. Trend in age-standardised prevalence (%) of obesity and abdominal fatness by gender and ethnic group. Data obtained from National Health Survey 2010 and National Health Survey 2004.[16,44]

GENDER / ETHNICITY	Age-standardised prevalence (%)			
	1992	**1998**	**2004**	**2010**
OBESITY[a]	**5.5**	**6.3**	**6.8**	**10.8**
Gender				
Males	4.0	5.4	6.3	12.1
Females	6.9	7.1	7.2	9.5
Ethnic Group				
Chinese	3.7	4.0	4.2	7.9
Malays	13.4	18.0	20.0	24.0
Indians	11.5	12.6	13.2	16.9
ABDOMINAL FATNESS[b]	**3.4**	**9.9**	**13.1**	**16.9**
Gender				
Males	0.7	2.3	3.5	5.6
Females	6.1	17.4	22.5	28.0
Ethnic Group				
Chinese	2.9	9.0	11.9	15.5
Malays	5.2	12.4	14.3	18.9
Indians	6.4	13.5	19.0	26.1
OBESITY (ASIAN)[c]	**-**	**-**	**16.0**	**23.0**
Gender				
Males	-	-	16.0	24.8
Females	-	-	16.1	21.4
Ethnic Group				
Chinese	-	-	12.2	19.4
Malays	-	-	33.6	38.0
Indians	-	-	26.3	32.8

[a]Based on WHO's international classification of obesity – individuals with a BMI ≥30 kg/m^2 are considered obese.

[b]Based on waist-hip ratio (WHR): WHR > 1.0 for males and WHR >0.85 for females as cut-offs.

[c]Based on WHO's 2004 revised classification of BMI cut-off values that warrant public health attention in Asian populations – a "high-risk" BMI category was defined as a BMI of 27.5-37.5 kg/m^2, a "moderate to high risk" BMI category was defined as a BMI of 23.0-32.5 kg/m^2, and a "low-risk" BMI category was defined as a BMI of 18.0-23.0 kg/m^2.[45]

The results above suggest that BMI alone underestimates the problem of obesity in Singapore. Indeed, numerous studies from Singapore demonstrated that Asians have a higher body fat percentage at a lower BMI compared to Caucasians.[46] For the same amount of body fat as obese Caucasians, the BMI cut-off for Singaporean Chinese would have to be lower.[47] Furthermore, Singaporeans within “normal” BMI ranges for Caucasians were still at an increased risk for cardiovascular risk factors.[25,48] Such studies prompted WHO to revise the BMI cut-off values for Asians (Table 6),[45] and the new classification shows a staggering 23.0% of Singaporeans who are in the “high-risk” BMI category.[16]

Results from the SCHS showed a significant increase in the risk of T2D, in a dose-response fashion, with BMI; even at “low-risk” BMI categories, the relationship persisted and remained significant.[49] Non-smokers who are obese (BMI≥27.5 kg/m^2) were at an increased risk of cardiovascular and cancer mortality.[50,51] Amongst current smokers, an inverse, dose-dependent association between BMI and lung cancer risk was found, even after adjustment for duration and intensity of smoking.[52] This has public health implications for a population like Singapore which has relatively low BMI.

Tobacco and alcohol consumption

Tobacco is the single most preventable cause of mortality in the world, with a death toll higher than HIV/AIDS, tuberculosis and malaria combined.[53] Introduction of the National Smoking Control Programme has led to a decrease in smoking prevalence,[54] although the trend seems to have reversed in 2010. Both tobacco and alcohol use were more common in males and certain ethnic groups (Tables 7 and 8).

Table 7. Trend in age-standardised prevalence (%) of smoking by gender and ethnic group. Data obtained from National Health Survey 2010.[16]

GENDER / ETHNICITY	**Age-standardised prevalence (%)**			
	1992	**1998**	**2004**	**2010**
TOTAL	**18.1**	**15.1**	**12.3**	**14.3**
Gender				
Males	32.3	26.9	21.5	24.7
Females	3.5	3.2	3.3	4.2
Ethnic Group				
Chinese	16.6	13.8	11.5	12.8
Malays	28.0	22.1	17.7	26.5
Indians	15.7	16.3	11.8	10.1

Compared to non-smokers, current smokers were at an increased risk of all-cause mortality and cause-specific mortality, including deaths due to cancer, IHD, other heart diseases and COPD.[55] The increased risk of cancer was found in several specific sites, including head and neck region, upper gastrointestinal tract, hepatobiliary and pancreas, lung and bladder/renal pelvis, compared to non-smokers. A high prevalence of daily smoking was also inversely associated with educational attainment,[56] suggesting that those with lower socioeconomic status are disadvantaged.

Table 8. Trend in age-standardised prevalence (%) of alcohol drinking by gender and ethnic group. Data obtained from National Health Survey 2010.[16]

GENDER / ETHNICITY	Age-standardised prevalence (%)			
	1992	1998	2004	2010
TOTAL	**3.2**	**2.8**	**3.3**	**2.6**
Gender				
Males	5.6	4.7	4.6	3.8
Females	0.8	0.9	2.0	1.5
Ethnic Group				
Chinese	3.7	3.1	3.7	2.9
Malays	0.3	0.6	0.7	0.6
Indians	2.0	3.3	3.5	3.3

Physical activity

The obesity epidemic has been linked to decreased physical activity,[57] whereas increased physical activity is associated with a multitude of health benefits especially for NCDs.[58] Data from the NHS 2010 showed modest increase in regular physical activity, but the more worrying trend is the rebound increase in prevalence of physical inactivity (Table 9).[16,44,59]

In light of recent reports of a more sedentary lifestyle amongst adolescents,[60,61] promotion of physical activity needs to target the young for maximum effectiveness. The psychosocial and environmental factors must be addressed: exercises that provide enjoyment and increase self-efficacy should be promoted, coupled with parental support to provide the ideal environment to boost physical activity levels.[62]

Table 9. Trend in age-standardised prevalence (%) of leisure-time regular exercise and total physical activity by gender and ethnic group. Data obtained from National Health Survey 2010, National Health Survey 2004 and National Health Survey 1998.[16,44,59]

GENDER / ETHNICITY	Age-standardised prevalence (%)			
	1992	**1998**	**2004**	**2010**
LEISURE TIME REGULAR EXERCISE[a]	**14.4**	**17.7**	**16.9**	**19.0**
Gender				
Males	19.1	21.2	21.4	22.8
Females	9.6	14.3	12.6	15.2
Ethnic Group				
Chinese	14.1	16.9	16.6	19.2
Malays	13.3	18.4	18.0	15.3
Indians	19.7	24.3	17.0	21.7
LEISURE TIME PHYSICAL INACTIVITY[b]	**-**	**54.7**	**48.1**	**54.0**
Gender				
Males	-	45.9	41.4	47.0
Females	-	63.5	54.8	60.9

[a]Defined as participation in any form of sports or exercise for at least 20 minutes per occasion, for 3 or more days a week.

[b]Defined as no participation in any form of sports or exercise for at least 20 minutes per occasion.

CONCLUSION

Singapore is visibly undergoing the epidemiologic transition. Deaths due to cancer, CVDs and diabetes are on the rise, with ethnic minorities carrying a disproportionate burden of some NCDs such as diabetes. Epidemiological evidence suggests that the rise of NCDs is driven by changes in risk factors, which are modifiable but require an Asian perspective. Of these, diet, obesity and physical activity in young adults still need improvement. The Singapore health system is sufficiently equipped for disease and risk-factor surveillance and delivery of primary healthcare,[63] but health promotion and primary prevention needs to be informed by a sound evidence-base from well-conducted epidemiological studies in order to effectively reverse the trend in NCDs.

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