DOI:http://dx.doi.org/10.7314/APJCP.2012.13.2.411

REVIEW

The Burden of Cancer in Member Countries of the Association of Southeast Asian Nations (ASEAN)

Merel Kimman[1]*, Rosana Norman[2], Stephen Jan[1], David Kingston[3], Mark Woodward[1]

Abstract

This paper presents the most recent data on cancer rates and the burden of cancer in the ASEAN region. Epidemiological data were sourced from GLOBOCAN 2008 and disability adjusted life years (DALYs) lost were estimated using the standard methodology developed within the World Health Organization's Global Burden of Disease study. Overall, it was estimated there were over 700,000 new cases of cancer and 500,000 cancer deaths in ASEAN in the year 2008, leading to approximately 7.5 million DALYs lost in one year. The most commonly diagnosed cancers were lung (98,143), breast (86,842) and liver cancers (74,777). The most common causes of cancer death were lung cancer (85,772), liver cancer (69,115) and colorectal cancer (44,280). The burden of cancer in terms of DALYs lost was highest in Laos, Viet Nam and Myanmar and lowest in Brunei, Singapore and the Philippines. Significant differences in the patterns of cancer from country to country were observed. Another key finding was the major impact played by population age distribution on cancer incidence and mortality. Cancer rates in ASEAN are expected to increase with ageing of populations and changes in lifestyles associated with economic development. Therefore, ASEAN member countries are strongly encouraged to put in place cancer-control health care policies, focussed on strengthening the health systems to cope with projected increases in cancer prevention, treatment and management needs.

Keywords: Burden of disease - cancer - DALY - Southeast Asia

Asian Pacific J Cancer Prev, **13**, 411-420

Introduction

The Association of Southeast Asian Nations (ASEAN) is a geopolitical and economic organisation of ten independent countries located in Southeast Asia: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Viet Nam. This region contains more than half a billion people, almost 9% of the world population, spread over highly diverse countries, from economic powerhouses like Singapore to poorer economies such as Laos, Cambodia and Myanmar (Table 1).

Table 1. Health and Development Indicators per ASEAN Country for 2008

Country	Population estimate (in millions)	GDP per capita (US$)	Classification by the Worldbank	Life expectancy[1] Female	Life expectancy[1] Male	Infant mortality	Literacy rate (% age ≥15) Males	Literacy rate (% age ≥15) Females	Proportion <20 years of age	Proportion ≥65 years of age
				per 1000 live births						
Source	UN	World Bank		WHO*	WHO*	WHO*	UNESCO		UNESCO	
Brunei	0.4	43,751	High income	77	75	3	97	94	36	3
Cambodia	14.5	741	Low income	64	59	31	85	71	47	3
Indonesia	225.9	2,180	Lower middle income	69	66	19	95	89	37	6
Laos	6.2	829	Low income	63	61	20	83	63	50	4
Malaysia	26.8	7,866	Upper middle income	76	71	3	95	90	40	5
Myanmar	49.4	233	Low income	56	53	48	95	90	37	5
Philippines	89.6	1,907	Lower middle income	74	67	15	95	96	45	4
Singapore	4.6	41,291	High income	83	79	1	98	92	25	9
Thailand	67.0	4,098	Upper middle income	74	66	10	96	92	30	7
Vietnam	86.6	1,047	Low middle income	75	70	9	95	91	37	6

[1]at birth; WHO, World Health Organization *(http://www.who.int/whosis/whostat/2010/en/); UN, United Nations (Population Reference Bureau, UN Statistics Division); IMF, International Monetary Fund (http://www.imf.org/external/data.htm#data);

*[1]The George Institute for Global Health, [2]The University of Queensland, Queensland Children's Medical Research Institute and School of Population Health, [3]University of New South Wales, School of Medical Sciences *For correspondence: mkimman@georgeinstitute.org.au*

Each year, more than 700,000 new cases of cancer occur in ASEAN countries and this number is expected to increase (Ferlay et al., 2010). Cancer has a severe impact on individuals and communities. Not only does it lead to disability and death, its treatment costs and associated loss of income can quickly undermine family finances. Consequently, globally, as well as for the ASEAN region, cancer has negative implications for poverty reduction and economic development. The United Nations has recently identified the socioeconomic and health toll from non-communicable diseases, such as cancer, as a major impediment to the achievement of the Millennium Development Goals (United Nations Non-Governmental Liaison Service, 2010).

Information about the burden of cancer in ASEAN countries, in common with many other developing countries, is incomplete and generally has not been systematically reviewed for coherence and consistency. National mortality data for most ASEAN countries have been shown to be deficient with significant under-registration and misclassification. This study aims to provide a comprehensive picture of the burden of cancer in ASEAN. It presents incidence and mortality data from GLOBOCAN 2008 and uses the Global Burden of Disease (GBD) methodology and assumptions (Murray and Lopez, 1997) to estimate the impact of illness in terms of disability adjusted life years (DALYs) lost. A burden of disease study such as this, combined with cost data, enables assessments to be made of the societal toll of cancer in terms of lost economic and social opportunities, and comparisons across countries. Such findings can raise awareness of the scale of the cancer problem, identify priorities for further research and catalyse political action to put in place effective cancer control health care policies (Lancet, 2010)

Materials and Methods

Methods developed for the Global Burden of Disease (GBD) Study by the World Bank and World Health Organization (WHO) (Murray and Lopez, 1997) were adapted and applied to ASEAN population health data.

Cancer sites included in this burden of disease study were: mouth and pharynx (ICD-10 C00-C14), oesophagus (C15), stomach (C16), colon and rectum (C18-C21), liver (C22), pancreas (C25), trachea, bronchus and lung (C33-C34), melanoma (C43), female breast (C50), cervix uterine (C53), corpus uteri (C54-55), ovary (C56), prostate (C61), bladder (C67), lymphomas and multiple myeloma (C81-C90, C96), leukaemia (C91-C95), and other malignant neoplasms (balance of ICD-10 C00-C97).

Incidence and mortality data

The primary source of cancer incidence and mortality data was GLOBOCAN 2008 (Ferlay et al., 2010). Incidence data are derived from population-based cancer registries, which may cover entire national populations but more often cover smaller, sub-national areas, and, particularly in developing countries, only major cities. Mortality statistics in GLOBOCAN are collected and made available by WHO (http://www.who.int/whosis/).

Population estimates

National population estimates for 2008 were extracted from the United Nations Population Division website (http://www.un.org/esa/population/). Age-standardised rates were calculated by utilising the WHO World Standard Population (Ahmad et al., 2001).

Disability adjusted life years (DALYs)

The DALY is a combined measure of mortality and morbidity, calculated as the sum of years of life lost due to premature mortality (YLL) and years lived with disability (YLD). YLL lost due to cancer was estimated using the standard GBD approach (Murray and Lopez, 1997). The date of death from cancer is subtracted from the date of death that would have occurred had the person lived an average life expectancy. An annual discount rate of 3% and standard life expectancies based on the West model levels 25 and 26 were used; that is, males are expected to live up to the age of 80 and females up to the age of 82.5 (Coale and Demeny, 1966). We did not apply the controversial non-uniform age weighting (adjustments which result in less weight given to years lived at young and older ages) which was used in the original GBD 1990 study.

The YLD is the disability component of the DALY based on non-fatal health outcomes. The YLD takes the severity and duration of the disability into account using the basic formula (Mathers et al., 2001): YLD = I x DW x L, where I is the number of incident cases for the reference period, DW is the disability weight in the range 0 – 1, and L is the average duration of disability (in years).

The basis of the YLD estimation is a model of disease progression developed in the Dutch burden of disease study (Stouthard et al., 1997). The disease model commences with an initial phase of diagnosis and primary therapy, with a duration of up to 12 months. After this initial phase, cancer cases are classified as those who will and will not be cured. Those who will be cured enter a phase of up to 5 years after which they are considered cured and have no further cancer-related disability. Those who will not be cured enter a phase (of variable length) of remission followed by a phase of disseminated carcinoma (lasting 12 months or less), then a terminal phase (lasting 1 month) and death. We modified the Dutch model to each cancer site following methods used in the Australian burden of disease study (Begg et al., 2007). Dutch disability weights were allocated to each of the phases in the model (Stouthard et al., 1997). Where no Dutch weights were available for a specific cancer site, we extrapolated weights based on the cancer that it most resembled. Five-year survival rates for developing and developed countries were obtained from a study on the worldwide mortality from 25 cancers (Pisani et al., 1999).

Results

Cancer Incidence and Mortality

There were an estimated 724,699 new cancer cases (excluding non-melanoma skin cancer) and 500,439 deaths in the ASEAN region in 2008. Of all new cases, 46% were in males and 54% in females. However, 52% of deaths occurred in men. Among women, breast cancer

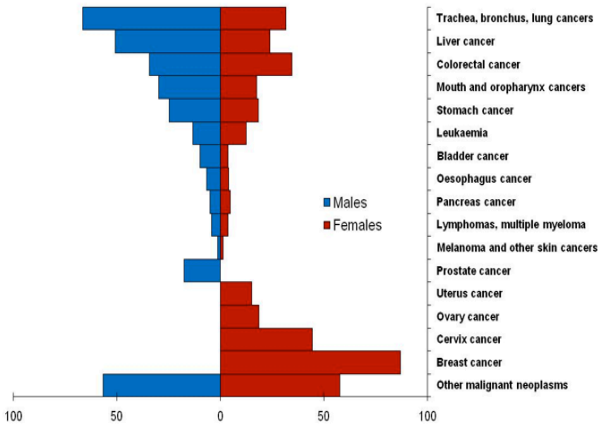

Figure 1. Cancer Incidence (Thousands) for Males and Females in ASEAN for 2008

Table 2. The Top 5 Cancer Sites in ASEAN, 2008

	Incidence		Mortality	
	Site	Incident cases	Site	Deaths
Males	Lung	66515	Lung	57935
	Liver	50817	Liver	46907
	Colorectal	34318	Colorectal	22152
	Mouth	29818	Stomach	20032
	Stomach	24899	Mouth	18107
Females	Breast	86842	Breast	36723
	Cervix	44351	Lung	27837
	Colorectal	34493	Cervix	22473
	Lung	31628	Liver	22208
	Liver	23960	Colorectal	22128
Overall	Lung	98143	Lung	85772
	Breast	86842	Liver	69115
	Liver	74777	Colorectal	44280
	Colorectal	68811	Breast	36724
	Mouth	47273	Stomach	35320

had the highest incidence, followed by cervical cancer and colorectal cancer. Among men, the three most common cancer sites were lung, liver, and colorectal (Figure 1). The most common fatal cancer in ASEAN for males and females combined was lung cancer (98,143 cases and 85,772 deaths). The second most common was liver cancer (74,777 new cases and 69,115 deaths), followed by colorectal cancer (68,811 cases and 44,280 deaths). Table 2 illustrates that the rank order of the burden of disease by cancer site differs slightly when measured by mortality versus incidence, although the top four cancers; lung, liver, colorectal and breast, are the same for men and women combined. The major change occurs in females; lung cancer in females ranks fourth in terms of incidence, but second in terms of mortality in 2008. These differences in rank order of incidence and mortality by cancer site are mainly due to the differing survival rates of specific cancers.

Crude incidence and mortality rates for all cancer sites combined, by age and sex, for each ASEAN country are presented in Tables 3 and 4. Among the ASEAN countries, the highest crude incidence rates per 100,000 for total cancer (all sites) are estimated in Singapore, for both males (277.3) and females (282.4), and the lowest in the Philippines, also for both males (80) and females (90.9). Singapore also has the highest crude mortality rates per 100,000 (148.5 for males and 115.9 for females) and the Philippines the lowest (57.3 for males and 49.6 for females).

Cancer incidence increases significantly with age (Figure 2). Figure 3 shows the age distribution in the ASEAN countries. When the effect of age is eliminated by age-standardisation, the difference between countries is less pronounced (Table 5). Singapore still ranks highest

Table 3. Estimated Incidence Rates (per 100,000) for All Cancers by Age, 2008

	Brunei	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Singapore	Philippines	Thailand	Viet Nam
Males	(228)	(5,873)	(136,172)	(2,735)	(15,095)	(27,930)	(6,434)	(36,409)	(50,407)	(55,045)
0-14	9.0	10.3	13	11.4	15.0	14.2	16.2	9.1	15.0	10.1
15-39	17.7	23.0	26.8	25.3	26.9	25.9	27.8	23.5	37.8	28.0
40-44	166.7	112.7	84.3	107.0	93.4	94.9	93.6	84.4	124.5	156.9
45-49	174.1	193.7	140.4	176.2	142.9	159.1	149.2	125.4	174.1	238.6
50-54	97.6	315.9	232.5	304.2	221.5	244.9	262.6	231.5	256.8	346.0
55-59	199.4	399.5	377.7	441.2	367.4	429.5	456.8	373.2	391.3	462.5
60-64	763.4	642.9	539.1	643.0	519.5	547.4	748.5	479.5	552.6	577.1
65-69	1222.4	769.3	822.5	786.2	838.2	736.9	1173.0	622.0	704.9	693.6
70-74	1090.2	1016.8	1003.4	1012.3	1009.4	862.1	1635.8	690.5	803.0	816.2
75+	2250.3	1094.4	1269.9	1091.2	1112.3	1055.2	2456.5	824.2	1080.2	1057.0
All ages	**112.5**	**82.5**	**120.0**	**88.4**	**110.0**	**115.3**	**277.3**	**80.0**	**152.0**	**128.1**
Females	(185)	(6,988)	(156,457)	(2,993)	(15,095)	(38,793)	(6,482)	(36,409)	(62,259)	(56,536)
0-14	5.8	8.0	10.9	9.4	12.3	15.7	9.4	6.5	12.1	12.0
15-39	26.2	31.9	47.0	40.2	42.6	51.8	48.2	36.5	49.3	37.9
40-44	94.4	152.8	174.8	180.7	179.5	209.9	199.9	174.0	196.1	148.8
45-49	210.7	231.1	280.5	247.9	276.2	313.7	313.3	202.0	285.9	231.5
50-54	380.5	316.9	324.0	330.4	346.8	393.6	414.4	323.8	396.2	329.7
55-59	286.3	369.6	424.2	407.4	455.0	480.9	531.7	363.0	459.8	395.6
60-64	821.9	456.2	495.9	506.9	499.9	543.1	627.1	343.2	573.9	424.1
65-69	819.2	494.6	534.9	577.9	582.0	639.5	785.0	424.0	582.7	464.5
70-74	1032.6	592.2	613.9	698.0	607.3	707.7	934.1	424.7	638.4	518.6
75+	757.3	509.3	757.6	652.1	657.8	766.8	1377.4	575.5	688.5	680.2
All ages	**97.6**	**93.9**	**137.5**	**96.2**	**127.1**	**153.1**	**282.4**	**90.9**	**181.9**	**128.1**

(total numbers of incident cases in parentheses)

Table 4. Estimated Mortality Rates (per 100,000) for All Cancers by Age, 2008

	Brunei	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Singapore	Philippines	Thailand	Viet Nam
Males	(114)	(4,590)	(110,084)	(2,208)	(10,917)	(21,672)	(3,446)	(26,062)	(35,484)	(43,688)
0-14	5.4	5.7	10.5	6.5	11.1	7.5	1.7	4.4	3.4	4.5
15-39	5.5	14.7	16.6	15.8	14.8	15.8	8.0	15.0	19.2	21.6
40-44	50.7	76.3	56.6	76.7	56.5	61.3	32.0	58.9	74.4	103.0
45-49	82.9	140.1	95.0	131.8	86.4	109.9	58.3	82.3	116.4	168.6
50-54	88.7	233.8	170.5	230.9	146.7	168.3	111.4	155.6	177.5	248.8
55-59	99.7	302.0	285.0	346.6	256.1	308.8	211.0	257.3	257.5	340.5
60-64	247.6	502.0	428.8	525.7	379.2	406.3	357.1	343.4	353.6	443.6
65-69	475.4	661.9	692.6	662.6	644.5	581.3	650.3	459.9	531.1	565.2
70-74	1040.6	929.6	906.8	941.9	836.0	749.4	969.4	550.7	749.4	720.1
75+	1317.2	1251.7	1273.8	1178.0	1015.7	1119.8	1695.8	770.9	940.2	1090.5
All ages	**56.3**	**64.5**	**97.0**	**71.4**	**79.6**	**89.5**	**148.5**	**57.3**	**107.0**	**101.7**
Females	(119)	(4,292)	(105,542)	(1,983)	(9,213)	(23,956)	(2,660)	(26,062)	(34,850)	(38,318)
0-14	7.8	4.9	8.8	5.8	8.5	9.9	1.3	3.0	3.2	5.6
15-39	6.6	12.2	19.5	14.4	15.6	17.4	7.7	12.9	18.6	18.5
40-44	29.0	54.6	81.1	70.7	66.4	73.1	33.5	74.3	64.0	74.2
45-49	120.4	103.4	143.8	119.5	115.5	132.5	63.6	83.6	117.9	120.7
50-54	214.1	164.1	209.5	192.7	179.2	194.9	115.7	147.3	162.6	177.8
55-59	210.0	231.1	293.2	278.1	257.4	285.6	181.5	195.1	224.4	240.0
60-64	376.7	307.5	362.2	372.4	303.4	351.7	239.1	217.6	277.8	300.8
65-69	983.1	393.0	425.0	490.0	387.8	488.8	374.1	299.4	414.3	366.1
70-74	760.9	528.5	539.6	670.5	446.0	628.8	521.2	326.7	526.3	449.0
75+	837.0	626.9	726.3	821.1	544.2	960.1	997.4	564.8	799.1	713.4
All ages	**62.8**	**57.7**	**91.8**	**63.7**	**69.3**	**94.5**	**115.9**	**49.6**	**101.8**	**86.8**

(total numbers of cancer deaths in parentheses)

and Philippines lowest for incidence rates; however, the ranking in terms of mortality rates changes. For instance Singapore falls to ninth in terms of cancer mortality. Importantly, geographic variation was still substantial after age-adjustment and large differences in rates exist when looking at specific cancer sites (Table 6).

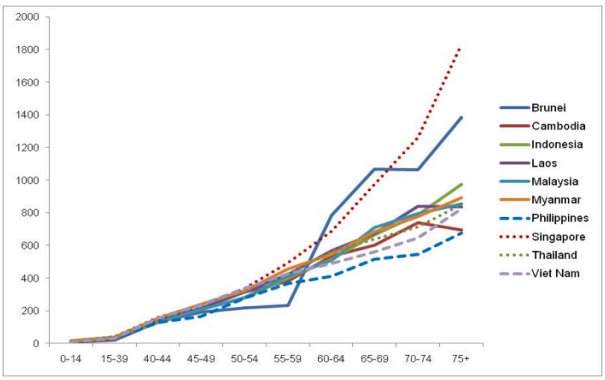

Figure 2. Age-Specific Incidence Rates (Per 100,000 Population) for All Cancers, by Country, in 2008

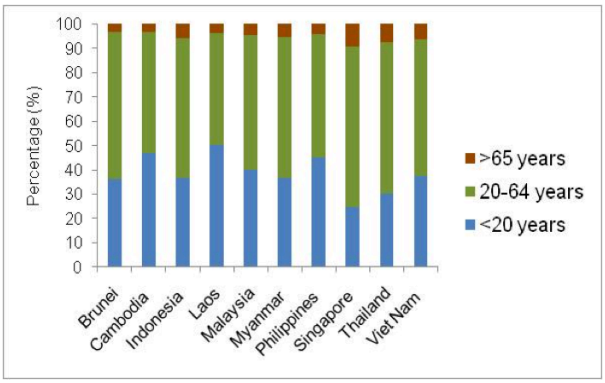

Figure 3. Age Structure of the Total Population, by Country, in 2008

The Seven Most Important Site-specific Cancers

Lung cancer

Lung cancer was the most commonly diagnosed cancer, as well as the leading cause of cancer death in ASEAN in 2008. Age-standardised mortality rates (per 100,000) for males and females combined were highest in Vietnam (21.5) and Singapore (21.2) and lowest in the Philippines (14.2) and Cambodia (14.7). In males, the age-standardised mortality rates were highest in Singapore and Vietnam (both 31.6) and lowest in Myanmar (20.9) and Brunei (19.8). In females, Brunei had the highest mortality rate (20.2), followed by Vietnam and Laos (both 13.9), which were all much higher than rates in the Philippines (6.4) and Cambodia (8.2) (Figure 4). Since the most important risk behaviour for lung cancer is tobacco smoking, the observed variations in rates and trends across countries, or between males and females within each country, are thought to largely reflect differences in the stage and degree of the tobacco epidemic (Youlden

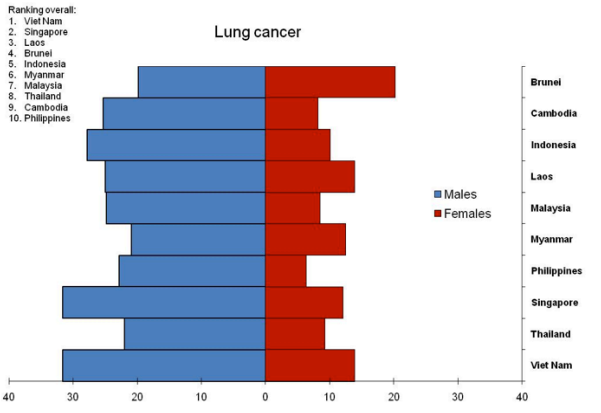

Figure 4. Estimated Age-Standardised Mortality Rates (Per 100,000 Population) for Lung Cancer, by Country, in 2008

Table 5. Estimated Age-standardised Incidence Rates (per 100,000) by Site, 2008

Cancer	Brunei	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Singapore	Philippines	Thailand	Viet Nam
Males										
Mouth[1]	21.8	16.0	13.7	9.5	17.3	13.0	14.2	8.0	12.0	8.7
Oesophagus	0.5	4.3	1.9	2.0	2.6	9.6	3.8	1.8	3.3	2.9
Stomach	5.6	15.3	9.3	4.7	10.7	13.6	13.9	6.1	4.2	24.4
Colorectal	38.3	11.8	19.1	9.5	19.6	12.2	41.6	10.0	13.2	8.7
Liver	6.0	25.8	10.3	48.7	8.4	16.5	17.0	16.5	40.6	42.3
Pancreas	5.5	1.7	3.1	1.3	2.4	1.5	5.1	2.3	1.7	0.8
Lung[2]	21.7	26.9	29.7	27.2	26.8	22.9	37.9	27.9	26.8	37.6
Melanoma[3]	4.0	0.8	0.7	0.5	0.7	0.2	0.5	0.6	0.4	0.6
Prostate	39.0	5.8	10.6	4.4	9.2	5.8	20.0	10.1	6.5	3.2
Bladder	1.5	3.4	5.8	4.6	5.4	5.1	7.3	1.8	5.5	1.1
Lymphomas[4]	1.3	1.3	2.4	1.5	1.7	1.2	2.3	1.0	1.8	0.7
Leukaemia	1.5	4.4	5.9	4.3	6.2	4.6	6.8	4.1	5.0	4.6
All	**176.7**	**152.9**	**145.9**	**154.1**	**142.9**	**141.0**	**208.2**	**118.7**	**146.0**	**154.4**
Females										
Mouth[1]	15.3	5.9	6.5	7.0	8.6	6.9	4.8	4.5	8.6	4.6
Oesophagus	4.9	0.9	1.2	0.6	1.6	5.6	0.7	0.9	0.8	1.1
Stomach	10.3	6.3	5.6	3.4	6.4	8.8	8.3	3.5	3.0	14.6
Colorectal	10.2	7.0	15.6	8.4	15.5	12.0	28.3	7.3	13.4	9.7
Liver	3.8	7.8	3.5	20.7	3.0	6.3	3.8	5.1	19.9	18.5
Pancreas	4.6	1.3	2.5	1.1	1.8	1.3	3.7	1.8	1.1	0.7
Lung[2]	14.3	8.8	10.9	15.1	9.2	13.8	15.3	7.7	12.2	16.4
Melanoma[3]	2.4	0.2	0.3	0.5	0.4	0.3	0.5	0.7	0.5	0.7
Breast	21.4	20.7	36.2	17.7	37.0	32.5	59.9	31.9	30.7	15.6
Cervix	11.2	27.4	12.7	22.1	17.9	26.4	6.8	11.7	24.5	11.5
Uterus	13.6	4.8	6.1	3.0	5.2	4.9	11.1	4.6	4.3	7.2
Ovary	8.7	4.4	8.8	5.6	7.5	6.8	7.7	5.7	6.8	1.9
Bladder	4.9	1.6	1.5	1.5	1.4	2.0	1.6	0.7	1.6	0.6
Lymphomas[4]	4.1	0.7	1.9	1.0	1.3	1.0	1.7	0.5	1.2	0.7
Leukaemia	1.2	3.6	4.6	3.5	4.8	4.6	4.5	3.6	4.0	6.0
All	**153.5**	**123.0**	**144.6**	**140.9**	**145.2**	**164.8**	**188.4**	**115.2**	**156.1**	**127.7**

[1]and oropharynx;[2]including trachea and bronchus; [3]and other skin cancers; [4]including multiple myeloma

Table 6. Estimated Age-standardised Mortality Rates (per 100,000) by Site, 2008

Cancer	Brunei	Cambodia	Indonesia	Laos	Malaysia	Myanmar	Singapore	Philippines	Thailand	Viet Nam
Males										
Mouth[1]	11.1	11.5	8.5	6.2	9.7	8.5	6.8	5.6	6.8	6.6
Oesophagus	0.5	4.3	1.8	1.8	2.4	9.0	3.1	1.4	2.6	2.3
Stomach	4.7	13.4	8.8	3.9	9.5	11.1	7.8	4.4	3.0	17.5
Colorectal	14.9	7.5	14.5	5.8	13.0	7.3	18.1	5.5	6.5	4.8
Liver	4.4	25.1	10.0	46.8	8.1	15.8	14.0	15.4	35.1	39.2
Pancreas	3.5	1.6	3.0	1.3	2.4	1.4	5.3	2.0	1.4	0.7
Lung[2]	19.8	25.3	27.8	25.0	24.8	20.9	31.6	22.8	22.0	31.6
Melanoma[3]	0.0	0.6	0.4	0.4	0.3	0.2	0.2	0.3	0.2	0.3
Prostate	6.1	3.6	8.0	2.5	5.8	3.2	3.9	5.3	2.0	1.9
Bladder	0.5	2.0	3.8	2.4	2.6	2.5	1.6	0.8	2.1	0.5
Lymphomas[4]	0.0	1.2	2.2	1.3	1.3	0.8	0.7	0.5	1.2	0.4
Leukaemia	1.0	4.3	5.4	4.2	5.2	4.2	2.3	3.4	4.0	3.7
All	**87.5**	**127.5**	**120.0**	**129.1**	**106.6**	**110.3**	**110.0**	**87.4**	**102.6**	**122.6**
Females										
Mouth[1]	3.6	4.0	3.8	4.5	4.6	4.3	1.7	3.2	4.4	3.3
Oesophagus	1.6	0.9	1.1	0.6	1.5	5.1	0.3	0.7	0.6	0.8
Stomach	5.2	5.3	5.1	2.9	5.6	7.1	4.6	2.7	2.1	11.2
Colorectal	9.5	4.3	11.7	5.0	10.2	7.0	10.7	3.9	6.5	5.1
Liver	6.8	7.5	3.5	19.7	2.9	6.0	4.5	4.9	16.6	17.3
Pancreas	4.6	1.2	2.4	1.0	1.8	1.2	3.7	1.6	0.8	0.6
Lung[2]	20.2	8.2	10.1	13.9	8.5	12.5	12.1	6.4	9.3	13.9
Melanoma[3]	0.0	0.2	0.2	0.5	0.1	0.2	0.3	0.3	0.3	0.3
Breast	17.8	8.0	18.6	6.9	14.7	12.2	13.6	11.9	10.8	5.7
Cervix	6.2	16.2	7.0	13.3	5.6	15.0	3.5	5.3	12.8	5.7
Uterus	3.1	1.5	1.9	0.9	1.4	1.4	1.4	2.2	1.1	3.3
Ovary	9.9	2.9	6.6	3.7	5.2	4.2	4.2	2.8	4.0	0.8
Bladder	1.7	0.9	1.0	0.8	0.7	1.0	0.6	0.3	0.6	0.3
Lymphomas[4]	4.1	0.6	1.6	0.8	1.0	0.9	0.4	0.2	0.9	0.4
Leukaemia	0.0	3.4	4.2	3.3	4.0	4.1	1.5	2.9	3.1	4.7
All	**107.7**	**80.1**	**98.2**	**98.8**	**82.2**	**103.5**	**73.3**	**65.9**	**85.9**	**85.0**

[1]and oropharynx;[2]including trachea and bronchus; [3]and other skin cancers; [4]including multiple myeloma

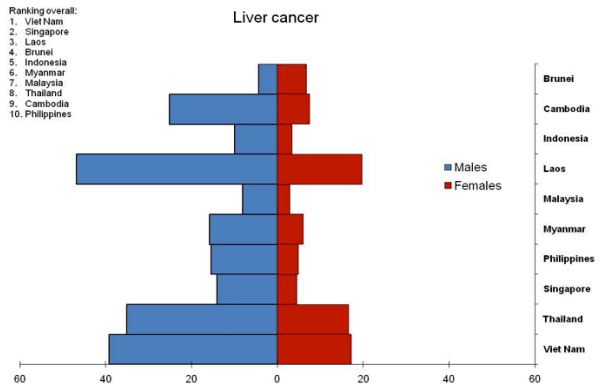

Figure 5. Estimated Age-Standardised Mortality Rates (Per 100,000 Population) for Liver Cancer, by Country, in 2008

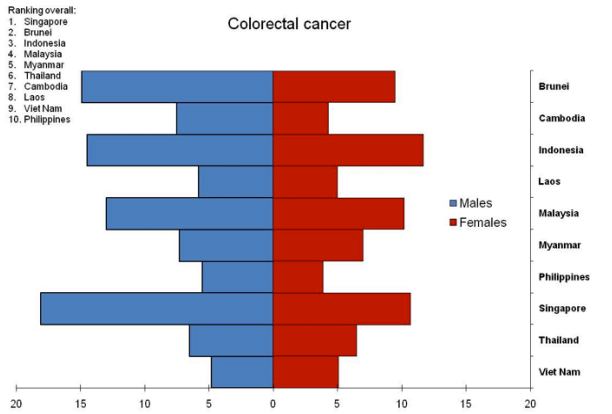

Figure 6. Estimated Age-Standardised Mortality Rates (Per 100,000 Population) for Colorectal Cancer, by Country, in 2008

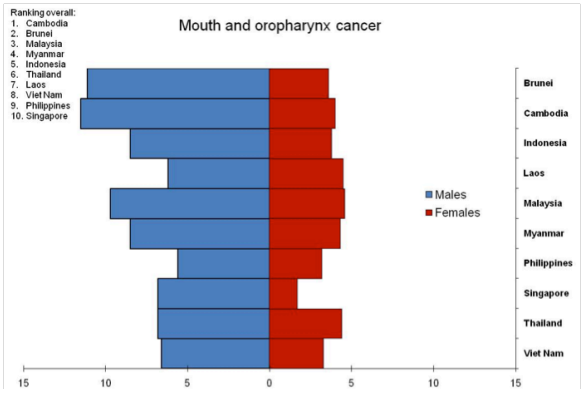

Figure 7. Estimated Age-Standardised Mortality Rates (Per 100,000 Population) for Mouth and Oropharynx Cancer, by Country, in 2008

et al., 2008). Yet, in less developed countries other risk factors, such as oral tobacco use, indoor coal smoke and occupational exposure to carcinogens, also have an impact (Ezzati et al., 2005).

Liver cancer

Liver cancer is the second most common cancer in ASEAN and the second leading cause of cancer death. The highest incidence and mortality rates per 100,000 are found in Laos (33.8 and 32.3), Thailand (29.7 and 25.4) and Vietnam (29.3 and 29.2), and the lowest in Brunei (5.2 and 5.4), Malaysia (5.7 and 5.4) and Indonesia (6.7 and 6.6) (Figure 5). Rates are more than twice as high in

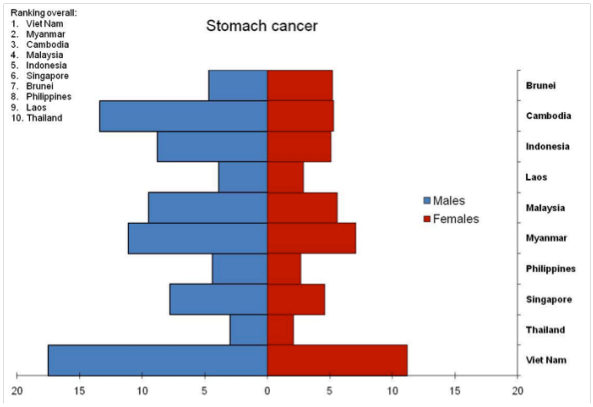

Figure 8. Estimated Age-Standardised Mortality rates (Per 100,000 Population) for Stomach Cancer, by Country, in 2008.

males as in females and survival is poor, as reflected by almost equal mortality and incidence rates. The high liver cancer rates may largely be explained by a high prevalence of chronic hepatitis B virus (HBV) infection. South-east Asia is considered a high endemicity area, in which about 70-90% of the population becomes HBV-infected before the age of 40, and 8 to 20% of people are HBV carriers (Hollinger and Liang 2001). HBV infections accounts for about 60% of the total liver cancer in developing countries and for about 23% of cancer in developed countries (Parkin 2006).

Colorectal cancer

Colorectal cancer is the third most commonly diagnosed cancer in both males and females, with 68,811 new cancer cases and 44,280 deaths estimated to have occurred in 2008. The highest incidence rates per 100,000 are found in Singapore (34.6), Brunei (26.7), Malaysia (17.5), and Indonesia (17.2). Rates are twofold of those in Vietnam (9.2), Thailand (13.3), Philippines (8.6) and Laos (8.9). Similarly, mortality rates are at least twofold in Singapore (14.2), Brunei (13.4), Malaysia (11.5) and Indonesia (12.9), compared to Vietnam (4.8), Thailand (6.5), Philippines (3.9) and Laos (5.4) (Figure 6). Unfavourable, increased colorectal cancer rates are thought to reflect changes in dietary patterns, obesity and smoking rates, often seen in economically transitioning countries (de Kok et al., 2008; Center et al., 2009).

Mouth and oropharynx cancer

Cancers of the mouth and oropharynx include cancers of the lip and oral cavity, nasopharynx and other pharynx cancers. This group of cancers is the fifth most common in ASEAN, with an estimated 47,273 new cases and 28,327 cancer deaths in 2008. Incidence and mortality rates (per 100,000) were highest in Brunei (17.4 and 7.6 respectively) and Malaysia (12.9 and 7.1 respectively) and lowest in the Philippines (6.1 and 4.4 respectively) and Vietnam (6.4 and 4.7 respectively) (Figure 7). Mouth and oropharynx cancers are associated with environmental and lifestyle risk factors, among which tobacco and alcohol play a major role. In addition to tobacco smoking, tobacco chewing is another risk factor as well as chewing betel quid and areca nut. Certain strains of virus, such as the

sexually transmitted human papilloma virus, also play a carcinogenic role (Lambert et al., 2011).

Stomach cancer

Stomach is the seventh most commonly diagnosed cancer in ASEAN and the fourth leading cause of death, with an estimated 43,238 new cases and 35,320 cancer deaths in 2008. Incidence rates (per 100,000) vary from as low as 4.2 in males and 3.0 in females in Thailand to a high 24.4 in males and 14.6 in females in Vietnam. Mortality rates are highest in Vietnam, Cambodia and Myanmar (14.0, 8.4 and 9.0), at least four times higher than rates in Thailand (2.5), Laos (3.4) and Philippines (3.5) (Figure 8). Regional variations in stomach cancer rates partly reflect differences in the prevalence of Helicobacter pylori infection, which accounts for more than 60% of stomach cancer worldwide (Parkin 2006; Thun et al., 2010).

Breast cancer

Breast cancer is the most frequently diagnosed cancer and the leading cause of cancer deaths in females in the ASEAN region, as well as worldwide. In ASEAN it accounts for 22% of the new (female) cancer cases and 15% of the total cancer deaths in 2008. The highest incidence rate per 100,000 is found in Singapore (59.9) and the lowest in Vietnam (15.6). Mortality rates per 100,000, however, are highest in Indonesia (36.2), quite low in Singapore (13.6), while Vietnam remains on the bottom of the ranking for breast cancer mortality (Figure 9). In low- and middle-income countries in Southeast Asia, women are developing breast cancer at a relatively young age (under 50 years), adding enormous pressure on families and societies (Institute for Health Metrics and Evaluation 2011). This trend is also apparent in the low-income countries within ASEAN, as illustrated by Figure 10. Factors that contribute to an increasing trend in breast cancer incidence among Asian women are not fully understood, but thought to reflect lifestyle changes associated with westernization, including late child bearing, having fewer children, and consumption of calorie-dense food, physical inactivity and obesity (Jemal et al., 2010).

Cervical cancer

Cervical cancer is the second most diagnosed cancer and the third leading cause of cancer death in females in ASEAN, accounting for 11% of the total new cancer cases and 9% of the total cancer deaths among females in 2008 (Figure 11). Similar to breast cancer trends, the fraction of women under 50 with cervical cancer is high (see Figure 12).

Cervical cancer incidence rates in Cambodia were almost five times as high as in Singapore (27.4 and 6.8 per 100,000 respectively). Incidence rates were also very high in Myanmar (26.4), Thailand (24.5) and Laos (22.1). In Cambodia and Myanmar, cervical cancer has the highest mortality rate of all cancers (16.2 and 15.0 per 100,000 respectively). The high burden of cervical cancer in countries such as Cambodia, but also Myanmar and Thailand (26.4 and 24.5 cases per 100,000 respectively) appears to be due to a combination of factors including

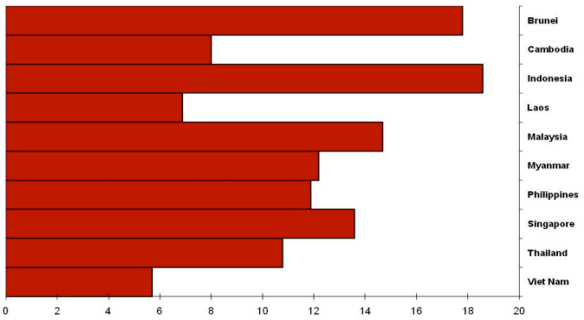

Figure 9. Estimated Age-Standardised Mortality Rates (Per 100,000 Female Population) for Breast Cancer, by Country, in 2008

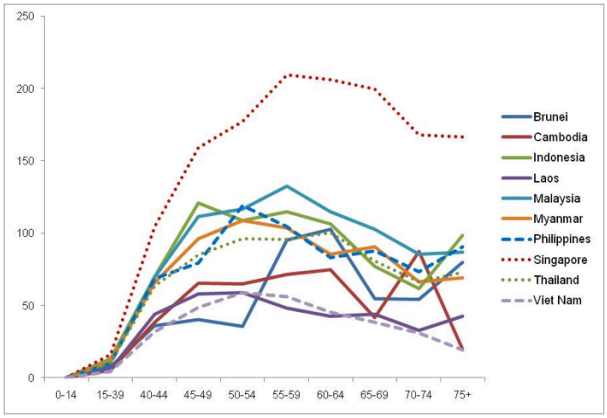

Figure 10. Estimated Age-Specific Incidence Rates (Per 100,000 Female Population) for Breast Cancer, by Country, in 2008

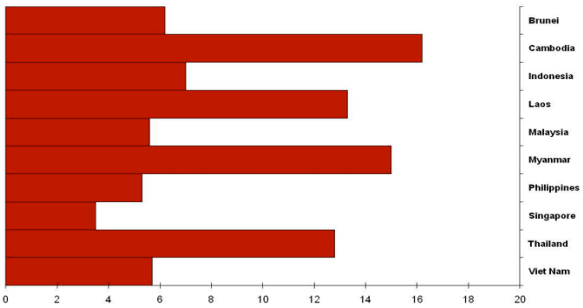

Figure 11. Estimated Age-Standardised Mortality Rates (Per 100,000 Female Population) for Cervical Cancer, by Country, in 2008

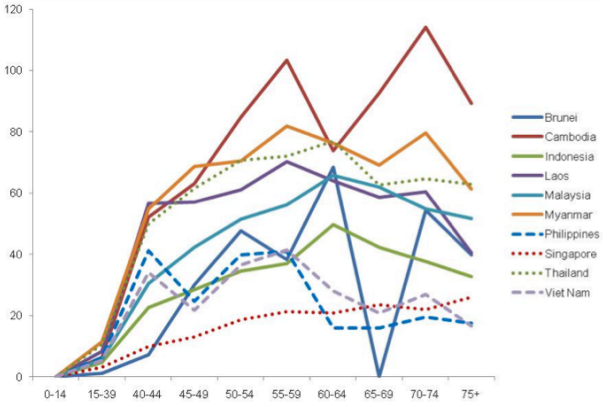

Figure 12. Estimated Age-Specific Incidence Rates (Per 100,000 Female Population) for Cervical Cancer, by Country, in 2008

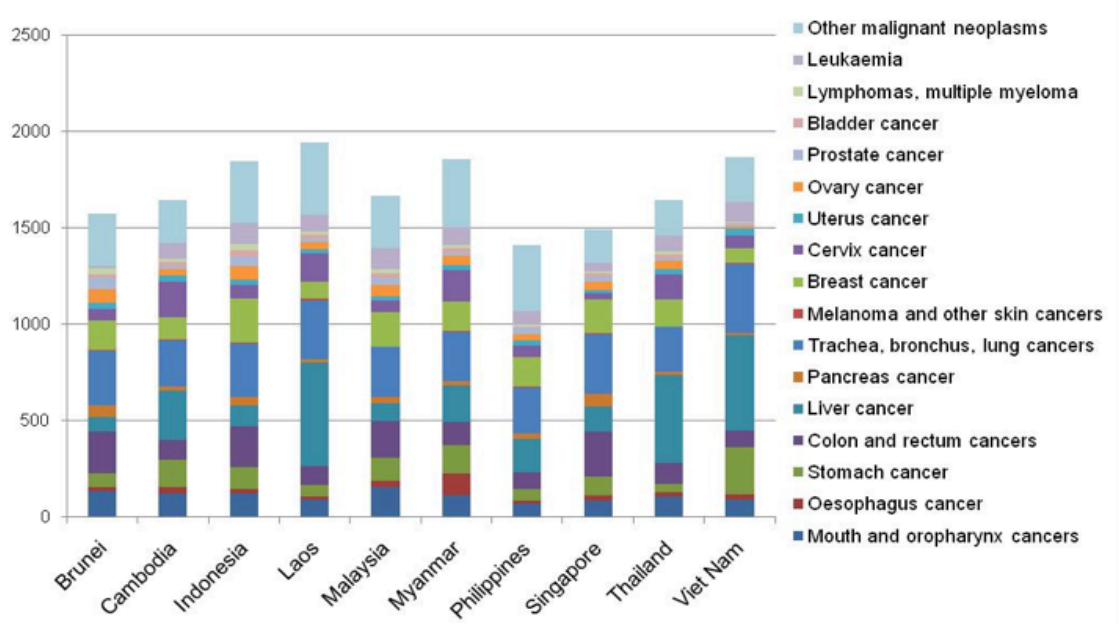

Figure 13. Burden of Cancer Expressed in Age-Standardised DALYs Lost (Per 100,000 Population), by Country, in 2008

lack of widespread screening and treatment facilities, and a greater proportion of persistent Human papillomavirus (HPV) infections (Garland et al., 2008; Mathew and George, 2009).

Disability Adjusted Life Years (DALYs)

In 2008, the number of DALYs, or healthy life years, lost to cancer in ASEAN was 7.5 million of which 48% was lost in males and 52% in females. In males, liver and lung cancers claimed most DALYs. In females, breast cancer claimed most DALYs, followed by cervix and lung cancers.

To compare between countries, age-standardised DALYs lost per 100,000 from all cancers by country are presented in Figure 13. The total burden of cancer is highest in Laos (1941 DALYs lost per 100,000), followed by Vietnam (1863), Myanmar (1853) and Indonesia (1841). The lowest total burden of cancer is found in the Philippines (1411) and Singapore (1492).These rankings largely reflect those derived on the basis of mortality.

Discussion

"As the prevalence of cancer continues to increase, it is imperative that we mobilise ASEAN member nations and encourage them to put in place a strategic, focussed cancer-control health care policy. This policy must be supported by organised, evidence-based cancer prevention programmes, and strengthened by reliable local patient registries and population databases," said Dr Surin Pitsuwan, Secretary General of ASEAN, at a stakeholders meeting on the socio-economic burden of cancer in ASEAN communities, held in Singapore on the 7th of July 2011 (Jan et al., 2012).

A first step towards a cancer control health care policy is an estimate of the burden of cancer at the population level, which is provided in this study, using well-established burden of disease measures. The data provided in this study can be used as a benchmark to monitor change and for identifying priorities in cancer prevention and care (Lancet, 2010).

Results show that there were over 700,000 new cases of cancer and 500,000 cancer deaths in ASEAN in the year 2008, leading to approximately 7.5 million DALYs (i.e. healthy life years) lost in that year. The burden of cancer in terms of DALYs lost is highest in Laos, Vietnam and Myanmar and lowest in Brunei, Singapore and the Philippines. Furthermore, we found that high income countries (i.e. Singapore and Brunei) generally have higher breast, lung and colorectal cancer rates and low liver cancer rates, while low income countries (i.e. Myanmar, Laos and Cambodia) have higher cervical and stomach cancer rates. Among other interesting findings was a high rate of oesophagus cancer in Myanmar, with an age-standardised incidence rate of 7.5 per 100,000, while all other countries have rates below 2 per 100,000. High liver cancer incidence rates in Laos (33.8), Thailand (29.7) and Vietnam (29.3) are also of concern.

Results from this study are generally in line with several recent reviews (Jemal et al., 2010; Moore et al., 2010a; 2010b), but this study differs in two respects; GLOBOCAN 2008 data was used (as opposed to GLOBOCAN 2002) and this study has added an estimation of the number of DALYs lost. An important difference between the 2002 and 2008 GLOBOCAN data is that country-specific cancer mortality estimates by sex and age group are now based on WHO mortality data, which, as well as being updated, have been corrected to take into account incompleteness or under-coverage (Ferlay et al., 2010). The global burden of disease 2004 update by WHO also reports DALY estimations for cancer (Mathers et al., 2008). However, WHO's DALY estimations and estimates found in this study cannot be reliably compared since the GBD 2004 update used incidence data from GLOBOCAN 2002 and mortality data from other sources.

Differences in lifestyle-related factors contribute to

regional differences in cancer rates, as well as access to screening programs and vaccines (Boyle et al., 2008). The continuing growth and ageing of ASEAN's population, their increasing wealth, changes in lifestyle, and pre-existing factors (especially cancer-related infections) mean that the burden of cancer will continue to increase (Mathers et al., 2008). A significant proportion of this burden of cancer could be prevented through the use of existing cancer control knowledge, and by implementing programs for tobacco control, vaccination (for liver and cervical cancers), and early detection and treatment, as well as public health campaigns promoting physical activity and healthier dietary patterns (Boyle et al., 2008). Targeted prevention and treatment strategies aimed at preventable forms of cancer not only could save lives, but also improve economic development prospects in ASEAN.

The strength of our study is the use of cancer registry data collected in GLOBOCAN 2008 (Lancet, 2010). However, estimates in GLOBOCAN are variable in accuracy, depending on the extent and validity of available data by country, ranging from real and valid counts of cases and deaths, to estimates based on samples, through those based on rates in neighbouring countries. Incidence data for most ASEAN countries were limited by their geographic coverage; therefore the estimates of cancer burden that were derived for a number of ASEAN countries were based on extrapolation. For example, estimates for Laos and Myanmar were based on incidence and mortality estimates from neighbouring countries (mainly Thailand) which were then applied to country-specific demographic data. Despite concern regarding the data quality and the methods of estimation, the GLOBOCAN 2008 data represent the best available, and an unbiased, source of information on the profile of cancer.

The addition of DALY estimations in this study provides a first indication of the burden of cancer in ASEAN countries. Nevertheless, for our estimations we used uniform survival rates across all low- and middle-income countries in ASEAN and thereby under-estimating between-country differences in cancer burden (Pisani et al., 1999). We also assumed no long term disability, although there are some cancers that are likely to have major sequelae causing long-term burden following successful treatment, such as breast and colorectal cancers. This assumption will have led to an underestimation of DALYs lost; however, due to poor survival rates, premature mortality remains the major component of the DALY in low- and middle-income countries and thus this disability assumption is unlikely to be a major source of error.

The limitations of the GLOBOCAN data emphasize the need for population-based cancer registries. Accurate national incidence and mortality data is necessary to monitor status and change, investigate success of cancer control activities, and help in decision making (Valsecchi and Steliarova-Foucher, 2008). Better information on the severity and duration of the disease is also essential to improve estimates of the extent of the cancer burden and to gauge its relative contribution to overall burden of disease. As an important step in addressing this, the ASEAN Foundation, together with The George Institute for Global Health and Roche are undertaking an observational study of 10,000 newly diagnosed patients with cancer within the ASEAN region. The ACTION study (Asean CosTs In ONcology) will assess, in each country, the impact of cancer on quality of life and the economic circumstances of patients and their households (Kimman et al., 2012). Local data from the ACTION study can be used to revise the initial estimates from this burden of cancer study, and combined with data on cost, result in better estimates of the economic burden.

In conclusion, the present study provides a snapshot of cancer burden in ASEAN. A key finding, as reflected in the effect of the age-standardisation procedure on disease burden estimates, is the major impact played by population age distribution on cancer incidence and mortality. Whilst many of the factors that will influence the epidemiology of cancer in this region over coming years such as the effectiveness of new health technologies and programs are uncertain, we can be sure that most, if not all of these countries will undergo some degree of economic growth, and with it, an ageing of their populations and increase in the burden of cancer (Kanavos 2006; Thun et al., 2010). Policy and funding priorities in each of these countries must therefore be geared toward dealing with this trend by planning for the strengthening of health systems to cope with projected increases in cancer prevention, treatment and management needs.

Acknowledgements

This study was funded through an unrestricted educational grant from the Roche Asia Pacific Regional Office.

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