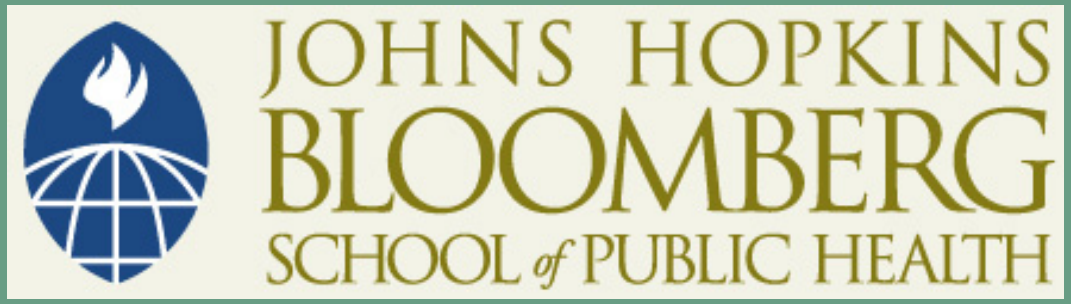

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Applications of Summary Measures: Case Studies

Prasanthi Puvanachandra, MB BChir, MPH
Johns Hopkins University

Outline

- Use of HeaLYs
  - Canadian public health unit and Mandatory Health Programs and Services Guidelines (MPGs)
- Use of DALYs
  - Comparative Risk Assessment (CRA) and environmental health
- DALY vs. HeaLY
  - Burden of cancer in Korea

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Using HeaLYs to Assess Programming Needs in a Public Health Unit

Source: Heale, M.A. et al. *Canadian Journal of Public Health, 91(*2),148-152.

Mandatory Health Programs and Services Guidelines

- December, 1997: Ontario MoH mandated public health units in Ontario to address population health in specific areas
  - Chronic diseases
  - Injury and substance abuse
  - Early detection of cancer
  - Child health
  - Reproductive health
  - Infectious diseases

- Identified **needs assessment** as first step in this process

Needs Assessment

- Wellington and Dufferin counties
- Used HeaLYs methodology to assess population health needs and discuss implications for resource allocation to meet requirements for MPGs
- Utilized simple spreadsheet methodology

Inc * {(CFR*dExF)+(CDR*ExtD*dcDT)}

Variable	Data source
Incidence, Age 0	Cancer: Ontario Cancer Registry Infectious disease: reportable disease Information systems Others: hospital data
Age F	Hospital mortality data: ICD 9 codes
ExO	Coale & Demeny level 26 (looking at natural history of disease)
CFR	Annual deaths/annual incidence (from above data sources)
CDR	Taken as 1 when hospitalization used as incidence (also Ghana and GBD study)
ExtD	Disability indices developed by international panel of experts from WHO
Dt	Hospital data, registries, and GBD study

Disability Variables for Injury from MVC

TABLE II

Disability Variables for Injury from Motor Vehicle Crash (MVC) for Wellington-Dufferin, 1995

Type of Injury	Type of Injury (%) of MVC Injury	De for Type of Injury*	Avg De† for MVC Injury	Avg Dt of Injury (yrs)	Avg Dt for MVC Injury
Spinal	1.3%	0.725	0.009	46.5	0.6
Head	16.9%	0.359	0.061	46.5	7.9
Internal	10.6%	0.208	0.022	1.0	0.1
Superficial	25.5%	0.108	0.028	0.1	0.0
Nerve	1.1%	0.064	0.001	46.5	0.5
Orthopaedic	39.8%	0.272	0.108	1.0	0.4
Disability Indices for MVC	Total:	De	0.229	Dt	9.5

Note: Types of injury used to calculate the disability indices represent 95% of MVC injuries (224 hospitalizations in Wellington-Dufferin in 1995).

* Based on Ontario MVC injury data from Minimal Dataset, 1997 Provincial Annual Report, Ontario Trauma Registry, p.75.

† De - Extent of Disability for each type of injury from The Global Burden of Disease, p.416; Dt - Duration of Disability estimated depending on whether type of injury is permanent or temporary on average.

Source: Heale, M.A. et al. *Canadian Journal of Public Health, 91(*2),148-152.

Input Data: Years of Healthy Life Lost

TABLE IV
Input Data Used in the Calculation of Years of Healthy Life Lost (YHLL), Wellington-Dufferin, 1995

Disease	ICD-9 Code	Incidence #/1000 Pop	Case Fatality Ratio	Average Age at Onset (yrs)	Average Age at Death (yrs)	Extent of Disability Index	Duration of Disability (yrs)
AIDS	042-044	0.009	1.000	32.6	38.0	0.505	5.40
Alcohol Dependence	291,301,305.0	0.816	0.005	41.6	73.0	0.180	43.46
Asthma	493	1.830	0.012	21.5	69.6	0.059	0.66
Bicyclist Crash	E826, E810-819(.6)	0.121	no deaths	22.5	no deaths	0.251	5.77
Breast Cancer	174	0.610	0.338	61.6	71.0	0.331	19.61
Cerebrovascular Disease	430-438	2.131	0.316	74.2	82.9	0.224	8.31
Cervical Cancer	180	0.049	0.273	48.8	62.4	0.275	31.86
Colorectal Cancer	153-154	0.462	0.660	69.4	74.8	0.608	10.52
COPD	490-492,495-496	1.287	0.188	70.3	79.0	0.388	14.79
Dementia	330,331,290	0.597	0.308	78.0	81.6	0.667	9.60
Depression	296.0,.3;300.4;298,309,311	1.234	0.004	39.0	82.5	0.302	48.36
Diabetes	250	0.996	0.100	57.8	73.9	0.129	28.11
Drowning	E910	0.004	1.000	8.0	30.0	0.005	22.00
Falls	E880-888	4.530	0.020	61.4	81.9	0.253	2.99
Hepatitis	70.2-70.9	1.399	0.006	39.0	80.0	0.209	0.16
Influenza	487	0.215	0.083	42.6	81.5	0.276	0.30
Ischaemic Heart Disease	410-414	4.557	0.310	66.7	77.0	0.300	17.30
Low Birthweight	764-765	0.632	0.007	0.0	0.0	0.256	81.91
Lung Cancer	162	0.417	0.935	67.4	69.1	0.766	2.90
Meningitis	036	0.054	no deaths	18.8	no deaths	0.613	0.10
Motor Vehicle Crash	E810-819	1.054	0.085	36.0	42.0	0.229	9.50
Oral Cancer	140-149	0.108	0.292	62.3	72.6	0.300	20.60
Osteoarthritis	715	1.408	0.003	68.3	73.0	0.108	20.39
Other HD	390-409,415-429	4.068	0.796	69.9	78.1	0.133	10.72
Pneumonia	480-486	2.803	0.099	52.8	83.5	0.280	0.30
Prostate Cancer	185	0.431	0.646	70.6	78.6	0.570	10.90
Skin Cancer	172-173	0.067	0.467	58.8	70.3	0.402	21.03
STD	09,614-616	1.032	no deaths	24.2	no deaths	0.250	0.10
Stomach Cancer	151	0.072	0.813	67.6	70.2	0.698	5.95
Substance Abuse	304,305.2-305.9	0.399	0.011	33.0	35.0	0.252	52.69
Suicide/Attempts	E950-959	2.306	0.078	33.0	36.7	0.302	14.82
Tuberculosis	013	0.108	0.167	54.9	65.3	0.264	30.05

Source: Heale, M.A. et al. *Canadian Journal of Public Health, 91(*2),148-152.

Years of Healthy Life Lost by Cause

TABLE V
Years of Healthy Life Lost (YHLL) by Cause, Wellington-Dufferin, 1995

Disease	Life Expectancy at Onset (yrs)	Discounted Life Expectancy at Death (yrs)	Discounted Duration of Disability (yrs)	YHLL/1000 Pop	Ranking
Other HD	20.44	10.22	9.17	38.07	1
Ischaemic Heart Disease	20.44	8.74	13.49	30.80	2
Suicide/Attempts*	53.27	25.80	11.97	12.96	3
Depression*	38.72	4.54	25.52	9.53	4
Cerebrovascular Disease	16.20	6.72	7.36	8.03	5
COPD	16.20	6.72	11.94	7.59	6
Lung Cancer	20.44	14.34	2.78	6.48	7
Colorectal Cancer	20.44	12.09	9.02	6.22	8
Breast Cancer	24.83	12.35	14.82	5.54	9
Dementia*	12.28	7.64	8.34	4.73	10
Prostate Cancer	16.20	7.27	9.30	4.30	11
Motor Vehicle Crash	48.38	23.98	8.27	4.14	12
Falls	24.83	4.10	2.86	3.64	13
Alcohol Dependence	43.53	10.17	24.28	3.61	14
Diabetes	29.37	10.95	18.99	3.47	15
Asthma	63.08	12.07	28.28	3.32	16
Substance Abuse	53.27	26.17	26.47	2.78	17
Osteoarthritis*	20.44	12.55	15.25	2.38	18
Pneumonia	33.99	3.13	0.30	1.10	19
Stomach Cancer	20.44	13.81	5.45	1.08	20
Tuberculosis	33.99	16.93	19.80	0.87	21
Skin Cancer	29.37	13.83	15.60	0.86	22
Oral Cancer	24.83	11.76	15.37	0.86	22
Low Birthweight	82.50	30.53	30.48	0.63	24
Cervical Cancer	38.72	17.67	20.51	0.52	25
Meningitis	68.02	30.87	0.10	0.34	26
AIDS	53.27	25.40	4.99	0.25	27
Bicyclist Crash	63.08	30.77	5.30	0.16	28
Drowning	77.95	27.11	16.10	0.12	29
Hepatitis	48.38	6.62	0.16	0.11	30
Influenza	43.53	4.32	0.30	0.10	31

* Not included in Mandatory Programs and Services Guidelines

Source: Heale, M.A. et al. *Canadian Journal of Public Health, 91(*2),148-152.

Outcome of Needs Assessment

- Cardiovascular disease (CVD) = greatest burden
  - 1st: all other heart disease
  - 2nd: ischemic heart disease
  - 5th: cerebrovascular disease

  } 80 YHLL

- Suicide/attempted suicide: 2nd
- Depression: 3rd
- Chronic obstructive pulmonary disease (COPD): 6th
- Ranking of years of healthy lives lost (YHLL) in Ontario was similar to the WHO's ranking of DALYs for developed countries in 1990

Comparing MPGs with Needs Assessment

MGPs list of diseases	Priority	Needs assessment findings	Ranking
Chronic disease	1	Other HD	1
Unintentional injury	2	IHD	2
Substance abuse	3	Suicide	3
Cancer	4	Depression	4
Child health	5	Cerebrovascular disease	5
Reproductive health	6	COPD	6
Infectious diseases	7	Lung cancer	7

Comments

- MPGs do not address some of the diseases/conditions which are responsible for a significant loss in healthy life

- HeaLYs also used to monitor change in health need, therefore used to evaluate programs with the MPG

- Suggested resource allocation
  - Chronic diseases: cardiovascular disease (CVD), asthma, chronic obstructive pulmonary disease (COPD), diabetes, cancer
  - Early detection programs: breast cancer
  - Injury and substance abuse: alcohol dependence, motor vehicle crashes, falls
  - Other areas needing attention: mental health as a separate needs category—suicide, depression, dementia (18th)
  - Old age conditions: osteoarthritis (10th)

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

DALYs and the Environment

Morrow, Hyder, Puvanachandra

Environmental Disease Burden

- Estimates of the attributable fraction of the total global burden of disease to the environment range from 2% to 80%
- World Bank, World Development Report (1993): 50%
- WHO Rio Earth Summit (2003) revised figure to 25% of Global DALYs being attributable to environment
- Comparative Risk Assessment (2007): 25%-33%

Comparative Risk Assessment (CRA)

- CRA carried out by WHO was first comprehensive evaluation of the global and regional burden of disease due to major risk factors

- Risks from major environmental hazards were analyzed and compared to non-environmental hazards such as smoking, unsafe sex, and malnutrition

Selection of Risk Factors: Criteria

- They were among the leading causes of disease burden
- They were not too specific (for example, every one of the hundreds of air pollutants) or too broad (for example, the environment as a whole)
- The likelihood of causality was based on scientific knowledge
- Sufficient data on exposure was available
- They were potentially modifiable

CRA Findings

- Modifiable environmental risk factors contribute to 24% (21-27%) of global burden of disease (reported in DALYs)
- 353,572 DALYs were reported for the global burden with 187,839 DALYs among children aged between 0-14 years
- 36% of all deaths amongst children (0-14) were attributable to modifiable environmental risk factors (diarrhea, malaria, and respiratory tract infections together equal more than 24% of all deaths)
- Infant death rate from environmental causes was 12 times higher in developing than in developed countries

Health Burden due to Environmental Risk Factors

Ranking of health burden due to environmental risk factors in 2000 by development status
(% total disability adjusted life-years lost due to each risk factor)

High mortality developing countries			Low mortality developing countries			Developed countries		
	% of burden	Rank		% of burden	Rank		% of burden	Rank
Underweight	14.7	1	Alcohol	6.3	1	Tobacco	12.2	1
Unsafe sex	10	2	Blood pressure	5.0	2	Blood pressure	10.9	2
Unsafe water, sanitation, and hygiene	5.5	3	Tobacco	4.0	3	Alcohol	9.2	3
Lack of vaccines	5.3	4	**Road traffic**	3.3	4	Cholesterol	7.5	4
Indoor smoke	3.6	5	Underweight	3.1	5	Overweight	7.4	5
Occupation	1.1	14	**Occupation**	2.4	7	**Road traffic**	1.9	8
Climate change	0.61	20	**Indoor smoke**	1.9	10	**Occupation**	1.5	10
Road traffic	0.31	24	**Unsafe water**	1.8	12	**Urban air**	0.55	15

Environmental risk factors shown in bold

Source: Smith & Ezzati, 2005. Adapted from McMichael, Kjellstrom & Smith. Chapter 9 – Environmental health. In *International public health, diseases, programs, systems and policies* (Second Edition). Merson Black and Mills.

Environmental Disease Burden in Selected Countries

Environmental disease burden in selected countries by World Health Organization region

WHO region	Country	Global burden of disease attributable to the environment		Burden of disease attributable to water, sanitation and hygiene (DALYs/1000 per capita/year)	Burden of disease attributable to indoor air (DALYs/1000 per capita/ year)	Burden of disease attributable to traffic injuries (DALYs/1000 per capita/ year)
		DALYs/1000 per capita/year [world lowest: 14, highest:16]	% of total burden of disease			
Africa	Angola	304	37	109	57	8.9
	Ghana	93	27	14	7.5	4.0
	Botswana	91	13	6.6	2.6	2.4
Europe	Russian Federation	54	20	0.3	0.0	3.7
	Turkey	30	19	3.0	0.9	1.2
Eastern Mediterranean	Pakistan	83	28	22	14	1.8
	Egypt	38	19	6.0	0.2	1.8
South East Asia	Bangladesh	65	25	14	9	2.0
	Viet Nam	38	22	4.0	2.0	2.0
	Thailand	39	19	2	1.5	4.2
Western Pacific	China	34	22	3.0	2.5	2.3
	Philippines	39	20	5.0	3.0	1.4
	Tonga	30	19	3.0	1.6	0.9
Americas	Bolivia	65	24	15	5	2.7
	Brazil	37	18	3.6	0.6	2.7
	Cuba	23	16	1.0	0.3	1.8

Source: World Health Organization (2007). *Environmental burden of disease: Country profiles*. Geneva. www.who.int/quantifying_ehimpacts/countryprofiles/en/index.html

DALY and Environmental Interventions

- Environmental health risks are largely preventable by interventions that often involve sectors other than health
  - For example, energy, transport, agriculture

- Few studies using DALY as indicator of effectiveness in economic analysis of environmental interventions
  - Water connections in rural areas: $35 per DALY saved
  - Malaria control: $35-70 per DALY saved
  - Improved stoves (indoor air): $50-100 per DALY saved
  - Kerosene or LPG stoves: $150-200 per DALY saved

JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Measuring the Burden of Major Cancers due to Smoking in Korea

DALY and HeaLY

Disease Burden in Korea

- Korean Association of Smoking and Health estimates 35,000 deaths per annum (2000) due to smoking-related diseases
- Economic loss due to premature death exceeding 3 trillion won (approx 2.5 billion USD)
- Smoking rate among Korean men is one of the highest in the world
- Of all cancer-related deaths, 35% attributable to smoking (28% due to lung cancer, 7% due to other cancers)

Estimating Disease Burden of Major Cancers in Korea

- Used BOTH DALYs and HeaLYs to assess the true disease burden of cancer in Korea
  - Selected smoking-related diseases by systematic reviews
  - Estimated smoking-related attributable risks using relative risks and age-specific smoking rates
  - Estimated some epidemiological indicators of major cancers such as incidence, CFR, etc.
  - Calculated DALY and HeaLY values of major cancers in Korea

Data Sources

- Incidence and disability indicators: social health insurance claim data
  - Patients who sought health care for the first time in given time period considered as incident cases
- CFR: national registries maintained by National Statistical Office (NSO)
- Dt: DISMOD method developed by GBD group
- ExtD: Global Burden of Disease Study estimates

DALY Results

Cancer	Men					Women				
	YLL		YLD		DALY	YLL		YLD		DALY
	n	%	*n*	%		*n*	%	*n*	%	
Lip, oral cavity, pharynx	23.6	23.5	76.9	76.5	100.5	1.6	4.9	31.3	95.1	33.0
Esophagus	62.2	34.0	120.7	66.0	182.9	3.3	4.9	64.4	95.1	67.7
Pancreas	32.4	61.5	20.3	38.5	52.7	6.3	90.1	0.7	9.9	7.0
Larynx	30.7	74.6	10.5	25.4	41.2	3.7	62.8	2.2	37.2	5.9
Trachea, lung, bronchus	409.5	85.2	71.4	14.8	480.9	71.0	73.5	25.6	26.5	96.6
Cervix uteri	NA		NA		NA	3.6	12.0	26.3	88.0	29.9
Urinary bladder	13.0	23.2	43.1	76.8	56.2	1.0	45.8	1.2	54.2	2.2
Kidney, other urinary	11.9	32.4	24.7	67.6	36.6	0.3	26.2	0.8	73.8	1.1
Stomach	251.1	50.4	246.7	49.6	497.8	37.4	57.8	27.3	42.2	64.6
Liver	132.3	51.8	123.1	48.2	255.4	5.5	20.0	22.0	80.0	27.5
Colorectal	35.5	15.7	190.4	84.3	255.9	4.1	25.2	12.2	74.8	16.3
Total	1000.2	51.8	927.8	48.2	1930.1	137.8	39.2	214.0	60.8	351.8
Units are person-years per 100 000 people. NA, not applicable; YLD, years lived with disability; TLL, years of life lost.										

HeaLY Results

Cancer	Men					Women				
	YHLLpm		YHLLd		YHLL	YHLLpm		YHLLd		YHLL
	n	%	n	%		n	%	n	%	
Lip, oral cavity, pharynx	19.8	20.6	76.4	79.4	96.2	1.2	7.6	14.9	92.4	16.1
Esophagus	46.9	21.3	172.9	78.7	219.8	2.1	4.1	55.7	95.9	58.1
Pancreas	27.6	48.1	29.7	51.9	57.3	4.1	63..5	2.3	36.5	6.4
Larynx	22.7	43.1	29.9	56.9	52.5	2.7	48.9	2.8	51.1	5.5
Trachea, lung, bronchus	311.8	63.7	177.9	36.3	489.7	47.1	55.5	37.8	44.5	84.9
Cervix uteri	NA		NA		NA	2.7	12.3	19.3	87.7	22.0
Urinary bladder	0.0	0.0	28.9	100.0	39.7	0.6	38.7	1.0	61.3	1.6
Kidney, other urinary	10.8	20.0	34.5	80.0	43.0	0.2	18.6	0.7	81.4	0.9
Stomach	160.6	51.7	146.3	48.3	306.8	20.3	25.2	60.2	74.8	80.5
Liver	69.9	30.7	157.8	69.3	227.7	3.0	12.7	20.5	87.3	23.5
Colorectal	20.3	13.7	127.8	76.3	148.1	2.4	17.1	11.7	82.9	14.1
Total	699.3	41.6	982.0	58.4	1681.3	86.7	27.6	226.9	72.4	313.6

Burden of Cancers due to Smoking: Korean Men (2001)

Cancer	DALY	DALY rank	HeaLY	HeaLY rank
Stomach	497.8	1	306.8	2
Trachea, lung, bronchus	480.9	2	489.7	1
Liver	255.4	3	227.7	3
Colorectal	225.9	4	148.1	5
Esophagus	182.9	5	219.8	4
Lip, oral cavity, pharynx	100.5	6	96.2	6
Urinary bladder	56.2	7	43.5	9
Pancreas	52.7	8	57.3	7
Larynx	41.2	9	52.5	8
Kidney, other urinary	36.6	10	39.7	10
Units are person-years per 100 000 people. DALY, disability adjusted life years; HeaLY, healthy life years lost				

Burden of Cancers due to Smoking: Korean Women

- Burden of major cancers due to smoking in Korean women (2001)

Cancer	DALY	DALY rank	HeaLY	HeaLY rank
Trachea, lung, bronchus	96.6	1	85.0	1
Esophagus	67.7	2	58.1	3
Stomach	64.6	3	80.5	2
Lip, oral cavity, pharynx	33.0	4	16.1	6
Cervix uteri	29.9	5	22.0	5
Liver	27.5	6	23.5	4
Colorectal	16.3	7	14.1	7
Pancreas	7.0	8	6.4	8
Larynx	5.9	9	5.5	9
Urinary bladder	2.2	10	1.7	10
Kidney, other urinary	1.1	11	0.9	11
Units are person-years per 100 000 people. DALY, disability adjusted life years; HeaLY, healthy life years lost				