ABSTRACT

In December 1997, public health units in Ontario received revised mandatory program guidelines from the Ministry of Health in advance of the downloading of public health to municipalities. Public health units face difficult decisions in allocating municipal resources to meet the Province's mandated programs. To set priorities for resource allocation, it is critical to assess need across program areas and to use a common unit in doing so. This paper applies the Healthy Life Years (HeaLYs) method in assessing health need related to the mandatory programs for the population of Wellington and Dufferin counties in Ontario. The HeaLYs method incorporates duration and severity of ill-health, incidence and mortality in calculating years of healthy life lost (YHLL). For Wellington-Dufferin, the leading causes of YHLL were concentrated in the program areas of chronic disease, injury, and substance abuse and included four areas not addressed in the MPG (suicide, depression, dementia, and osteoarthritis).

ABRÉGÉ

En décembre 1997, les services de santé publique ontariens ont reçu les critères obligatoires révisés des programmes du ministère de la Santé en prévision du transfert de la santé publique aux municipalités. Les services de santé publique, qui doivent répartir les ressources municipales entre les programmes provinciaux obligatoires, sont confrontés à des décisions difficiles. Pour fixer les priorités en la matière, ils doivent absolument évaluer les besoins des divers secteurs de programme et utiliser un indicateur commun. Le présent article porte sur la méthode des années de vie en santé (AVS), qui a permis d'évaluer les besoins de santé de la population des comtés ontariens de Wellington et de Dufferin par rapport aux programmes obligatoires. La méthode des AVS tient compte de la durée et de la gravité des maladies, de leur incidence et du taux de mortalité pour calculer les années de vie en santé perdues (AVSP). Pour Wellington-Dufferin, on a recensé les principales causes d'AVSP essentiellement dans les secteurs de programme des maladies chroniques, des blessures et de la toxicomanie, mais aussi dans quatre secteurs non visés par les critères obligatoires des programmes (le suicide, la dépression, la démence et l'ostéoarthrose).

Using Healthy Life Years (HeaLYs) to Assess Programming Needs in a Public Health Unit

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In December 1997, the Ontario Ministry of Health published a document, Mandatory Health Programs and Services Guidelines (MPG),[1] which directed public health units in Ontario to address population health in specific areas: chronic diseases, injury and substance abuse, early detection of cancer, child health, sexual and reproductive health, and infectious diseases. The Ministry also encouraged needs/impact-based planning in public health units and identified needs assessment as the first step in this process.[2]

Coinciding with the release of the MPG, responsibility for funding public health programming in Ontario was downloaded to municipalities (January 1, 1998). This change further added to the demand to assess population health needs in order to allocate municipal resources judiciously while simultaneously meeting the requirements of the MPG.

To accurately assess population health needs within the context of the MPG, both the acute effects (e.g., death, hospitalization) and the long-term effects (e.g., pain, suffering, lost productivity, family impact) of ill-health must be considered. In 1996 the World Health Organization (WHO) in collaboration with the World Bank developed a method of assessing disease burden, called Disability Adjusted Life Years (DALYs) which incorporated these components.[3,4] Using this method, WHO compared the burden due to different causes for each of eight geographic groupings. Canada was included in the "established market economies". Hyder, Rotllant and Morrow modified the WHO method as Healthy Life Years (HeaLYs) using a natural history of disease approach and demonstrated their model to be more appropriate in assessing health needs in smaller geographic areas.[5,6]

This paper uses the HeaLYs method to assess population health needs in Wellington and Dufferin counties in 1995 and discusses the implications for resource allocation to meet the requirements of the MPG.

METHODS

Table I provides the equation for calculating years of healthy life lost (YHLL) and describes the variables and their data sources. Data were entered into interlinked electronic spreadsheets (Excel©) developed for the calculation of HeaLYs.[5]

Incidence. While incidence databases exist in Ontario for cancer[7] and infectious diseases,[8] hospitalization[9] was used as a proxy for incidence for all other diseases and conditions. Hospitalization may underestimate incidence, i.e., diseases or conditions may present themselves well in advance of being serious enough to warrant hospitalization or may never require hospitalization. To attempt to adjust for this, the disability ratio in the HeaLYs equation was set at the maximum of 1.0. Rates per 1000 population were calculated based on the 1995 population estimate for Wellington-Dufferin (222,937).[10]

Average Age at Onset. Average age at onset data were obtained from the respective incidence databases or were queried from the hospitalization database in the PHPD.

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TABLE I
Variables Used in the Calculation of Years of Healthy Life Lost (YHLL)

Variable	Explanation	Data Source
Incidence (I) Average Age at Onset (Ao)	Incidence rate per 1000 population per year; Average age of occurrence of disease or condition.	Cancer: Ontario Cancer Registry; Infectious disease – Reportable Disease Information System (RDIS); All other – hospitalizations data from Provincial Health Planning Database (PHPD).
Average Age at Death (Af)	Average age at which death occurred for that disease or condition.	PHPD mortality data for all diseases/conditions by ICD-9 category.
Expectation of Life at Onset (E(Ao)) Expectation of Life at Death (E(Af))	Based on model life tables (Coale and Demeny level 26[11]), using 5-year age groupings for age at onset or age at death.	See data sources for Ao and Af above. Calculation is included in HeaLYs spreadsheet.[11]
Case Fatality Ratio (CFR)	Proportion of those developing the disease who die from the disease (expressed as a decimal between 0.00 and 1.00).	Calculated as annual deaths divided by annual incidence – incidence and death data sources as above.
Case Disability Ratio (CDR)	Proportion of those developing the disease who have disability from the disease (expressed as decimal between 0.00 and 1.00).	Set at 1.0 when hospitalization used as incidence otherwise taken from references 3 and 5.
Extent of Disability (De)	Expressed as decimal from 0.00 for no disability to 1.00 for complete disability equivalent to death.	Disability indices developed by an international panel for the World Health Organization (Ref 3, Vol. 1, pp.412-18).
Duration of Disability (Dt)	Expressed in years – calculation differs depending on whether the resulting disability is permanent or temporary.	Uses EAo and EAf, Incidence and death data sources described above; also Global Burden of Disease, Vol. 1.
Discounting (D%)	Discounting (3% per annum) is applied to life expectancy at death (Af) and to duration of disability (Dt).	See data sources for Af and Dt above. Calculation is included in HeaLYs spreadsheets.[11]

Calculation of Years of Healthy Life Lost (YHLL):
YHLL/1000 pop/yr = I x {[CFR x {E(Ao)-[Af-Ao]}] + [CDR x De x Dt]}
(Ref. 5, p.198)

Average Age at Death. This was queried from the vital statistics database in the PHPD for all diseases and causes.

Life Expectation at Onset and at Death. E(Ao) and E(Af) were determined using a model life table based on a natural history of disease and an average life expectancy of 82.5 years (life expectancy of the longest-living population – the Japanese – as used by WHO).[3,5]

Case Fatality Ratio. This was calculated by dividing the number of deaths in Wellington-Dufferin in 1995 by the incidence (number of new cases or hospitalizations).

Case Disability Ratio. As mentioned above, if hospitalization was used as a measure of incidence, this ratio was determined to be 1.0. For infectious diseases, cancer, and low birthweight, disability ratios were obtained from the background documentation for the development of HeaLYs.[3,5]

Duration of Disability (Dt). The calculation for this variable depends on the nature of the disease or condition, i.e., whether the disease or condition results in permanent or temporary ill-health. Some diseases, e.g., diabetes, result in some level of disability from the time of onset of the disease until death. For these diseases or conditions, the duration of disability is a function of the life expectation at onset and the case fatality ratio. Other diseases or conditions (e.g., pneumonia) are episodic and result in disability for a short period of time with each incident. For these, the duration of disability indices are based on a natural history of disease model.[11]

For the injury causes included in the MPG (i.e., motor vehicle crash, falls, bicycle crash, and drowning), the duration of disability depends on the type of injury sustained. For example, a spinal cord injury will result in permanent disability from the time of incident while a broken arm or leg will result in a much shorter duration of disability. In Ontario, data are available on the proportion of each type of injury that results from each of the injury causes.[12] This information was used to calculate the duration of disability variable for each injury cause based on the proportion of different types of injury for that cause and their respective average duration of disability. Tables II and III illustrate the calculation of Dt for motor vehicle crashes and lung cancer respectively.

Extent of Disability (De). This variable is a measure of the level of ill-health resulting from a disease or condition. The WHO used an international panel to develop a De index between 0.0 and 1.0 for all ICD-9 diseases and conditions.[3] For example, the De for quadrapalegia and parapalegia are 1.0 and 0.5 respectively. The De was taken directly from the WHO tables[3, pp.412-18] for most causes.

However, the De indices for injury and cancer required additional calculations. For injury, the WHO assigned different De for each 'type of injury' , e.g., head injury, fracture, etc.,[3, p.416] rather than for each 'cause of injury' (motor vehicle crash, etc.). As mentioned above, the proportion of each type of injury resulting from each injury cause is reported annually for Ontario.[12] Thus, it was possible to calculate the De separately for each of the injury

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.

TABLE III
Disability Variables for Lung Cancer

Extent of Disability (De) = {[(I-D) x DePT] + [D x DeT]}/I
where,
D = Deaths (for lung cancer = 87)
I = Incidence (93)
DePT = Disability Index for pre-terminal cases (0.146)*
DeT = Disability Index for terminal cases (0.809)*
De for Lung Cancer = {[(93-87) x 0.146] + [87 x 0.809]}/93
= 0.766

Duration of Disability = {[CFR x (Af-Ao)] + [(1-CFR) x EAo]}
where,
CFR = Case Fatality Ratio (for lung cancer = 0.935)
Ao = Average Age at Onset (for lung cancer = 67.4 yrs)
Af = Average Age at Death (69.1)
EAf = Life Expectancy at Onset - discounted (20.44 yrs)
Dt for Lung Cancer = {[0.935 x (69.1-67.4)] + [(1-0.935) x 20.4]}
= 2.92 yrs

* DePT/DeT - Extent of Disability for pre-terminal or terminal cases from The Global Burden of Disease, pp.414-15

causes by multiplying the proportion of each type of injury by the respective De for that type. An example of this calculation is presented in Table II using 1995 data for motor vehicle crashes.

For cancer, there are different De indices depending on the type of cancer and whether or not the case is terminal or pre-terminal.[4, pp.414-15] The De for each type of cancer was determined using the De from the WHO table and factoring in the number of terminal (i.e., deaths), and pre-terminal (i.e., incidence minus deaths) cases (see Table III for an example).

Discounting. Since an individual is more likely to die from any cause as they age, the life expectancy at death and the duration of disability are both discounted 3% per year in calculating HeaLYs (see Table I for equation).[5]

RESULTS

Table IV presents the data from Wellington-Dufferin Counties for 1995 which were used to calculate the YHLL, i.e., incidence, case fatality ratio, age at onset, age at death, duration of disability, and severity of disability. This table also provides the corresponding ICD-9 code for each of the diseases or conditions. The derived variables (life expectancy at onset and death, discounted duration of disability) and the total YHLL are listed in Table V.

Cardiovascular diseases resulted in the greatest burden of disease in Wellington-Dufferin in 1995 as measured by YHLL. These diseases ranked first (all other heart disease), second (ischaemic heart disease) and fifth (cerebrovascular disease) in total YHLL and together represented almost 80 years of healthy life lost per 1000 population in 1995. The third and fourth leading causes of YHLL were suicide/attempted suicide (13.0 years per 1000 population) and depression (9.5 years), while chronic obstructive pulmonary disease (COPD) was sixth (7.6). Others in the top fifteen included four cancers (lung - 6.5 yrs/1000, colorectal - 6.2, breast - 5.5, and prostate - 4.3), alcohol dependence (6.4), motor vehicle crash (4.1), falls (3.6), alcohol dependence (3.6), diabetes (3.5), and asthma (3.3).

DISCUSSION

The ranking of YHLL for diseases/conditions, i.e., the population's health needs in Wellington-Dufferin in 1995, was similar to the WHO's ranking of DALYs for the developed regions of the world for 1990[4, p.262] with cardiovascular diseases and depression ranking highest. The WHO reported that Group II diseases (non-communicable diseases) represented 84% of the years lived with disability for developed regions, Group III (injuries) accounted for 10%, and Group I (communicable disease) 6%. For Wellington-Dufferin in 1995, HIV/AIDS ranked in the bottom quarter of YHLL, whereas for the world's developed regions in 1990, it ranked in the top third.

Although mental health is not included in the MPG, the HeaLYs method applied to Wellington-Dufferin data indicated that depression and suicide/attempted suicide are high-need areas in population health. The WHO also indicated that these two conditions were among the top ten causes of disease burden in the developed regions of the world (depression - 2nd, 6% of total DALYs; suicide - 9th, 2.3% of total DALYs).[4, p.262] Two other diseases/conditions that are not included in the MPG, rank in the WHO's top DALY rankings for developed regions (osteoarthritis - 6th and dementia - 8th). These two conditions ranked 18th and 10th in Wellington-Dufferin and may have ranked higher if incidence data other than hospitalizations were available.

Incidence data may be available in the future through such population surveys as

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

the Ontario Health Survey and the National Population Health Survey. These surveys will be conducted in alternate years beginning in the year 2000 and may provide better incidence data for some conditions, e.g., diabetes or osteoarthritis. However, because of sample size limitations in these surveys, they may only provide incidence data for the most prevalent conditions at the local health unit level.

The MPG also includes programs that are related to risk factors or risk conditions rather than to diseases in the ICD-9 classifications, e.g., tobacco control, nutrition, physical activity. However, this needs assessment could be used to prioritize programming for those factors which relate to diseases with the greatest HeaLYs, e.g., tobacco use, physical inactivity, and obesity, which are risk factors for cardiovascular disease, colon cancer, lung cancer, diabetes. The WHO is currently developing a method of assessing the DALYs for ten risk conditions world-wide (scheduled for publication in 1999), including six that are in the MPG (alcohol abuse, illicit drug use, tobacco use, physical inactivity, unsafe sex, hypertension). The HeaLYs for these risk conditions could then also be used to monitor and evaluate interventions within the MPG.

The use of the HeaLYs method is also suggested as a means of monitoring *change* in health need and should prove useful in evaluating programs within the MPG. A reduction in the total YHLL for a disease or condition could be achieved by interventions which: reduce the number of deaths, the number of premature deaths (i.e., average age at death), or the incidence of the disease or condition; increase the age at onset of the disease or condition; or, decrease the duration of disability associated with the disease or condition.

CONCLUSIONS

Data exist at the public health unit level within Ontario to support the calculation of years of healthy life lost (YHLL) for the diseases and conditions included in the Mandatory Health Programs and Services Guidelines (MPG). In 1995, the areas of greatest health need as measured by YHLL for Wellington-Dufferin were cardiovascular diseases (76.9 YHLL/1000 population), suicide/attempted suicide (13.0) and depression (9.5). Within specific MPG program areas, this would suggest concentrating programming resources as follows: chronic disease – cardiovascular diseases, asthma, COPD, diabetes, lung, colorectal, and prostate cancers; for early detection of cancer – breast cancer; for injury and substance abuse – alcohol dependence, substance abuse (other than alcohol), motor vehicle crashes, and falls. This needs assessment also suggests that the MPG do not address some diseases or conditions which are responsible for significant loss of healthy life in Wellington-Dufferin, including suicide, depression, dementia and osteoarthritis.

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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

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