Age-Standardized Expected Years of Life Lost: Quantification of Cancer Severity

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BACKGROUND

The critical implications of the expected years of life lost (EYLL) index of cancer for health policy assessments have been largely overlooked. In this study, we advocate to standardize life lost indices, named age-standardized EYLL.

METHODS

We calculated the unstandardized EYLL (UEYLL) and the age-standardized EYLL (AEYLL) to facilitate comparisons among 20 major cancer types including cancers of oral cavity, nasopharynx, esophagus, stomach, colon, rectum, liver, pancreas, bronchus and lung, female breast, cervix uteri, corpus uteri, ovary, prostate, kidney, bladder, brain, thyroid, leukemia, and non-Hodgkin lymphoma from the Taiwan Cancer Registry (TCR) database. The International Cancer Survival Standard was used for calculating AEYLL.

RESULTS

A total of 797,314 patients aged more than 15 years between 2006 and 2015 were collected from the TCR database. The unstandardized EYLLs of three leading cancers for both genders were brain (22.5 years), esophagus (19.0 years), and pancreas (15.2 years). However, the age-standardized EYLLs of three leading cancers for both genders were pancreas (16.6 years), brain (15.7 years) and esophagus (14.6 years).

Table 1 Unstandardized EYLLs and age-standardized EYLLs of 20 cancers in men and women combined in Taiwan (standard error in parenthesis)

Cancer type	Number of patients	Mean age at diagnosis	Unstandardized		Age-standardized	
			EYLL (SE)	Rank	EYLL (SE)	Rank
Pancreas	17,994	67.6	15.2 (0.2)	3	16.6 (0.2)	1
Brain	6929	49.4	22.5 (1.5)	1	15.7 (0.3)	2
Esophagus	22,244	58.9	19.0 (0.4)	2	14.6 (0.1)	3
Bronchus and lung	109,075	68.0	13.0 (0.2)	7	14.0 (0.1)	4
Liver	112,904	64.5	14.7 (0.1)	4	14.0 (0.1)	5
Leukemia	18,120	57.4	11.9 (0.7)	8	11.0 (0.3)	6
Stomach	37,994	68.2	9.6 (0.3)	10	10.6 (0.2)	7
Ovary	12,308	52.0	13.7 (1.3)	6	10.5 (0.5)	8
Oral cavity	62,406	55.0	14.0 (0.3)	5	9.8 (0.2)	9
Nasopharynx	15,699	51.0	10.5 (0.9)	9	8.0 (0.3)	10
Non-Hodgkin	17,615	61.9	8.7 (0.7)	11	7.7 (0.3)	11
Kidney	10,812	61.2	6.9 (0.8)	12	7.1 (0.6)	12
Colon	79,349	66.6	6.3 (0.2)	14	6.5 (0.1)	13
Rectum	53,339	64.7	6.7 (0.3)	13	6.3 (0.2)	14
Bladder	20,920	69.6	5.3 (0.3)	18	5.6 (0.3)	15
Cervix uteri	16,665	57.4	5.9 (0.3)	16	5.5 (0.2)	16
Corpus uteri	17,336	54.3	5.4 (0.9)	17	5.1 (0.4)	17
Female breast	96,204	53.9	6.0 (0.5)	15	4.3 (0.2)	18
Prostate	43,320	73.2	2.8 (0.2)	19	3.4 (0.5)	19
Thyroid	26,081	48.4	2.1 (1.5)	20	3.0 (0.8)	20
All cancers irrespective of types	903,935	62.3	9.8 (0.1)	–	8.9 (0.1)	–

Table 2 Unstandardized EYLLs and age-standardized EYLLs of 16 cancers in men in Taiwan (standard error in parenthesis)

Cancer type	Number of patients	Mean age at diagnosis	Unstandardized		Age-standardized	
			EYLL (SE)	Rank	EYLL (SE)	Rank
Pancreas	10,224	66.7	15.2 (0.2)	3	15.6 (0.2)	1
Esophagus	20,745	58.4	19.3 (0.3)	2	14.6 (0.1)	2
Brain	3923	49.5	20.0 (1.8)	1	14.5 (0.3)	3
Bronchus and lung	67,687	69.0	12.2 (0.2)	6	13.8 (0.1)	4
Liver	78,676	62.6	15.2 (0.1)	4	13.4 (0.1)	5
Stomach	23,977	69.0	9.2 (0.3)	9	10.5 (0.3)	6
Leukemia	10,695	58.3	11.1 (0.8)	7	10.1 (0.4)	7
Oral cavity	56,946	54.5	14.6 (0.3)	5	10.0 (0.2)	8
Nasopharynx	11,882	51.1	10.2 (0.8)	8	8.0 (0.4)	9
Non-Hodgkin	9669	62.3	8.6 (0.9)	10	7.5 (0.4)	10
Rectum	32,286	64.8	6.6 (0.3)	11	6.1 (0.2)	11
Kidney	7136	60.8	5.7 (0.7)	13	6.1 (0.6)	12
Colon	43,822	66.8	6.1 (0.3)	12	6.0 (0.2)	13
Bladder	14,869	69.5	4.3 (0.4)	14	4.6 (0.3)	14
Thyroid	6188	49.9	4.1 (2.7)	15	4.1 (0.8)	15
Prostate	43,320	73.2	2.8 (0.2)	16	3.4 (0.5)	16
All cancers irrespective of types	502,842	63.7	10.6 (0.1)	–	9.7 (0.1)	–

Table 3 Unstandardized EYLLs and age-standardized EYLLs of 19 cancers in women in Taiwan (standard error in parenthesis)

Cancer type	Number of patients	Mean age at diagnosis	Unstandardized		Age-standardized	
			EYLL (SE)	Rank	EYLL (SE)	Rank
Pancreas	7770	68.7	15.8 (0.4)	2	18.0 (0.4)	1
Brain	3006	49.1	26.0 (2.1)	1	17.1 (0.5)	2
Liver	34,228	68.8	13.5 (0.2)	6	15.1 (0.3)	3
Esophagus	1499	66.0	15.0 (1.0)	3	15.0 (0.4)	4
Bronchus and lung	41,388	66.2	14.3 (0.3)	4	14.3 (0.2)	5
Leukemia	7425	56.1	13.5 (1.3)	7	12.0 (0.5)	6
Stomach	14,017	66.8	10.1 (0.4)	10	10.8 (0.3)	7
Ovary	12,308	52.0	13.7 (1.3)	5	10.5 (0.5)	8
Kidney	3676	61.8	10.6 (1.6)	9	9.2 (1.0)	9
Nasopharynx	3817	50.7	11.5 (2.5)	8	8.6 (0.8)	10
Bladder	6051	70.0	7.7 (0.6)	13	8.5 (0.6)	11
Non-Hodgkin	7946	61.5	8.6 (0.9)	12	7.8 (0.6)	12
Oral cavity	5460	60.4	9.2 (1.2)	11	7.7 (0.5)	13
Colon	35,527	66.4	6.2 (0.3)	15	7.0 (0.2)	14
Rectum	21,053	64.6	7.0 (0.4)	14	6.9 (0.4)	15
Cervix uteri	16,665	57.4	5.9 (0.3)	17	5.5 (0.2)	16
Corpus uteri	17,336	54.3	5.4 (0.9)	18	5.1 (0.4)	17
Female breast	96,204	53.9	6.0 (0.5)	16	4.3 (0.2)	18
Thyroid	19,893	47.9	1.5 (2.1)	19	3.6 (1.1)	19
All cancers irrespective of types	401,093	60.4	8.6 (0.1)	–	8.0 (0.1)	–

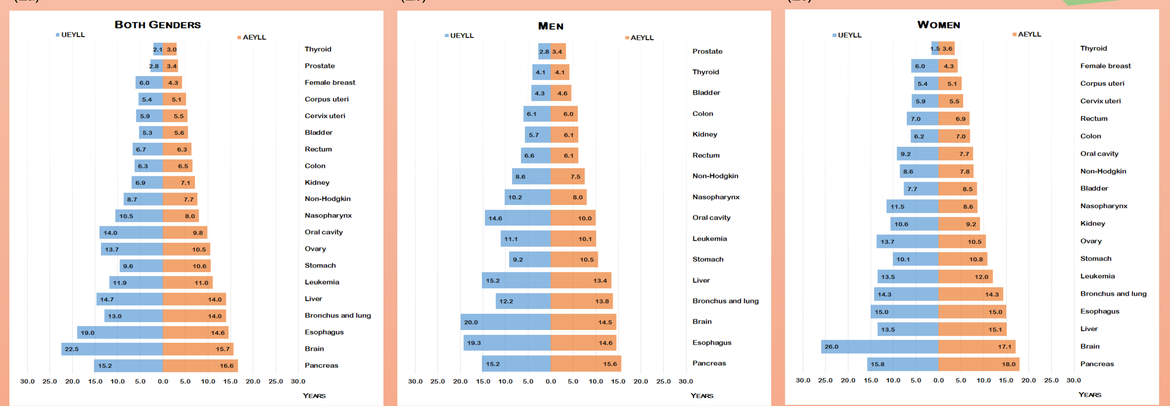

Fig. 1 Unstandardized expected years of life lost (UEYLL) and age-standardized EYLL (AEYLL) associated with 20 cancers in men and women combined (a), 16 cancers in men (b), and 19 cancers in women (c).

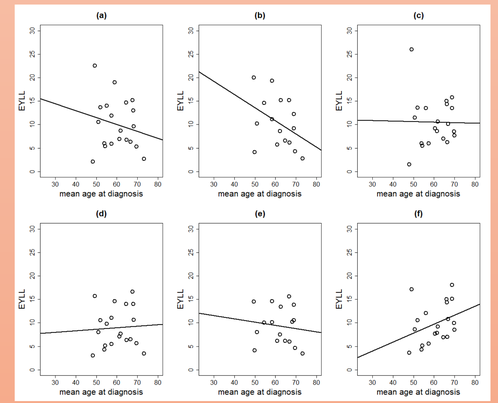

Fig. 2 Scatterplots of mean ages at diagnoses and the unstandardized expected years of life lost (EYLL) associated with 20 cancers in men and women combined (a), 16 cancers in men (b), and 19 cancers in women (c), as well as the age-standardized EYLL associated with 20 cancers in men and women combined (d), 16 cancers in men (e), and 19 cancers in women (f).

Among 16 cancers in the men and 19 cancers in the women, pancreatic cancer was the most severe cancer in Taiwanese population, with the greatest age-standardized EYLL for men (15.6 years) and women (18.0 years). Negative correlations of moderate magnitudes were observed between the unstandardized EYLLs and the mean corresponding patient ages at the time of diagnosis among 20 cancers for both genders (correlation coefficient = −0.20). This indicated that a larger unstandardized EYLL for a cancer type may have been due to a younger mean age at diagnosis rather than greater severity. After adjusting the confounding effect of age, the age-standardized EYLL properly reflected the severity of the corresponding cancer type (correlation coefficient = 0.06).

CONCLUSION

The unstandardized EYLL represents an overall assessment of disease burden, whereas the age-standardized EYLL is a suitable measure of disease severity. We suggest that both measures be incorporated into routine annual reports of cancer statistics alongside the usual incidence and mortality rates and their age-standardized counterparts.

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