Decomposing Cancer Burden: Impact of Ageing and Demographic Shifts in Future Projections up to 2050 in Korea

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Introduction: With a rapidly aging population in Korea, individuals aged 65 and older are projected to account for over 40% of the population by 2050. This demographic shift presents significant public health challenges, particularly in the rising cancer burden. Despite the established link between cancer risk and aging, the systematic impact of population aging on future cancer trends remains unaddressed, creating a gap in public health planning. This study employs advanced predictive modeling and decomposition analysis to assess the impact of aging and population changes on future cancer trends, aiming to guide targeted public health policies and interventions tailored to the evolving demographic landscape.

Materials and Methods: Age- and sex-specific cancer incidence and mortality data from the Korea Central Cancer Registry and Statistics Korea were analyzed, focusing on five major cancers. The CanProj (Qiu Z et.al) model was used to forecast cancer incidence and mortality up to 2050, based on the recent cancer statistics from 2001 to 2020. Decomposition analysis, following Chen et al.'s methodology, quantified the contributions of population size, aging, and potential risk factors on cancer incidence and mortality. The projected future cancer burden was quantified by stratifying it into four disease-burden levels- Declining disease Burden, Aging-fueled disease burden, multi-factor disease Burden, Escalating disease burden.

Results: An aging-fueled burden is projected for male prostate cancer, where population ageing alone is expected to raise incident cases by 1093 % and produce a commensurate surge in deaths despite a stable age-standardized incidence rate (ASIR) and mortality rate (ASMR). A multi-factor burden characterizes colorectal cancer (ageing contributions 188 % in men, 151 % in women) and lung and trachea (ageing contributions 295 % in men, 328 % in women): rising ASIRs combine with ageing to enlarge incident cases, while declining ASMRs moderate—but do not prevent—absolute increases in deaths. A declining burden is observed for stomach, liver, and female cervical cancers; concurrent decreases in ASIR and ASMR lead to falling incident cases and deaths, thereby offsetting demographic pressure. An escalating burden is evident in female breast cancer, where ageing contributes 133 % to the projected rise in deaths alongside a growing ASMR, yielding simultaneous increases in cases and mortality. These findings show that demographic ageing systematically amplifies both incidence and mortality, underscoring the need for cancer-specific control strategies that integrate demographic dynamics.

Conclusion: Population aging has emerged as the primary driver of the rising cancer burden, despite potential declines in other cancer risk factors. Our study highlights the profound impact of aging on cancer burden, particularly for cancers like prostate, lung, and breast, which are projected to rise substantially. These findings underscore the urgent need to integrate demographic shifts into future public health planning and to develop targeted cancer control strategies that address the challenges posed by an aging population.

Keyword: Health and Morbidity; Population Ageing; Decomposition analysis; Population projections, forecasts, and estimations

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Table1. Analysis of Male Cancer Burden Attributable to Population Shifts (2001-2050)

Type	Cancer	Period 2001–2005		Period 2046-2050		Case/Death Changes over Period 2046–2050			
		Case/Death	ASR	Case/Death	ASR	Net Change (%)	Population Size (%)	Population Ageing Shift (%)	Potential Risk (%)
Incidence	Stomach	79,108	65.70	69,707	16.52	-11.9	-1.2	149	-160
	Colon/rectum	42,693	35.5	79,166	3.69	85.4	-1.5	188	-101
	Liver	53,858	44.70	37,917	4.02	-29.6	-1.0	108	-137
	Pancreas	9,148	7.60	47,013	23.28	413.9	-2.8	351	66
	Lung, trachea	57,266	47.60	173,395	115.19	202.8	-2.1	295	-90
	Prostate (male)	13,873	11.50	276,538	7.65	1893.4	-8.1	1093	809
Mortality	Stomach	37,271	31.00	15,447	3.00	-58.6	-1.2	205	-262
	Colon/rectum	14,888	12.4	36,262	5.69	143.6	-2.0	322	-177
	Liver	40,816	33.90	23,009	4.59	-43.6	-1.0	123	-165
	Pancreas	8,615	7.20	31,879	5.99	270	-2.3	329	-57
	Lung, trachea	47,532	39.50	95,476	15.93	100.9	-1.8	293	-190
	Prostate (male)	3,998	3.30	30,579	3.21	664.9	-4.5	837	-167

Note: The case/death in the table represents the total number of cases or deaths over the period, i.e. five years.

* **Net Change:** Actual variation in the comparison year.
† **Population Size:** Impact on occurrences or deaths due to changes in total population size.
‡ **Population Aging Shift:** Change in the proportion of the elderly population affecting the distribution of occurrences or deaths.
§ **Potential Risk:** endo-exogenous factors affecting individuals and society, beyond population changes.

Table2. Analysis of Female Cancer Burden Attributable to Population Shifts (2001-2050)

Type	Cancer	Period 2001–2005		Period 2046-2050		Case/Death Changes over Period 2046–2050			
		Case/Death	ASR	Case/Death	ASR	Net Change (%)	Population Size (%)	Population Ageing Shift (%)	Potential Risk (%)
Incidence	Stomach	40,798	34.40	40,418	16.90	-0.9	2.3	119	-122
	Colon/rectum	31,756	26.7	60,330	22.21	90	3.0	151	-64
	Liver	17,719	14.90	16,356	9.74	-7.7	2.3	124	-134
	Pancreas	7,099	6.00	52,836	11.50	644.3	7.4	378	259
	Lung, trachea	20,782	17.50	113,133	36.76	444.4	5.8	328	110
	Breast (female)	43,500	36.60	230,349	47.45	430	5.5	106	318
	Cervix Uteri (female)	21,726	18.30	10,551	17.99	-51	1.6	32	-85
Mortality	Stomach	20,135	17.00	9,085	1.60	-54.9	2.2	159	-216
	Colon/rectum	12,329	10.4	24,708	3.32	100.4	3.4	241	-144
	Liver	13,317	11.20	10,432	1.72	-21.7	2.3	142	-166
	Pancreas	6,593	5.60	35,170	5.09	433.4	5.7	354	74
	Lung, trachea	16,940	14.30	29,112	3.60	71.9	3.3	238	-170
	Breast (female)	7,071	6.00	20,093	6.12	184	3.5	133	48
	Cervix Uteri (female)	5,106	4.30	3,850	1.71	-25	2.2	111	-138

Note: The case/death in the table represents the total number of cases or deaths over the period, i.e. five years.

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Table3. Trends and patterns in future cancer burden by sex

Pattern	Time Trends (2001-2005 VS 2046-2050)			Cancer example
	Population Size	Population Ageing Shift	Potential Risk	
Declining disease Burden				
ASR Δ < 0 and Net Case Δ < 0, ASR Δ < 0 and Net Case Δ < 0	↓/↓	↑↑/↑↑	↓↓/↓↓+	Stomach, Liver (Male)
	↑/↑	↑↑/↑↑	↓↓/↓↓+	Stomach, Liver (Female)
	↑/↑	↑/↑↑	↓/↓↓	Cervix Uteri (Female)
Aging-fueled disease burden				
ASR Δ < 0 but Net Case Δ > 0, ASR Δ < 0 but Net Case Δ > 0	↓/↓	↑↑/↑↑↑	↓↓/↓↓	Colon/rectum (Male)
	↑/↑	↑↑/↑↑	↓/↓↓	Colon/rectum (Female)
	↓↓/↓	↑↑↑/↑↑↑	↑↑↑/↓↓	Prostate (Male)
Multi-factor disease Burden				
ASR Δ > 0 and Net Case Δ > 0, ASR Δ < 0 but Net Case Δ > 0	↓/↓	↑↑/↑↑	↓/↓↓	Lung, trachea (Male)
	↑↑/↑	↑↑↑/↑↑	↑↑/↓↓	Lung, trachea (Female)
Escalating disease burden				
ASR Δ > 0 and Net Case Δ > 0, ASR Δ > 0 and Net Case Δ > 0	↑↑/↑	↑↑/↑↑	↑↑↑/↑	Breast (Female)

Note: The + mark indicates the presence of a factor that affects at least one more level than the current state. Blue color is Incidence, Red color is mortality.

* **Population Size:** (↑): Increase or decrease from 0% to ±5%; (↑↑): Increase or decrease of more than ±5% but less than ±10%; (↑↑↑): Increase or decrease of more than ±10%.
† **Population Ageing Shift:** (↑): Increase or decrease from 0% to ±100%; (↑↑): Increase or decrease of more than ±100% but not more than ±300%; (↑↑↑): Increase or decrease of more than ±300%.
‡ **Potential Risk:** (↑): Increase or decrease from 0% to ±100%; (↑↑): Increase or decrease of more than ±100% but less than ±200%; (↑↑↑): Increase or decrease of more than ±200%.