Effects of future population aging on the incidence burden of cancers in South Korea: A projection and decomposition analysis

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INTRODUCTION

- Amid global medical advancements leading to increased life expectancy, Korea is projected to experience the **world's highest aging rate**, further exacerbated by low birth rates, signalling an **intensified aging population trend.**
- Given the concurrent rise in cancer cases and related fatalities in Korea, the **burden on the elderly population is escalating**. This underscores the emergent necessity for research into future cancer burdens within this rapidly aging demographic.
- Therefore, the purpose of this study is to analyse the impact of aging by quantifying the burden of future cancer incidence among **the elderly for a strategic approach to cancer burden in Korea**, which has entered an aging society.

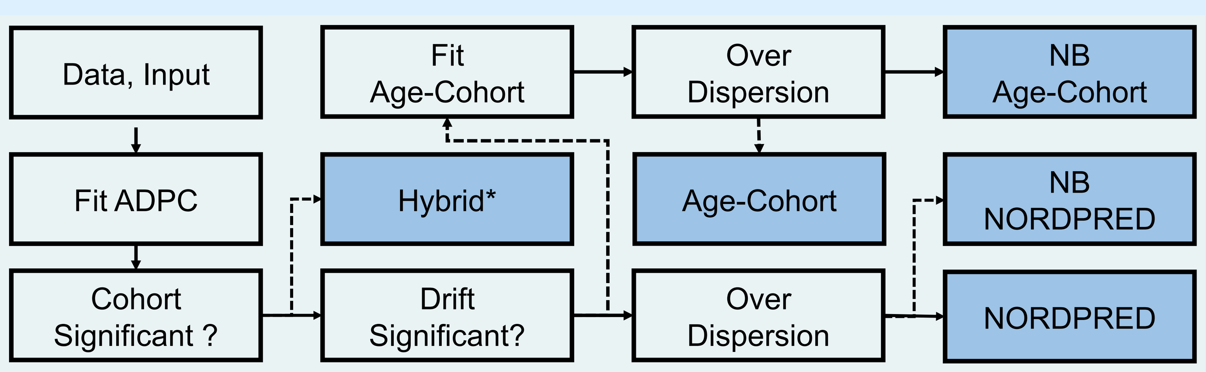
AIM

1) What is the best model for each cancer type?
2) How can use decomposition analysis to determine the effects of aging?
3) Which cancer types have the biggest impact on aging?

→ Through understanding and measurement of the aging effect, elucidate the relationship between population aging and the cancer burden in South Korea.

METHOD

- Based on data obtained from the Korean Statistical Information Service (KOSIS) from 2000 to 2019, the number of people and deaths from gastric cancer (C16), colorectal & anal cancer (C18-C21), liver cancer (C22), pancreatic cancer (C25), lung cancer (C33-C34), skin cancer(C43-C44), breast cancer (C50), prostate cancer (C61), bladder cancer (C67), and thyroid cancer (C73) was projected by 2040 using the composite NORDPRED(NP) model which is decision tree for cancer incidence projection model selection (canproj algorithms)
- Changes in the projected measurements were quantified into ageing, population growth, and age- standardized incidence rate through decomposition analysis (using Cheng's method).



Decision tree for cancer incidence projection model selection

Main effects (Mp, Ms, MI)
2 & 3-way interactions (Ips, IpI, IsI, $IpsI$)

$$\sum_{i=1}^{p}(N_2 - N_1)[(s_{i1}r_{i1} - s_{i2}r_{i2}) + (s_{i2}r_{i1} - s_{i1}r_{i2})] \equiv 0$$
$$\sum_{i=1}^{p}(s_{i2} - s_{i1})[(N_2m_{i1} - N_1r_{i2}) + (N_1r_{i1} - N_2r_{i2})] \equiv 0$$
$$\sum_{i=1}^{p}(r_{i2} - r_{i1})[(N_2s_{i2} - N_1s_{i1}) + (N_1s_{i2} - N_2s_{i1})] \equiv 0$$

$$PS = Mp + 1/2IpI + 1/2Ips + 1/3IpsI$$
$$AS = Ms + 1/2IsI + 1/2Ips + 1/3IpsI$$
$$ASIR = MI + 1/2IpI + 1/2IsI + 1/3IpsI$$

Cheng's decomposition method

RESULTS

Male	Selection		2019 (Reference)			2040 (Projection)			Attributable Incidence Case				
ICD-10	Method	GoF	Case	65+ Case	65+ PAF	Case	65+ Case	65+ PAF	Population growth	Population aging	ASIR	* Net Change	%
C16	Hybrid (nba-specific)	0.468	19,760	10,240	44.8	18,240	14,106	66.8	-775	12387	-13131	-1520	62.7
C18-C21	Hybrid (age-specific)	0.121	17,256	8,888	44.4	20,181	14,935	61.9	-752	11924	-8247	2925	69.1
C22	ADPC (Negative-binomial)	0.326	11,541	5,405	39.1	10,074	7,215	58.4	-441	6431	-7458	-1467	55.7
C25	ADPC (Poisson)	0.058	4,150	2,522	55.1	7,820	6,287	71.3	-233	4081	-178	3670	98.3
C33-34	ADPC (Negative-binomial)	0.711	20,331	14,740	68.5	32,681	28,144	79.7	-1070	21652	-8233	12350	106.5
C43-C44	ADPC (Poisson)	0.488	3,133	1,985	58.0	8,086	6,889	78.3	-212	4123	1042	4953	131.6
C61	ADPC (Negative-binomial)	0.017	16,803	12,965	73.8	47,429	44,734	91.7	-1193	24852	6967	30626	148
C67	ADPC (Poisson)	0.514	3,984	2,816	66.4	6,877	6,046	82.3	-217	4531	-1421	2893	113.7
C73	Hybrid (nba-specific)	0.549	7,516	794	-2.5	12,611	2,084	-22.3	-397	-585	6077	5095	-7.8
Female	**Selection**		**2019 (Reference)**			**2040 (Projection)**			**Attributable Incidence Case**				
ICD-10	Method	GoF	Case	65+ Case	65+ PAF	Case	65+ Case	65+ PAF	Population growth	Population aging	ASIR	* Net Change	%
C16	ADPC (Negative-binomial)	0.372	9,732	5,304	45.19	10,615	8,251	64.69	-242	5188	-4063	883	53.3
C18-C21	ADPC (Negative-binomial)	0.129	12,095	7,127	50.52	13,918	10,648	62.75	-313	7195	-5059	1823	59.5
C22	ADPC (Poisson)	0.443	4,064	2,696	59.45	3,807	2,975	65.35	-97	2444	-2604	-257	60.1
C25	ADPC (Poisson)	0.364	3,949	2,792	64.7	7,868	6,540	73.24	-137	3531	525	3919	89.4
C33-34	ADPC (Negative-binomial)	0.315	9,629	6,074	55.52	18,685	15,705	74.71	-324	7933	1446	9056	82.4
C43-C44	ADPC (Negative-binomial)	0.307	4,041	3,078	71.29	9,225	8,422	86.2	-151	4640	696	5184	114.8
C50	ADPC (Negative-binomial)	0.087	24,820	4,374	0.76	37,977	18,425	18.37	-709	3738	10127	13157	15.1
C67	ADPC (Poisson)	0.709	911	701	72.23	1,559	1,384	82.2	-29	844	-167	648	92.7
C73	Hybrid (nba-specific)	0.512	23,160	2,402	-7.98	27,677	5,989	-24.25	-594	-2304	7414	4517	-9.9

*GoF : Goodness of Fit
* nba-specific : Negative-binomial distribution based age-specific trend * age-specific : Poisson distribution based age-specific trend

Table 1. Attribution by factor from decomposition analysis of cancer incidence by sex projected from 2019 to 2040

- When observations indicated substantial variability in trend, the hybrid model was selected, while the NP model was selected for instances presenting a steady increase.
- In order of increasing absolute number of cases, C33-C34, C61, and C16 were the top three cancers in men, followed by C33-C34, C18-C21, and C16 in women.
- While all cancer incidences are trending upwards, thyroid cancer shows a negative contribution, stemming from a larger surge in the elderly population relative to the increase in cases.

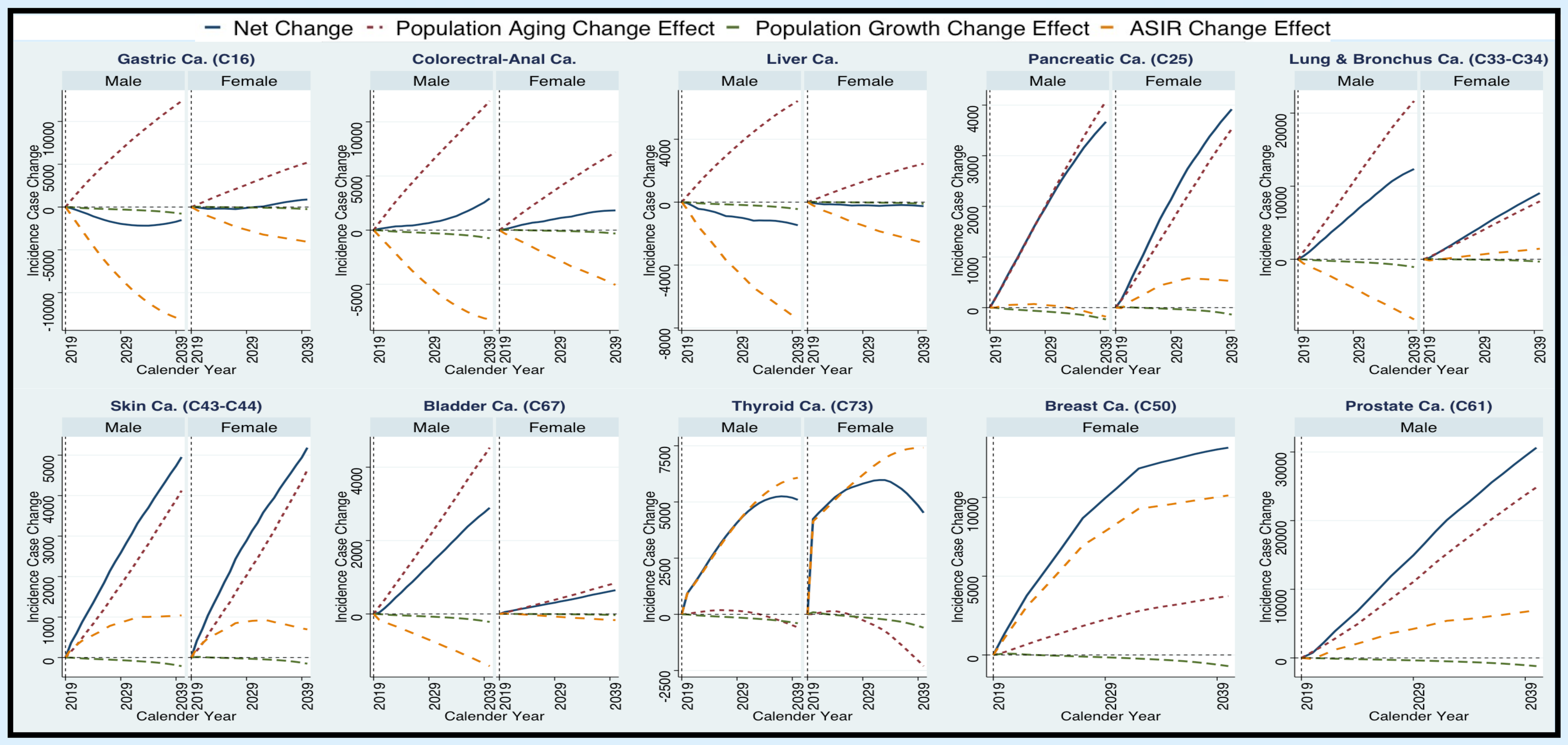


Figure1. Changes in the attribution of factors to cancer incidence for men and women with projections from 2019 to 2040

- Attribution to population growth in all cancers is on the decline.
- Except for C50 and C73, the aging effect emerged as the principal attributor to the rise in leading cancer causes.
- Long-term trends reveal a sustained decline in the incidence of stomach cancer in men, liver cancer in both sexes, and thyroid cancer. This pattern is likely attributable to a substantial reduction in cases among younger age groups, despite a continued rise within the elderly population.

CONCLUSIONS

- The NP model, a predictive tool extensively used in epidemiological studies, may not ideally accommodate non-sustained incremental changes, suggesting the need for Hybrid approach for such dynamical patterns.
- For all cancers and sexes, the incidence increases in older age groups, with the ageing factor's attribution rising for all but thyroid cancer (attribution is declining, but incidence case is still increasing in older age groups).
- As our society ages, health professionals and policymakers must enact preventive measures to mitigate the growing burden of cancer in the elderly.

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