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Research article

The trend of DALY of breast, colorectal, oral, and cervical cancers in Taiwan in 2005–2017

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ABSTRACT

Objectives: This study used the Disability-Adjusted Life Years (DALYs) to quantify the long-term trends for four cancers (oral cancer, colorectal cancer, breast cancer, and cervical cancer) that have undergone cancer screening in Taiwan.
Methods: DALYs were calculated as the sum of Years of Life Lost (YLL) due to premature mortality and Years Lived with Disability (YLD). YLLs were determined using cancer-specific mortality data from the Health Promotion Administration (HPA), Ministry of Health and Welfare, based on age-specific life expectancy. YLDs were estimated by combining the incidence rates of the cancers, average disability durations, and disability weights, with data sourced from the Taiwan Cancer Registry. Results were expressed as DALYs per 100,000 population.
Results: The disease burden has significantly increased over the past 12 years. Oral cancer rose from 263 to 368 DALYs per 100,000 population (40 % increase), colorectal cancer from 343 to 563 DALYs (64 % increase), and breast cancer from 446 to 782 DALYs (75 % increase), while the burden of cervical cancer decreased from 168 to 147 DALYs per 100,000 population from 2010 to 2017, showing a 13 % reduction. At the cancer stages, the impact of YLDs was mostly at cancer stage IV (oral cancer), cancer stage 0 (colorectal and cervical cancer), and stage I (breast cancer).
Conclusion: Oral cancer increased by 40 %, colorectal cancer by 64 %, and breast cancer by 75 % from 2005 to 2017, while cervical cancer decreased by 13 % between 2010 and 2017. YLD contributions were highest in stage IV for oral cancer, stage 0 for colorectal and cervical cancers, and stage I for breast cancer. The highest DALYs consistently occurred in the 50–69 age group across all cancer types, highlighting the significant burden on middle-aged populations.

1. Introduction

Cancer is a leading cause of death worldwide, accounting for nearly 10 million deaths in 2020, presents a significant mortality burden, and is rapidly rising in incidence globally [1]. The World Health Organization (WHO) mentioned that between 30 % and 50 %

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of cancers can currently be prevented by avoiding risk factors and using evidence-based prevention strategies; however, governments and WHO still urge to accelerate action to achieve the targets specified in the 2030 United Nations (UN) Agenda for Sustainable Development to reduce premature mortality from cancer (https://www.who.int/news-room/fact-sheets/detail/cancer) [2].

The National Cancer Prevention Program in Taiwan aims to reduce the incidence and mortality of cancer while improving the quality of life for cancer patients. Early identification and treatment of cervical, breast, colorectal, and oral cancers are promoted through Papanicolaou (Pap) smears, mammography, fecal immunochemical testing (FIT), and oral mucosa screening, respectively [3]. Following the population-based screening policy in Taiwan, studies have already been evaluated the incremental cost-effectiveness ratio (ICER) for oral [4] and breast cancer [5]; the life-years savings and costs of cervical cancer [6]; the mortality reduction by FIT [7]; and the prospective cohort study of low-dose CT (LDCT) screening among never-smokers [8].

Disability-adjusted life years (DALYs) are a key measure of disease burden that include both fatal and non-fatal impacts of disease and are used in the development of national and global health policy [9,10]. Soerjomataram et al. [11,12] have established a validated methodological framework for estimating country-specific DALYs related to 27 different cancer types. This framework is based on a three-stage natural history model for each cancer site and estimates the cancer stage-specific disability duration and disability weight (*DW*) [11,12]. This model better simulates progressing cancer, especially in assessing treatment accessibility and quality of survival, and differs from GLOBOCAN and the Global Burden of Disease's (GBD) methods for estimating the burden. This modeling approach produces extensive simulations of each stage's consequences to address differences in current estimates and improve prediction reliability and accuracy [11,12].

However, there is a lack of studies investigating and comparing the overall combined effect of these four types of cancer, including different cancer stages (stage 0 - IV) and the disease burden across various age groups in Taiwan. This information is essential for the effective distribution of resources and the development of strategies for cancer control. Moreover, population-scale data on temporal changes are provided to improve the design of interventions and public health policies, while evaluating the impact of cancer incidence and mortality on the disease burden. Hence, this study assesses the DALYs-based disease impact assessment for oral, colorectal, breast, and cervical cancers in Taiwan regions from 2005 to 2017 and guides governmental agencies supporting priorities on cancer control priorities, thereby contributing to cancer prevention and the promotion of human health.

2. Materials and methods

2.1. Estimating DALYs

The DALYs calculation in each confirmed case of oral cancer, colorectal cancer, breast cancer and cervical cancer in Taiwan for the period 2005–2017 was estimated using the following formula [11]. *YLLs* and *YLDs* are independently calculated and then combined in a single summary measure (Eq. (1)).

$$DALYs = YLLs + YLDs \tag{1}$$

YLLs were calculated by multiplying the number of cancer-specific deaths at a given age by the standard life expectancy for that age group (Eq. (2)).

$$YLLs = \sum_{x} M_x \times L_{2,x} \tag{2}$$

where M_x represents the number of cancer-specific deaths in different age groups. The age categories (x) used were 0–39, 40–59 and 60+ years for oral cancer, 0–49, 50–69, and 70+ years for colorectal cancer, 0–34, 35–49, 50–69 and 70+ years for breast cancer, and 0–29, 30–49, 50–69, and 70+ years for cervical cancer. Those groups were collected according to data collection protocols at the Health Promotion Administration, Ministry of Health and Welfare (https://www.hpa.gov.tw/Pages/List.aspx?nodeid=119) [13]. $L_{2,}x$ is the number of years of life lost due to premature death in different age groups. We used the average life expectancy for each age group, corresponding to the age-specific deaths available.

YLDs were derived as the product of the number of new cases, the average duration of the disability and disability weightings for the disease stages (Eq. (3)).

$$YLDs = \sum_{x,y} I_{x,y} \times P_{x,y} \times S_y \times DW_y \times L_{1,y} \tag{3}$$

where $I_{\mathrm{x,y}}$ represent age-specific (x) incidence case at different disease stage (y); $P_{x,y}$ represent age/disease stage-specific (x, y) proportion treated; S_y represent disease stage-specific (y) proportion cured; DW is the disability weight ($DW = 1$ for premature death, 0 for perfect health). Disabilities are then classified into six categories or grades, with each grade assigned a value weighting between 0 and 1. The lower the value, the less impact the disability has on a person's life [14]. $L_{1,y}$ represent disease stage-specific (y) disability duration and DW_{y} represent the disease stage-specific (y) disability weight. Finally, these yearly-specific DALYs were then divided by the year-specific population to give DALYs per 100,000 population per year, which were the units used in the World Bank report [14,15].

2.2. Three-stage natural history of cancer

The proposed natural history model for cancer is illustrated in Fig. 1 [11]. The model incorporates three possible pathways for newly diagnosed cancer cases. Briefly, (i) those who were treated (*P*) and then successfully cured (*S*) from cancer, underwent a period of disability during the primary diagnosis and therapy phase (L_D), as well as during remission (L_{R1}). The remission phase involved intensive follow-up to detect any signs of recurrence or dissemination. (ii) those who died from cancer after treatment (1-*S*) experienced disability duration in the following phases: (a) primary diagnosis and therapy (L_D), (b) remission (L_{R2}), (c) pre-terminal phase (L_M) and (d) terminal phase (L_T). And (iii) those who did not receive treatment (1-*P*) faced disability periods during the pre-terminal (L_M) and terminal phases (L_T).

In order to estimate the disease stages-*YLD*s, this study combined Eq. (3) with a three-stage natural history of cancer, summing the burden for each cancer stage. Values for *D* and *L* were set based on those used in previous publications [11]. Appendix Table 1 presents cancer-specific disease weights (D_D, D_R, D_M, and D_T) and disease durations (L_D, L_{R1}, L_{R2}, L_M, and L_T) for oral cancer, colorectal cancer, breast cancer, and cervical cancer. *DW*s for each phase of the natural history of cancer were derived from Dutch and Victorian burden of disease studies, along with earlier estimates from the global burden of disease project [11,16–18].

2.3. Incidence cases and deaths

The incidence number of cancer cases across age groups was sourced from the Taiwan Cancer Registry Database, Health Promotion Administration, Ministry of Health and Welfare (https://www.hpa.gov.tw/Pages/List.aspx?nodeid=119) [13]. This study focused on four cancer sites: oral cancer (ICD-10 C00-C14), colorectal cancer (C18-C20), breast cancer (C50), and cervical cancer (C53). Disease staging followed the 8th edition of the American Joint Committee on Cancer (AJCC_8th).

Appendix Fig. 1 represents the cancer-specific incidence cases categorized by age groups from 2005 to 2017 in Taiwan. The columns represent incidence cases at 0–39 years, 40–59 years, and 60+ years, classified into five disease states (stages 0, I, II, III, and IV). Analyzing the long-term trend between 2005 and 2017, the major contributor to the incidence of oral cancer is 40–59 years (60 %), and the predominant states are stage IV (49 %) (Appendix Figure 1A). For colorectal cancer, the major contributors are 50–69 years old (45 %), and the predominant states are stage III (27 %) (Appendix Figure 1B). For breast cancer and cervical cancer, the major contributors are 50–69 years old (50 %) and 30–49 years old (44 %), and the predominant states are stage II (34 %) (Appendix Figure 1C) and stage 0 (67 %) (Appendix Figure 1D).

Appendix Fig. 2 represents the cancer-specific deaths by age groups from 1998 to 2018 in Taiwan. Data was extracted from the Health Promotion Administration, Ministry of Health and Welfare (https://cris.hpa.gov.tw/pagepub/Home.aspx?itemNo=cr.q.10) [19]. The number of deaths from oral cancer, colorectal cancer and breast cancer is increasing year by year, but the number of deaths from cervical cancer is slightly decreasing.

2.4. Proportion treated

The proportion treated (*P*) is estimated as the percentage of patients who received either surgery, chemotherapy, radiotherapy or a combination of these treatments. In this study, we adopted data from the population-based Taiwan Cancer Registry to calculate *P* for four selected cancers in Taiwan. Multiple combinations of treatments were documented, and we excluded instances related to "palliative care" in cancer, "untreated registry", and the number of "other treatment registry". Our data primarily come from the annual Cancer Registry Reports, published by the Health Promotion Administration, Ministry of Health and Welfare. Unfortunately, these reports are in Chinese, and an English version is currently unavailable.

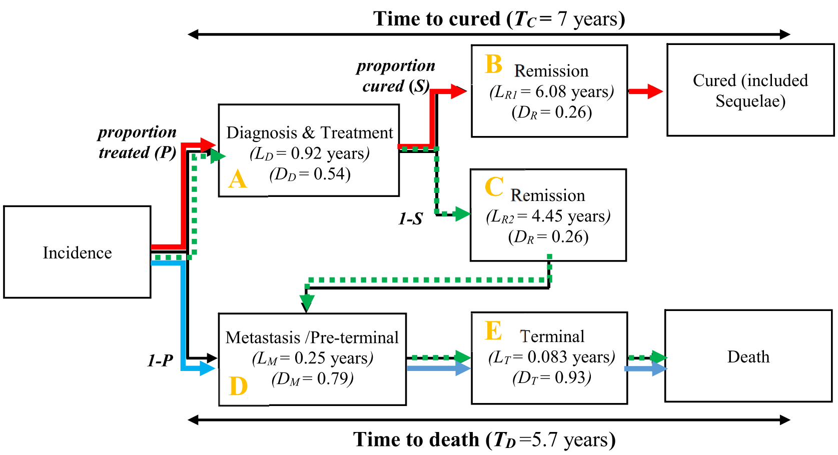

Fig. 1. Three-stage natural disease history for cancer.

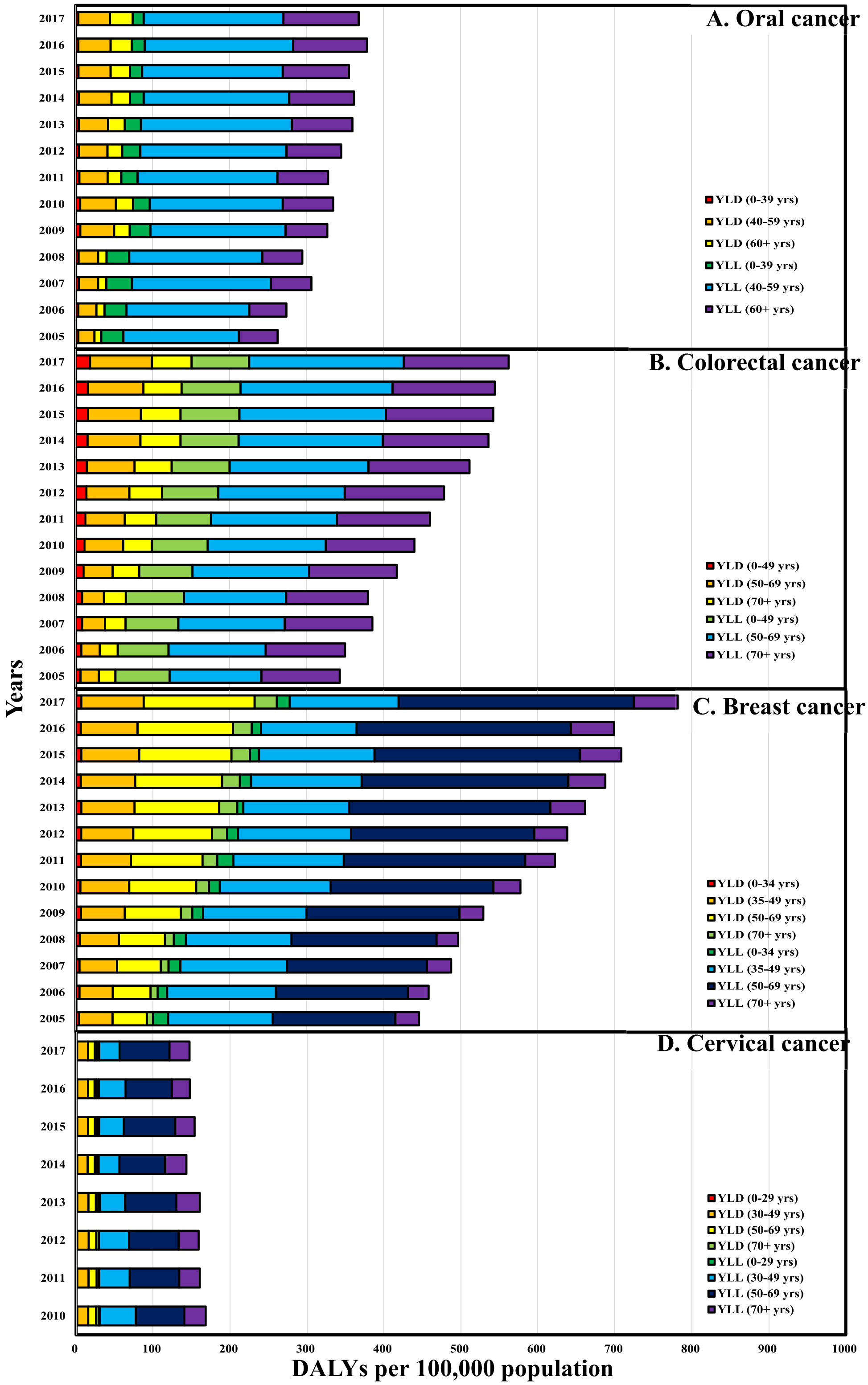

Fig. 2. The distribution of YLDs and YLLs in DALYs for four different cancer types during the period of 2005–2017, classified by different age groups.

2.5. Proportion cured and life expectancy

The proportion cured (*S*) was obtained from a 5-year survival report published by the Cancer Registry of Taiwan [20]. Appendix Table 3 lists the proportion cured (*S*, %) for the years 2010–2014 at different cancer stages (stages 0, I, II, III, and IV) and cancer sites. In Taiwan, the average *S* for oral cancer ranges from 78.2 % to 33.1 % across stages 0 to IV. Breast cancer and cervical cancer exhibit the highest *S* at stage 0, with an average of 97.5 % and 96.9 %, respectively. Conversely, colorectal cancer and cervical cancer have the lowest *S* at stage IV, with averages of 11.2 % and 17.8 %.

For life expectancy calculations, we used a life table with variable life expectancies based on birth year (Appendix Table 4) Incidence [21]. Oral cancer and colorectal cancer use all population life tables, while breast cancer and cervical cancer specifically use female population life tables.

3. Results

3.1. Trends and characteristics of the cancer burden

This study provides a comprehensive analysis of the distribution of *YLDs* and *YLLs* within DALYs for four cancer types in Taiwan from 2005 to 2017 (Fig. 2). Over the 12 years, the overall disease burden shows significant increases: oral cancer rose from 263 to 368 DALYs per 100,000 population (40 % increase), colorectal cancer from 343 to 563 DALYs (64 % increase), and breast cancer from 446 to 782 DALYs (75 % increase). In contrast, the burden of cervical cancer decreased from 168 to 147 DALYs per 100,000 population from 2010 to 2017, showing a 13 % reduction over the years (Fig. 2).

The average *YLLs* and the percentage of *YLLs* over DALYs were 271 (82 %), 356 (78 %), 423 (70 %), and 127 (82 %) DALYs per 100,000 population for oral, colorectal, breast, and cervical cancer, respectively. The major proportions of *YLLs* over this age group

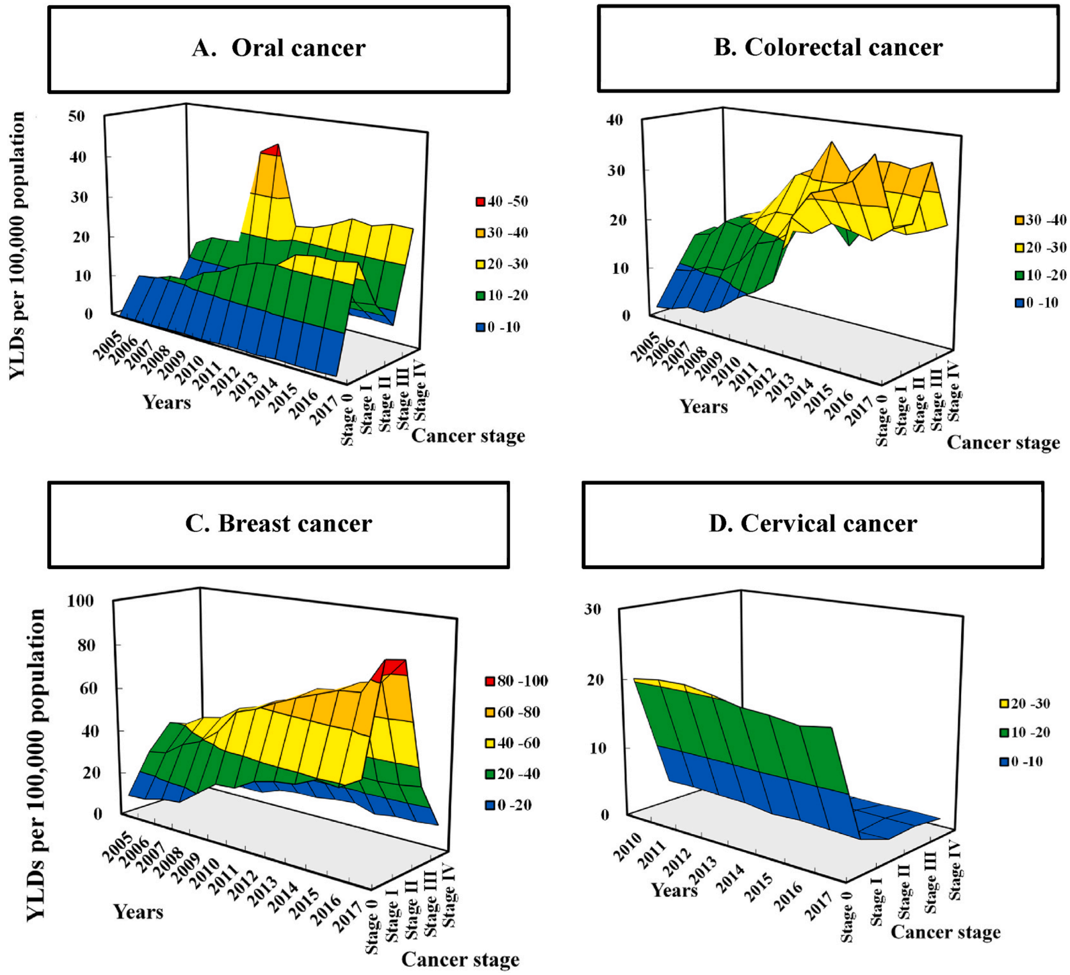

Fig. 3. The correlation between disease stages and YLDs for four types of cancer among different age groups (A) 0–29; (B) 30–49; (C) 50–69; and (D) 70 years of age or older.

were 66 % (for oral cancer in the 40–59 age group), 45 % (for colorectal cancer in the 50–69 age group), 54 % (for breast cancer in the 50–69 age group), and 50 % (for cervical cancer in the 50–69 age group). Across the four types of cancer, the majority of DALYs lost are attributed to premature mortality from these cancers, with a primary contribution from the 40–69 age group (Fig. 2).

3.2. *Trends of YLDs with cancer stage*

Fig. 3 illustrates the 3D image for time, cancer stages, and *YLD*s per 100,000 population for oral, colorectal, breast, and cervical cancer, respectively. Overall, breast cancer exhibits the highest *YLD*s, followed by oral, colorectal, and cervical cancers. The proportions of *YLD*s over DALYs were found to be 18 % (oral), 22 % (colorectal), 30 % (breast), and 18 % (cervical cancer), respectively.

In the case of oral cancer, the stage that predominantly affects disability is stage IV (28 DALYs per 100,000 population, 38 % of *YLD*s), followed by stage I (25 DALYs per 100,000 population, 34 % of *YLD*s) (Fig. 3A). Colorectal cancer primarily causes disability in stages 0 and III (Fig. 3B). The major contributors to disability are stage I (89 DALYs per 100,000 population, 34 % of *YLD*s) and stage II (87 DALYs per 100,000 population, 33 % of *YLD*s) for breast cancer (Fig. 3C). Lastly, in the case of cervical cancer, the cancer stage primarily responsible for disability is stage 0 (20 DALYs per 100,000 population, 71 % of *YLD*s) (Fig. 3D). It demonstrates the different patterns in *YLD*s' contribution of cancer stages to disability.

3.3. *Trends for age-specific DALYs*

Fig. 4 provides long-term trends of disease burden for four cancers across different age groups. It reveals that the 40–69 age group shows the highest DALYs for all four cancer types, demonstrating an increasing trend over time. Nevertheless, DALYs for oral, breast,

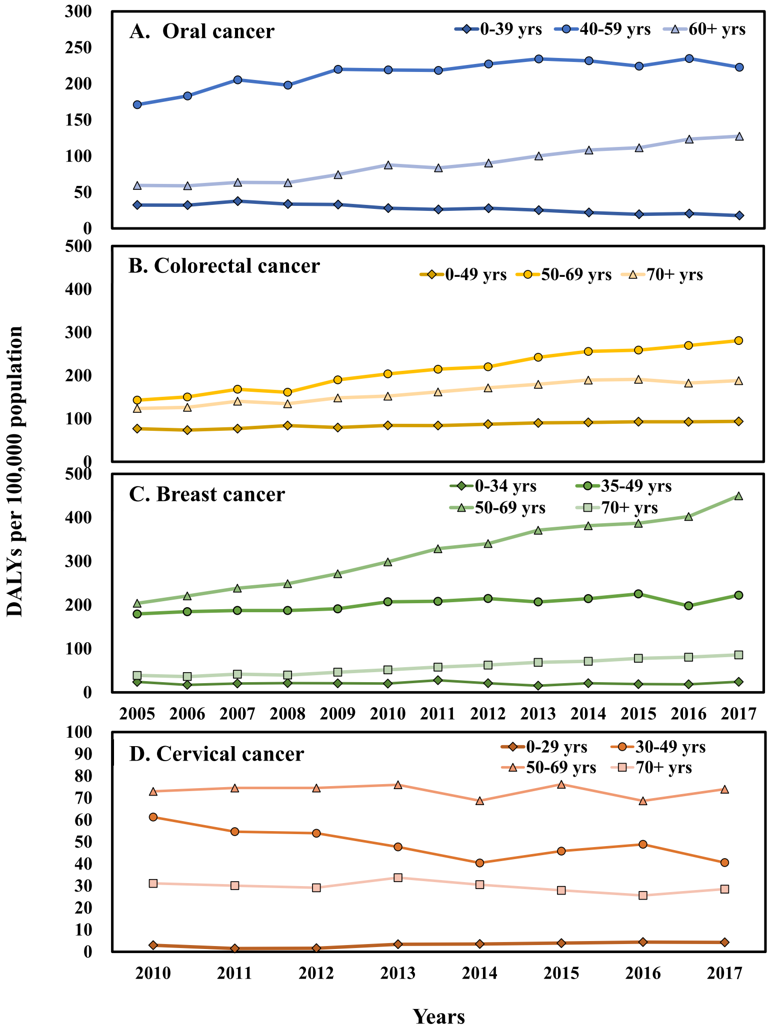

Fig. 4. Age groups-specific DALYs estimations for (A) oral cancer; (B) colorectal cancer; (C) breast cancer, and (D) cervical cancer.

and cervical cancer in the 0–39 and 30–49 age groups exhibit a declining trend.

DALYs for oral cancer in the 0–39 age group consistently decreased from 32 to 18 DALYs per 100,000 population between 2005 and 2017. For the age group 40–59 and the age group 60+, DALYs increased from 171 to 223 and 59 to 127 per 100,000 population during the same period, respectively (Fig. 4A). Similarly, DALYs for colorectal cancer in the 0–49, 50–69, and 70+ age groups increased from 77 to 94, 143 to 281, and 123 to 188 DALYs per 100,000 population (Fig. 4B). Among individuals aged 35–49, 50–69 and 70+, DALYs for breast cancer increased from 179 to 222, 204 to 450, and 39 to 86 DALYs per 100,000 population, respectively (Fig. 4C). Cervical cancer DALYs in the 0–29 and 50–69 age groups increased from 3 to 4 and 73 to 74 DALYs per 100,000 population between 2010 and

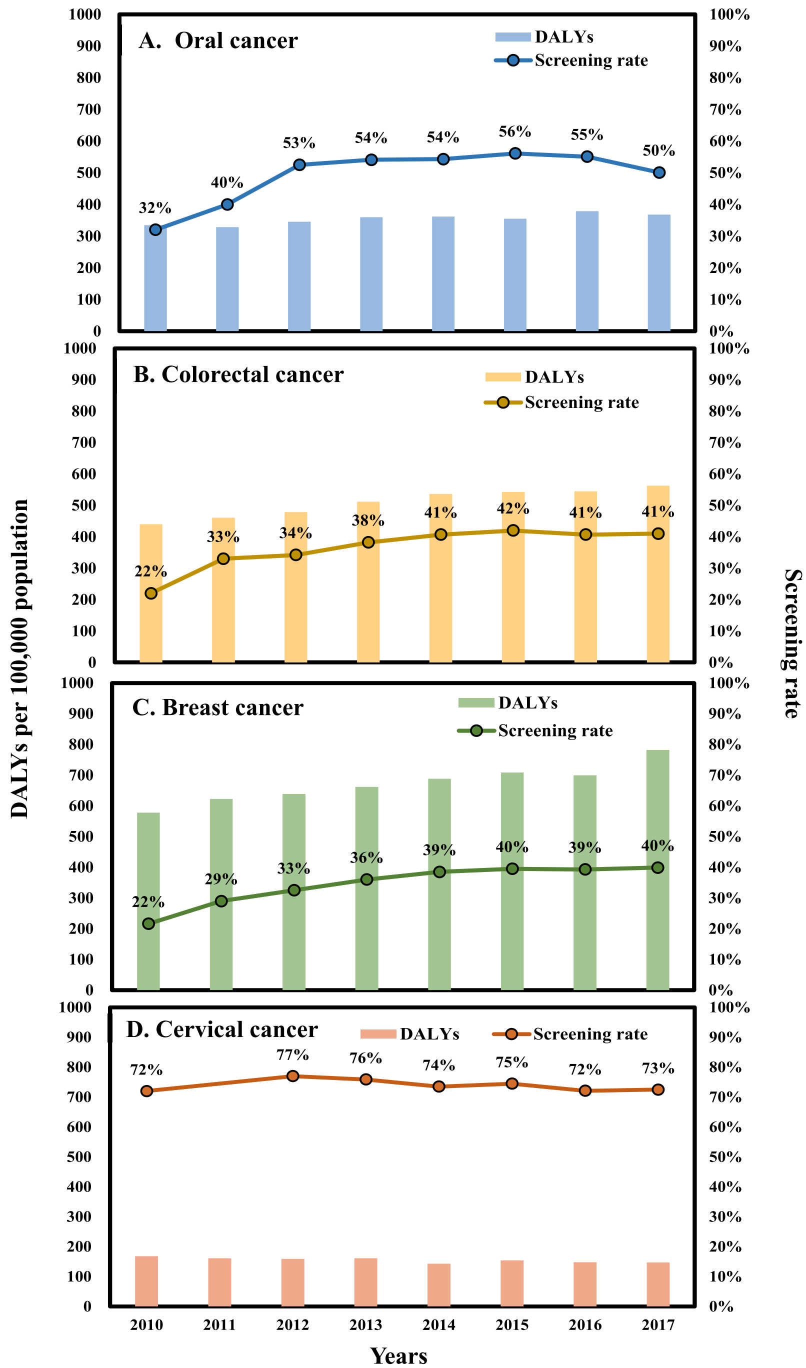

Fig. 5. The relationship between DALYs and the screening rates for four specific types of cancer.

2017 (Fig. 4D).

The findings underscore the necessity for age-specific interventions to address the varied burden of cancer across different age strata. DALYs for the 40–69 age group represent the primary burden for each cancer, showcasing an increasing trend over the years. Remarkably, a consistent declining trend is observed in DALYs for oral cancer in the 0–39 age group and cervical cancer in the 30–49 and 70+ age groups.

4. Discussion

This study quantified the burden of disability and premature death for four cancers that have undergone cancer screening in Taiwan by applied the DALYs measure from 2010 to 2017 in Taiwan. The cancer burden of breast, colorectal, and oral cancers has increased, while cervical cancer has decreased in the past few years. Breast cancer had the highest disease burden, followed by colorectal, oral, and cervical cancers.

For the trends of cancer mortality, appendix Figure 2A–Appendix Figure 2E from a 20-year study in Taiwan show increasing deaths from breast and colorectal cancers, highlighting the need for improved public health policies and awareness. While cervical cancer deaths are decreasing, oral cancer deaths have slightly risen. Oral cancer has a significant impact on those over 50, and colorectal cancer risks increase sharply after 80. Breast cancer data suggests starting screenings at age 40, particularly due to a higher death rate in those aged 50–59. These trends emphasize the importance of age-specific cancer screening, preventive measures, and lifestyle changes to reduce cancer risks, especially among older and high-risk individuals.

For the trends of proportion treated, appendix Table 2 shows the average proportion treated (*P*) from 2005 to 2017 at different cancer stages and age groups. For oral cancer, the average *P* for each stage ranges from 95 % to 98 %. However, *P* decreased from 97 % to 92 % in the older age group (60+ years) at stage IV. Similarly, for the other three cancers, *P* values remain consistently high, exceeding 90 %, except for the elderly population at severe cancer stage IV. For instance, in colorectal cancer, *P* drops from 90 % (0–49 years) to 76 % (70+ years), and in breast cancer, it decreases from 81 % (0–34 years) to 60 % (70+ years), both at stage IV.

The following section discusses several findings and comprehensive analyses from this study. First, Fig. 5 shows the relationship between cancer screening rates and cancer burdens. The screening rates for oral cancer went up from 32 % to 50 % from 2010 to 2017, and it reveals a steady burden of about 300 DALYs per 100,000 population. However, the increased screening rates for colorectal and breast cancer did not reflect a reduction in DALY. For colorectal cancer, biennial fecal immunochemical testing (FIT) was implemented. The screening rate rose from 22 % in 2010 to 41 % in 2017. Based on statistics, the incidence of advanced cancer detected in the colorectal cancer screening group was significantly lower compared to the non-screening group [7]. Nevertheless, its five-year survival rate for each cancer stage was the lowest among the four cancers (Appendix Table 3). For breast cancer, although mammography screening is considered effective for early detection of breast cancer, its average proportion treated (*P*) was the lowest in this study (Appendix Table 2). In addition, the screening rates of colorectal and breast cancers were relatively low among the four cancers (Fig. 5), and there was also a need to improve the proportion treated and more effective treatment. Most importantly, cervical cancer maintained high screening rates with a DALY decrease that also might be related to having better five-year survival rates (Appendix Table 3). Although mammography screening is considered effective for early breast cancer detection, the average proportion treated (*P*) was the lowest in this study (Appendix Table 2). Furthermore, the screening rates for colorectal and breast cancers were relatively low among the four cancers (Fig. 5), and there was also a need to improve the proportion treated and provide more effective treatment. Crucially, cervical cancer upheld elevated screening rates, resulting in a reduction in DALY, which could potentially contribute to improved five-year survival rates (Appendix Table 3) and the effects of HPV vaccination. The Taiwan Health Promotion Administration also provided published documents to discuss the critical challenge of prevention policy in Taiwan. Examples include the readiness to gather specimens for colorectal cancer and the misunderstandings that hinder the adoption of mammography for breast cancer [22]. However, the national cancer screening program aims to reduce incidence and mortality and improve life quality for the public, emphasizing the need for widespread screening and comprehensive public health approaches to have a more significant impact on cancer burden.

Secondly, Appendix Table 5 and Appendix Table 6 show the burden comparison with the DALYs database of the GBD and other countries, respectively. Results reveal higher DALYs in this study but with a lower mortality (*YLLs*) proportion than the Global Burden of Disease (GBD). For example, breast cancer in Taiwan shows a substantial burden (600 DALYs per 100,000 population per year, 70 % *YLLs*) compared to GBD's burden (288 DALYs per 100,000 population per year, 91 % *YLLs*). In contrast, the colorectal burden was less than GBD's estimation (Appendix Table 5). These findings highlight the differences in raw data in incidence and mortality rates. For example, colorectal cancer reveals lower incidence and mortality numbers than GBD, with comparable incidence and mortality. Additionally, this study adopted the natural history of the cancer model, which isn't included in GBD calculations. On the other hand, oral cancer recorded 330 DALYs per 100,000 population per year, exceeding burdens from the UK, New Zealand, and the USA, with 78%–84 % due to mortality (*YLLs*) (Appendix Table 6). Similar to other findings, the *YLLs* are the main contributor to the DALYs for four cancers. There are variations in temporal trends, cancer susceptibility, disease prevalence, healthcare evolution, especially in cancer screening, and methodological differences in data collection and analysis across different countries [23–26].

Thirdly, this study observed an increasing trend in three cancer burdens in the past decade. Numerous studies have highlighted the correlation with metabolic factors in the incidence of cancer patients. Zhi et al. [27] highlight the increase in cancer, particularly breast, esophageal, colorectal, and liver cancers, attributed to high glucose and BMI, especially in low SDI and developing regions. Zhang et al. [28] reveal mixed trends in cervical cancer globally, noting significant reductions in areas with effective screening and HPV vaccination programs, but increases in regions challenged by socioeconomic and healthcare issues. In oral cancer trends, Xie and Shang [29] report an overall global rise, with smoking, alcohol, and tobacco as leading risk factors, particularly in South Asia.

Our study indicates that in Taiwan, breast cancer is the most burdensome disease (600 DALYs per 100,000 population per year), exceeding colorectal, oral, and cervical cancers. The predominant factor is life years lost due to mortality (68%–82 %), mainly in the 40–69 age group. The rise in breast cancer DALYs in Taiwan can be attributed to several factors, including an increase in incidence, improved detection methods, and aging of the population [30]. Breast cancer screening programs, although effective in early detection, have led to more cases being identified, particularly among older women, as shown by the rising DALYs in all age groups (35–49, 50–69, 70+). Lifestyle changes, such as lower birth rates, later pregnancies, and Westernized diets [31], have also contributed to the increasing incidence. Recent studies indicate that the leading global risk factor for death attributable to BC in 2019 was metabolic risks, followed by behavioral risks [32]. Although we couldn't differentiate between HR+ and HER2+ breast cancer types, we recognize that HR+ and HER2+ subtypes typically show better survival rates, likely due to effective targeted therapies [33]. In the near future, it is needed to assess the impact of specific tumor types on the overall burden of breast cancer, including aspects such as incidence, survival, and DALYs, to guide targeted research and resource allocation.

For colorectal cancer, the significant 64 % increase in colorectal cancer DALYs over 12 years, rising from 343 to 563, may be attributed to both demographic changes and rising incidence rates. While the introduction of biennial fecal immunochemical testing (FIT) increased screening from 22 % in 2010 to 41 % in 2017, the burden remains high, particularly in advanced stages like stage III, which contribute to disability (Fig. 3B). A study by Marmot et al. [34] suggested that the higher incidence of colorectal cancer among individuals with high socioeconomic status may be linked to unhealthy lifestyle habits, such as inadequate physical activity, obesity, and excessive consumption of red meat. In Taiwan, the Nutrition and Health Survey revealed that 24.3 % of the population reported excessive daily red meat intake, while the prevalence of obesity (BMI $\geq$27) stood at 22.3 % [35].

Finally, we recognized the limitations of parameter estimation in our study. First, the proportion cured (S) data was derived from a five-year survival report covering only 2010–2014, which may not capture recent advancements in cancer treatments or changes in survival outcomes. Second, the disability weights and durations were adapted from international studies, such as the Dutch and Victorian burden of disease studies, which, while methodologically robust, may not fully reflect Taiwan's local cultural perceptions or healthcare practices. Third, the analysis does not differentiate between specific cancer subtypes, such as HR + or HER2+ breast cancer, which may differ significantly in terms of incidence, treatment outcomes, and survival rates, potentially leading to generalized estimates that overlook critical nuances. A key limitation of this study is the use of average life expectancy for each age group as a proxy for premature death in the calculation of YLLs. This approach was chosen because detailed, age-specific data on disease stage and treatment proportions were not available for more refined age stratifications. For instance, we used broad age categories such as 0–39, 40–59, and 60+ for oral cancer, and similar groupings for other cancers, in line with the available mortality data. However, a more granular approach, such as stratifying by 5-year age intervals, could have provided a more precise estimation of YLLs. The lack of finer age-specific data on disease stages and treatment outcomes means that the YLLs might be slightly underestimated, particularly for certain cancers where the age-related variation is significant. This limitation is important to consider when interpreting the findings and highlights the need for more detailed data to refine future estimates of cancer burden. Lastly, although trends in screening rates were analyzed, the direct relationship between increased screening and reductions in advanced cancer cases or improved survival outcomes was not fully explored. These limitations are acknowledged as areas for improvement, guiding future efforts to enhance methodological rigor and the applicability of findings.

5. Conclusion

This study provides a comprehensive analysis of the burden and trends of four cancers in Taiwan over time, utilizing DALYs as the main indicator. It reveals an increasing trend in DALYs for cancers like oral, colorectal, and breast, especially in certain age groups and stages, highlighting the persistent burden of these conditions. Breast cancer, in particular, stands out as a major contributor to disease burden, largely due to mortality. This study identifies significant differences in incidence and mortality across different cancer stages and underscores the critical importance of cancer screening programs in reducing disease burden in Taiwan.

CRediT authorship contribution statement

Chun-Hui Lin: Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Cheng-Chieh Hsieh:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Si-Yu Chen:** Writing – review & editing, Methodology, Formal analysis, Data curation. **Hong-Ru Chen:** Methodology, Formal analysis, Data curation. **Szu-Chieh Chen:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Data curation, Conceptualization.

Ethical approval

No ethical approval was obtained because the data included in this study were publicly available.

Data availability statement

The datasets used in this study are available from the corresponding author upon reasonable request.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.heliyon.2025.e41686.

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