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Original Article

# Different impacts of cancer types on cancer screening during COVID-19 pandemic in Taiwan

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## KEYWORDS

COVID-19;  
Early detection of  
cancer;  
Mass screening

**Background:** The COVID-19 pandemic has rapidly become a major challenge for global health care systems and affected other priorities such as the utilization of population-based cancer screening services. We sought to examine to what extent the COVID-19 pandemic has affected cancer screening utilization in Taiwan, even the use of inreach and outreach screening services for different types of cancer screening and different regions.

**Methods:** Using nationwide cervical, breast, colorectal and oral cancer screening data, the percentage changes in screening participants at inreach and outreach services were calculated and compared between January to April 2020 (COVID-19 pandemic) and January to April 2019.

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**Results:** The average percentage change declined from 15% to 40% for cervical, breast, and colorectal cancer screening, with a nearly 50% decline in oral cancer screening. There was a greater preference for breast and colorectal cancer screening outreach services, which had greater accessibility and declined less than inreach services in most regions. The screening utilization varied in different regions, especially in eastern Taiwan where the less convenient transportation and lower risk of COVID-19 transmission had a positive change on four types of cancer screening outreach services.

**Conclusion:** The COVID-19 pandemic may have had an effect not only in the utilization of different types of cancer screening but also in the preference between inreach and outreach services, and even in variations in screening services in different regions.

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## Introduction

The outbreak of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2), was first identified in Wuhan City, China, and has become a global pandemic and a major challenge for global health care systems. The Taiwan government immediately implemented isolation and preventive transmission strategies in January 2020 to avoid the spread of COVID-19,<sup>1,2</sup> however the first local case in Taiwan was diagnosed at the end of January 2020. In addition to the strategies to combat COVID-19, the Central Epidemic Command Center (CECC) also announced recommendations with regards to large-scale public gatherings in order to lower the risk of community transmission.<sup>3</sup>

Preventing transmission, caring for and treating patients with COVID-19 have been the main objectives, however they may have affected other priorities of global health care systems such as cancer treatment, and possibly even delaying the identification and diagnosis of patients with cancer, which may affect cancer survival.<sup>4–7</sup> The American Society of Clinical Oncology advised that cancer screening procedures such as mammography and colonoscopy requiring clinic and center visits should be postponed to reduce patient contact with health care facilities,<sup>8</sup> and this strategy for cancer screening was also implemented in other countries at the beginning of the COVID-19 pandemic.<sup>9</sup>

The aim of population-based cancer screening services is to increase the detection of cancer at an early stage and reduce cancer mortality.<sup>10</sup> Several strategies have been implemented to increase accessibility to screening services in different countries, including mobile screening units in rural and urban regions to expand access to screening services, which have been shown to be effective at reaching elderly and medically underserved populations in the United States.<sup>11,12</sup> In Europe, national breast, cervical and colorectal cancer screening programs have been implemented in most countries, and even high-income countries have approved screening centers and mobile units to increase breast cancer screening coverage.<sup>13</sup> In addition, colorectal cancer screening services have been offered by mailing invitation letters to eligible populations, which even includes providing stool tests.<sup>14,15</sup>

The Health Promotion Administration, Ministry of Health and Welfare has implemented four types of nationwide

cancer screening programs in Taiwan, including biennial breast cancer mammography screening for women aged 45–69 years and for those aged 40–44 years under high risk, annual cervical cancer screening (pap smear test) for women aged older than 30 years with sexual experience, biennial colorectal cancer screening (fecal immunochemical test (FIT)) for people aged 50–74 years, and biennial oral cancer screening (oral mucosal examination) for those aged more than 30 years (or aborigines aged more than 18 years) who smoke tobacco or chew betel quid. Both inreach and outreach screening services are provided by qualified hospitals to improve accessibility to cancer screening programs.<sup>16</sup> Outreach screening services are held across the country, and eligible people are invited to attend cancer screening programs in the local community including the setting of mobile screening units for mammography and pap smears. Inreach screening services, being with the concept of more cancer prevention in the hospitals, are held in the setting of out-patient departments in qualified hospitals for those who are eligible, including both patients and those accompanying patients who may seek medical treatment unrelated to cancer.<sup>14,17–19</sup>

After the first COVID-19 imported case in Taiwan, outreach cancer screening programs were required to follow the guidelines of the Department of Health in each city and county and the CECC's recommendations for large-scale public gatherings. The local public health centers which cooperated with qualified hospitals could decide whether to hold outreach screening programs depending on the risk of transmission and the allocation of enough space with protective measures, and the Department of Health in each city and county had the right to stop all outreach service if there was a severe risk of a local COVID-19 outbreak in their region.<sup>3,20</sup>

In this observational study, we investigated whether the global COVID-19 pandemic had an impact on the utilization of different types of cancer screening services in Taiwan. Specifically, we compared screening utilization between January to April 2020 (COVID-19 pandemic) and January to April 2019 of inreach and outreach services of four types of cancer screening, and further evaluated the utilization of screening services in different cities and counties of Taiwan. Given that few studies have examined the impact of the COVID-19 pandemic on accessibility and feasibility of cancer screening services, the study findings may provide

information on cancer screening services during the global pandemic.

## Material and methods

### Data source and study population

We conducted a cross sectional observational study of four types of cancer screening, and compared the participants who received inreach and outreach cancer screening between January to April 2020 (COVID-19 pandemic) and January to April 2019 to evaluate the impact of the COVID-19 pandemic on screening services in Taiwan. The numbers of eligible participants who received screening in each city and county of Taiwan during the study periods were obtained from the nationwide cancer screening registry database. Participants who lived on the surrounding islands of Taiwan were excluded due to the small local populations and less accessibility to cancer screening. The numbers of confirmed local and imported COVID-19 cases in Taiwan from January to April 2020 were obtained from the website of the Taiwan National Infectious Disease Statistics system.<sup>21</sup> Ethical approval was not required because all the information was county level but not personal data and derived from the open data of the government.

### Variable definitions and statistical analysis

We compared cancer screening utilizations descriptively between January to April 2019 and January to April 2020. The amount of change was defined as the difference in the number of cancer screening participant between the same month of 2019 and 2020. The 1-week traditional Lunar New Year holiday in Taiwan occurred in different months of 2019 and 2020 (in February 2019 and January 2020), which may have confounded comparisons in cancer screening utilization in these months. Therefore, the amount of change for “January to February” was also calculated for analysis. Percentage change was defined as the proportion of the amount of change to the amount of screening services in the month of the previous year. In addition to the nationwide analysis of percentage change, we also analyzed average percentage change in four types of cancer screening inreach and outreach services in a total of 18 cities and counties around Taiwan. The results were mapped using Tableau software to visualize geographic variations.<sup>22</sup> All statistical analyses were performed using SAS 9.4.

## Results

**Table 1** summarizes all confirmed COVID-19 cases and the numbers of participants in the four types of cancer screening inreach and outreach services between 2019 and 2020. The total number of confirmed local and imported COVID-19 cases in Taiwan increased from January 2020, reached the highest number (283 cases) in March, and then decreased in April 2020 (107 cases). A similar trend of percentage change in participation was found for each type of cancer screening inreach and outreach service, which gradually declined from January to February, March, and

then April. For cervical cancer and oral cancer screening, the average percentage change in outreach screening declined more than inreach screening, however there were smaller declines in average percentage change in outreach compared to inreach screening for breast cancer and colon cancer screening. The number of participants gradually declined by month in 2020 for both inreach and outreach services for each type of cancer screening (**Fig. 1**). More participants received inreach than outreach services for cervical, colon, oral cancer screening, however more participants received outreach services than inreach services for breast cancer screening in 2020.

**Table 2** summarizes the average percentage change in the different types of cancer screening in each city and county between 2019 and 2020. Nearly half of the cities and counties had a >40% decline in outreach services for cervical cancer screening, and more than half had a >40% decline in both inreach and outreach services for oral cancer screening. For breast cancer and colorectal cancer screening, there were greater average percentage change declines in inreach services than in outreach services in most cities and counties, and half of the cities and counties had a >40% decline in inreach services for breast cancer screening. However, more than half of the cities and counties had a positive average percentage change in outreach services for colon cancer screening. **Fig. 2** shows maps of average percentage changes in inreach and outreach services for each type of cancer screening by city and county. Negative average percentage changes were noted in most cities and counties, however some areas showed positive changes, especially in outreach colon cancer screening. Hualien County, located in eastern Taiwan, was the only county to have positive changes in all four types of outreach screening services.

## Discussion

The trend of percentage change declined in each type of cancer screening for both inreach and outreach screening services in this nationwide study. The average percentage change declined from 15% to 40% for cervical, breast, and colorectal cancer screening, and by nearly 50% for oral cancer screening. A similar trend of decreasing screening rate was reported in the United States, where rates of colon, breast and cervical cancer screening dropped by 80%–90% during the COVID-19 pandemic.<sup>23</sup> However, there were still slight variations in the average percentage change in different types of cancer screening in the current study, especially between cities and counties.

GS et al. (2020) reported that there were several factors associated with adherence in the cancer screening including patient demographics and financial status, physicians' attitudes, and even health care system interaction.<sup>24</sup> In Taiwan, financial issue was not the barrier because the Health Promotion Administration covered fees for population-based cancer screening programs for eligible population, and even there was less geographic barrier through in-reach and out-reach screening service since 2010.<sup>19</sup> From the statistics of the Health Promotion Administration, the participant numbers of each cancer screening gradually increased every year after 2010, and the whole year numbers in cervical,

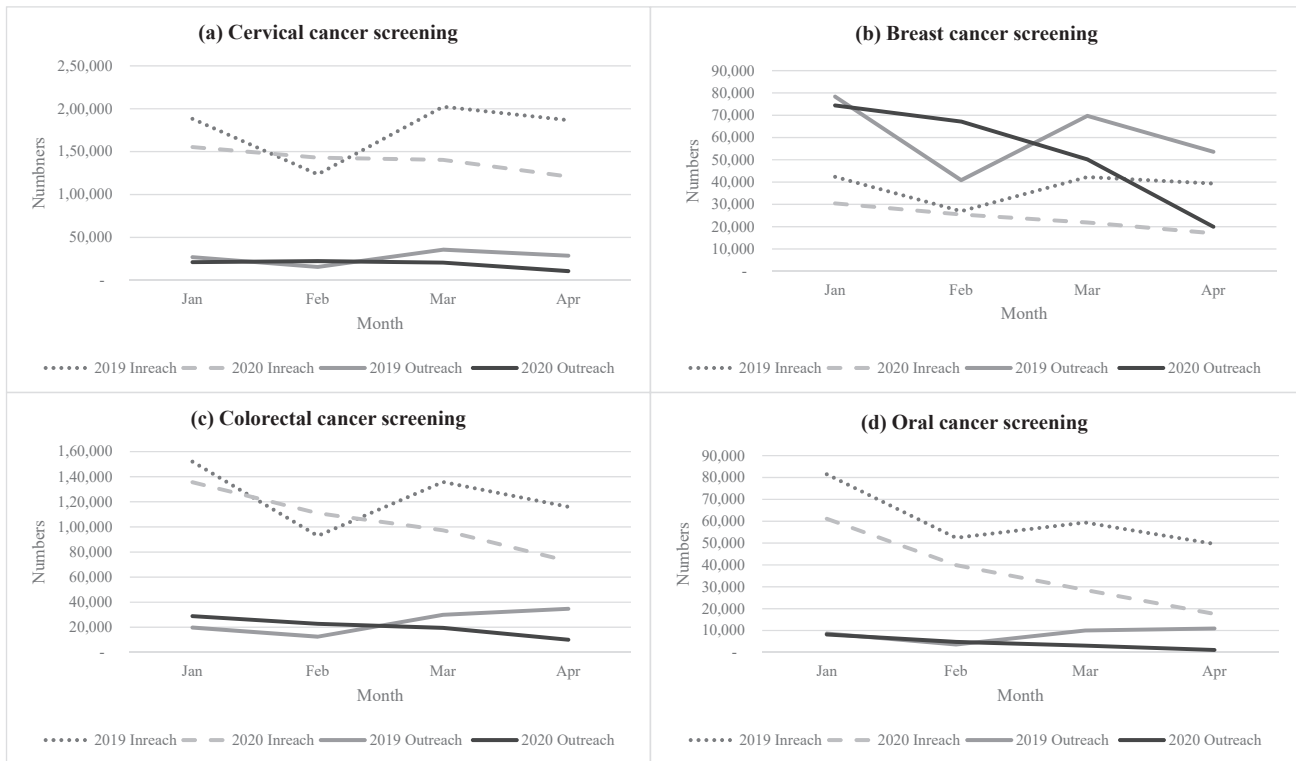
**Table 1** The numbers of confirmed COVID-19 cases and participants and changes in inreach and outreach services for different types of cancer screening between 2019 and 2020.

| COVID-19 cases (2020)    | Jan        | Feb        | Jan to Feb        | Mar        | Apr        |                |
|--------------------------|------------|------------|-------------------|------------|------------|----------------|
|                          | 10         | 29         | 39                | 283        | 107        |                |
| <b>Cervical cancer</b>   | <b>Jan</b> | <b>Feb</b> | <b>Jan to Feb</b> | <b>Mar</b> | <b>Apr</b> | <b>Average</b> |
| <b>Inreach</b>           |            |            |                   |            |            |                |
| 2019                     | 188,272    | 123,521    | 311,793           | 202,396    | 186,675    |                |
| 2020                     | 155,384    | 142,965    | 298,349           | 140,413    | 121,005    |                |
| Amount of change         | -32,888    | 19,444     | -13,444           | -61,983    | -65,670    | -47,032        |
| Percentage change        |            |            | -4.31%            | -30.62%    | -35.18%    | -23.37%        |
| <b>Outreach</b>          |            |            |                   |            |            |                |
| 2019                     | 26,944     | 15,529     | 42,473            | 35,713     | 28,698     |                |
| 2020                     | 21,039     | 22,348     | 43,387            | 20,633     | 10,669     |                |
| Amount of change         | -5905      | 6819       | 914               | -15,080    | -18,029    | -10,732        |
| Percentage change        |            |            | 2.15%             | -42.23%    | -62.82%    | -34.30%        |
| <b>Breast cancer</b>     | <b>Jan</b> | <b>Feb</b> | <b>Jan to Feb</b> | <b>Mar</b> | <b>Apr</b> | <b>Average</b> |
| <b>Inreach</b>           |            |            |                   |            |            |                |
| 2019                     | 42,356     | 26,929     | 69,285            | 42,254     | 39,364     |                |
| 2020                     | 30,435     | 25,448     | 55,883            | 21,880     | 17,033     |                |
| Amount of change         | -11,921    | -1481      | -13,402           | -20,374    | -22,331    | -18,702        |
| Percentage change        |            |            | -19.34%           | -48.22%    | -56.73%    | -41.43%        |
| <b>Outreach</b>          |            |            |                   |            |            |                |
| 2019                     | 78,357     | 40,860     | 119,217           | 69,693     | 53,572     |                |
| 2020                     | 74,408     | 67,152     | 141,560           | 50,213     | 19,957     |                |
| Amount of change         | -3949      | 26,292     | 22,343            | -19,480    | -33,615    | -10,251        |
| Percentage change        |            |            | 18.74%            | -27.95%    | -62.75%    | -23.99%        |
| <b>Colorectal Cancer</b> | <b>Jan</b> | <b>Feb</b> | <b>Jan to Feb</b> | <b>Mar</b> | <b>Apr</b> | <b>Average</b> |
| <b>Inreach</b>           |            |            |                   |            |            |                |
| 2019                     | 152,013    | 92,854     | 244,867           | 135,837    | 115,996    |                |
| 2020                     | 135,604    | 110,888    | 246,492           | 97,319     | 72,658     |                |
| Amount of change         | -16,409    | 18,034     | 1625              | -38,518    | -43,338    | -26,744        |
| Percentage change        |            |            | 0.66%             | -28.36%    | -37.36%    | -21.68%        |
| <b>Outreach</b>          |            |            |                   |            |            |                |
| 2019                     | 19,773     | 12,522     | 32,295            | 30,006     | 34,714     |                |
| 2020                     | 28,905     | 22,770     | 51,675            | 19,547     | 10,067     |                |
| Amount of change         | 9132       | 10,248     | 19,380            | -10,459    | -24,647    | -5242          |
| Percentage change        |            |            | 60.01%            | -34.86%    | -71.00%    | -15.28%        |
| <b>Oral cancer</b>       | <b>Jan</b> | <b>Feb</b> | <b>Jan to Feb</b> | <b>Mar</b> | <b>Apr</b> | <b>Average</b> |
| <b>Inreach</b>           |            |            |                   |            |            |                |
| 2019                     | 81,485     | 52,414     | 133,899           | 59,407     | 49,607     |                |
| 2020                     | 61,104     | 39,912     | 101,016           | 28,569     | 17,599     |                |
| Amount of change         | -20,381    | -12,502    | -32,883           | -30,838    | -32,008    | -31,910        |
| Percentage change        |            |            | -24.56%           | -51.91%    | -64.52%    | -47.00%        |
| <b>Outreach</b>          |            |            |                   |            |            |                |
| 2019                     | 8610       | 3587       | 12,197            | 10,017     | 10,926     |                |
| 2020                     | 8188       | 4815       | 13,003            | 3076       | 1118       |                |
| Amount of change         | -422       | 1228       | 806               | -6941      | -9808      | -5314          |
| Percentage change        |            |            | 6.61%             | -69.29%    | -89.77%    | -50.82%        |

breast and colorectal cancer screening were similar in 2018 and 2019 but decline change was observed while compared between January to April 2019 and 2020. Otherwise, the numbers of oral cancer screening had 18% decline between 2018 and 2019, but nearly 50% decline of average percentage change was found during the study period before and after COVID-19 pandemic.<sup>25</sup>

The greatest decrease in screening utilization was observed for oral cancer screening compared to the other

three types of cancer screening service, which had a nearly 50% decline in average percentage change. The reason for this decline may be associated with postponed or canceled screening services during this period to reduce the risk of direct COVID-19 transmission through droplets. In addition, a previous study in Taiwan reported a repeat screening rate of only 21%, and this may reflect a lack of motivation to use screening services during the COVID-19 pandemic.<sup>26</sup> The smallest decline in average percentage change was



**Figure 1** The numbers of participants in inreach and outreach services for each type of cancer screening from January to April in 2019 and 2020.

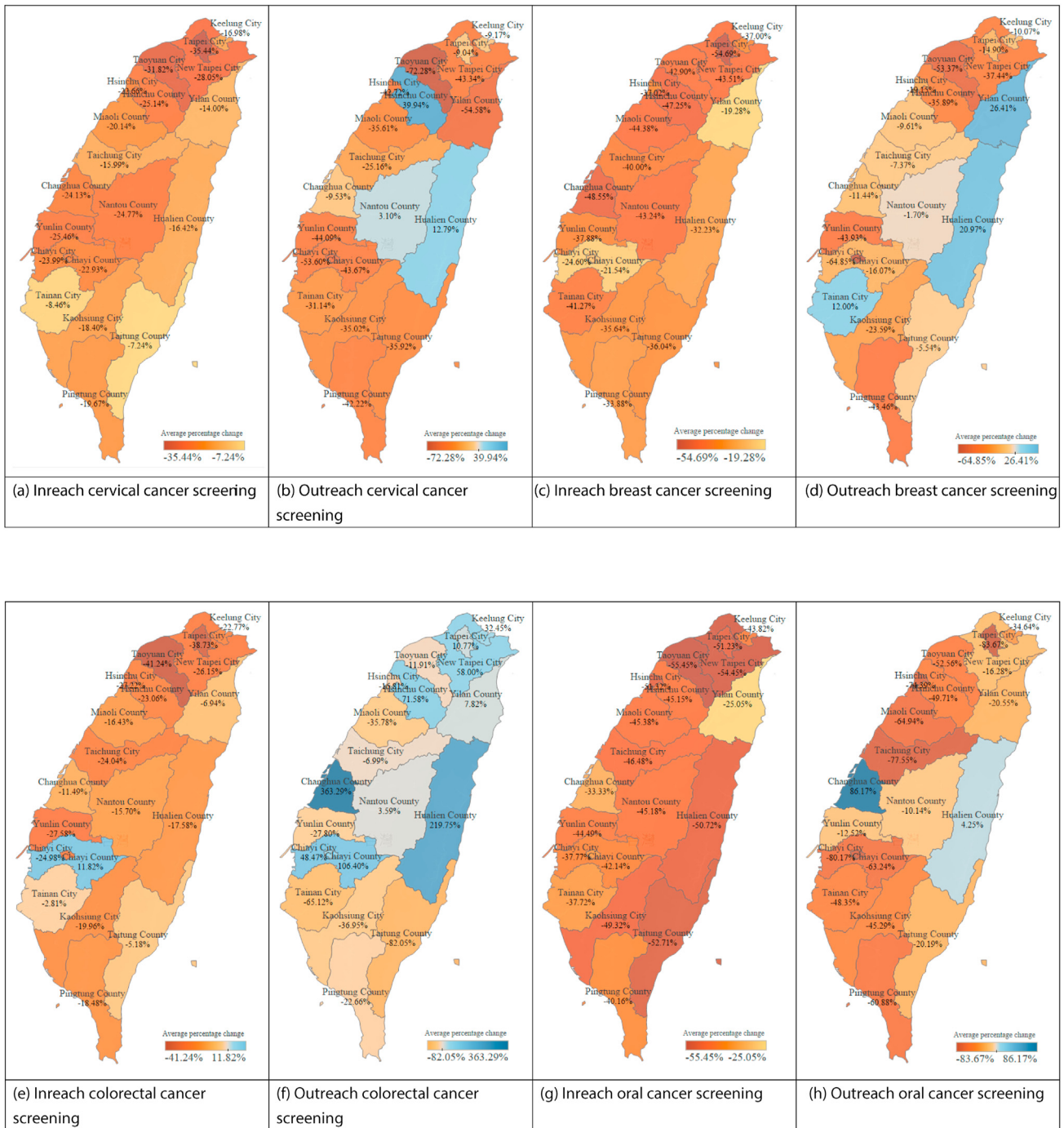
**Table 2** Average percentage changes in different types of cancer screening in each city and county between 2019 and 2020.

| City            | Cervical Cancer |          | Breast Cancer |          | Colorectal Cancer |          | Oral Cancer |          |
|-----------------|-----------------|----------|---------------|----------|-------------------|----------|-------------|----------|
|                 | Inreach         | Outreach | Inreach       | Outreach | Inreach           | Outreach | Inreach     | Outreach |
| Taipei City     | -35.44%         | -9.04%   | -54.69%       | -14.90%  | -38.73%           | 10.77%   | -51.23%     | -83.67%  |
| New Taipei City | -28.05%         | -43.34%  | -43.51%       | -37.44%  | -26.15%           | 58.00%   | -54.45%     | -16.28%  |
| Taoyuan City    | -31.82%         | -72.28%  | -42.90%       | -53.37%  | -41.24%           | -11.91%  | -55.45%     | -52.56%  |
| Taichung City   | -15.99%         | -25.16%  | -40.00%       | -7.37%   | -24.04%           | -6.99%   | -46.48%     | -77.55%  |
| Tainan City     | -8.46%          | -31.14%  | -41.27%       | 12.00%   | -2.81%            | -65.12%  | -37.72%     | -48.35%  |
| Kaohsiung City  | -18.40%         | -35.02%  | -35.64%       | -23.59%  | -19.96%           | -36.95%  | -49.32%     | -45.29%  |
| Hsinchu County  | -25.14%         | 39.94%   | -47.25%       | -35.89%  | -23.06%           | 71.58%   | -45.15%     | -49.71%  |
| Changhua County | -24.13%         | -9.53%   | -48.55%       | -11.44%  | -11.49%           | 363.29%  | -33.33%     | 86.17%   |
| Yunlin County   | -25.46%         | -44.09%  | -37.88%       | -43.93%  | -27.58%           | -27.80%  | -44.49%     | -12.52%  |
| Pingtung County | -19.67%         | -42.22%  | -33.88%       | -43.46%  | -18.48%           | -22.66%  | -40.16%     | -60.88%  |
| Keelung City    | -16.98%         | -9.17%   | -37.00%       | -10.07%  | -22.77%           | 32.45%   | -43.82%     | -34.64%  |
| Yilan County    | -14.00%         | -54.58%  | -19.28%       | 26.41%   | -6.94%            | 7.82%    | -25.05%     | -20.55%  |
| Hsinchu City    | -22.66%         | -42.72%  | -37.02%       | -19.15%  | -27.22%           | -16.81%  | -51.32%     | -74.39%  |
| Miaoli County   | -20.14%         | -35.61%  | -44.38%       | -9.61%   | -16.43%           | -35.78%  | -45.38%     | -64.94%  |
| Chiayi City     | -23.99%         | -53.60%  | -24.60%       | -64.85%  | -24.98%           | 48.47%   | -37.77%     | -80.17%  |
| Chiayi County   | -22.93%         | -43.67%  | -21.54%       | -16.07%  | 11.82%            | 106.40%  | -42.14%     | -63.24%  |
| Hualien County  | -16.42%         | 12.79%   | -32.23%       | 20.97%   | -17.58%           | 219.75%  | -50.72%     | 4.25%    |
| Taitung County  | -7.24%          | -35.92%  | -36.04%       | -5.54%   | -5.18%            | -82.05%  | -52.71%     | -20.19%  |
| Nantou County   | -24.77%         | 3.10%    | -43.24%       | -1.70%   | -15.70%           | 3.59%    | -45.18%     | -10.14%  |

observed for colorectal cancer screening, with average percentage change rates for inreach and outreach services of -21.68% and -15.28%, respectively. This may imply that the participants preferred the stool test with FIT which

they could perform at home, and thereby lower the risk of COVID-19 transmission.

Our analysis revealed larger declines in the percentage change in outreach services for each type of cancer



**Figure 2** Geographic variations in the average percentage changes in inreach and outreach services for each type of cancer screening in each city and county of Taiwan.

screening in March and April, which may be associated with more reported COVID-19 cases and more postponed outreach screening service during that time. However, compared with inreach services, the outreach service of breast cancer screening had a smaller average percentage change (-23.99%). This may suggest that the participants preferred outreach services with mobile mammography, which was gradually increased to 50% of breast cancer screening in 2014.<sup>27</sup> This is supported by a previous study which used questionnaires to survey women who received

screened at mobile units, and found that convenience was the most important factor when choosing a screening service.<sup>28</sup> Moreover, the screening utilization of outreach services with mobile mammography was even higher than for inreach services during the COVID-19 pandemic.

Similar findings were observed between inreach and outreach services for colorectal cancer screening, and several cities and counties had positive average percentage changes in outreach services but negative changes in inreach services. In the outreach screening service, the

eligible participants could get an FIT kit in the community, and then they just needed to send it back to the public health center or the cooperating hospital,<sup>14</sup> which increased accessibility and feasibility. In particular, more of the screening participants preferred outreach services for breast and colorectal cancer screening during the COVID-19 pandemic, which may be associated with a lower risk of direct COVID-19 exposure in the community than when visiting a hospital. However, the opposite was found for cervical cancer screening. The eligible women who were encouraged to receive screening at least every 3 years if the previous pap smear test had no abnormal findings may have been less willing to participate in cervical cancer screening during the COVID-19 pandemic.<sup>29</sup> The smaller average percentage change in inreach services for cervical cancer screening may be associated with the basic number of patients who visit hospitals for disease diagnosis and treatment in most regions.

Geographic inequalities are known to affect the utilization of cancer screening, where mobile screening units can provide greater accessibility to screening than fixed units for underserved populations or in remote areas.<sup>11</sup> Transportation in eastern Taiwan is less convenient, and there were no confirmed COVID-19 cases during the study period. Hualien County, which is located in eastern Taiwan, had positive percentage changes in all four types of cancer outreach screening, but negative changes in inreach services. A possible reason may be associated with its location and less access to inreach services, so that the local population may have been more motivated to attend outreach services due to the accessibility. Moreover, there were no confirmed local COVID-19 cases during the study period, and thus a lower risk of exposure.

The American Cancer Society suggested that cancer screening during the COVID-19 pandemic was still important, but that it needed to be done safely. They recommended several options for screening services for eligible participants, such as pap-smear tests not being urgent if previous tests showed normal results, arranging the next mammogram up to 2 years later if the previous report was normal for women aged >55 years, and using a FIT or stool DNA test at home to increase safety.<sup>30</sup> In Taiwan, cancer screening services continued during the COVID-19 pandemic, and no community COVID-19 cases were caused directly by joining inreach or public outreach services. Following the CECC's recommendations for social distancing, requiring the strict use of surgical face masks and hand hygiene, and checking the participants' health status may have helped to lower the risk of COVID-19 transmission.<sup>31,32</sup>

The strength of this study is that we used a nationwide cancer screening registry database to evaluate the utilization of inreach and outreach screening services, including the analysis of cancer screening utilization in counties and cities around Taiwan during the COVID-19 pandemic. There are also several limitations to this study. First, we did not record the participants' information such as age at screening, income level, underlying disease and psychological or social assessments. Second, the local public health centers in each city and county could make their own decision whether to postpone or stop outreach screening services when evaluating the risk of COVID-19 transmission, and that may be a confounding factor in the comparisons of

screening service utilization between geographic areas. Third, the average percentage change which was used to analyze variations in inreach and outreach services in each city and county may have been affected by the number of screening utilizations in the previous year if the local population was smaller or fewer participants received screening. Finally, this study was an observational study evaluating the association between screening utilization and the possible impact of the COVID-19 pandemic, but not the causation. The results may not be generalized to different COVID-19 outbreak level and other countries because of the different risk of COVID-19 transmission and confirmed number of cases. For instance, our study discussed the impact of COVID-19 pandemic in the screening utilization between January and April 2020. However, there was a new outbreak of COVID-19 pandemic with more than 7000 confirmed cases in Taiwan in May 2021, and then the CECC quickly announced nationwide Level 3 epidemic alert. Further research should follow the change of cancer screening utilization and the time for cancer diagnosis after this new episode of COVID-19 outbreak.

## Conclusion

We found that screening utilization declined in the four types of cancer screening, the screening participants may have preferred outreach services for breast and colorectal cancer screening with more accessibility, and even positive changes in outreach services of four types of cancer screening was observed in eastern Taiwan where the less convenient transportation and lower risk of COVID-19 transmission. Our findings provide evidence that the COVID-19 pandemic may have had an effect not only in the utilization of different types of cancer screening but also in the preference between inreach and outreach services, and even in variations of screening services in different regions.

## Conflict of interest

We assure that each author meets authorship requirements. The authors have no conflicts of interest relevant to this article.

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