National Burden and Trend of Cancer in Ethiopia, 2010–2019: a systemic analysis for Global burden of disease study

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Over the last two decades, we have tracked the national burden of cancer and its trends in Ethiopia, providing estimates of incidence, death, and disability adjusted life years. In Ethiopia, there were an estimated 53,560 (95% UI 52,480–55,540) new incident cases, 39,480 deaths (95% UI 32,640–46,440), and 1.42 million (95% UI 1.16–1.68) DALYs of cancer 2019. Cancer incidence, death, and DALYs counts increased by 32% (95% UI 11–55%), 29% (95% UI 12–44%), and 19% (95% UI 2–44%) between 2010 to 2019, respectively, while age-standardised incidence, death, and DALYs rates increased by 5% (95% UI 0.9–1.6) 2019. In 2019, the leading incidence cases were leukemia, cervical cancer, breast cancer, colon and rectum cancer, and stomach cancer, while leukemia, breast cancer, cervical cancer, and stomach cancer were the most common killer cancers in Ethiopia. According to the findings of this study, tobacco-related cancers such as pancreatic, kidney, and lung cancer have increased in Ethiopian females over the last decade, while genitourinary cancer has increased in Ethiopian males. Another significant finding was that infection-related cancers, such as stomach cancer and Hodgkin lymphoma, have been rapidly declining over the last decade.

Cancer is a newly evolved noncommunicable global disease burden that accounts for a significant portion of global morbidity, mortality, and economic loss. Cancer is the first or second leading cause of premature death in 134 of the world’s 183 countries, and it ranks third or fourth in 45 more for people under the age of 70. According to WHO, cancer caused 4.5 million (29.8 percent) of the 15.2 million premature deaths from noncommunicable diseases worldwide in 2016, while cardiovascular diseases caused 6.2 million (40.8 percent). Cancer caused approximately 24 million new cases, 10.0 million deaths, and 250 million DALYs globally in 2019. Because of demographics, epidemiological transitions, advanced diagnostic tools, and screening programs, these global records revealed that the burden of cancer is increasing while the burden of infectious diseases is decreasing. Because of the rapid rise in cancer cases, the United Nations (UN) Sustainable Development Goals (SDGs) include cancer burden reduction as a goal. According to 3.4, noncommunicable disease premature mortality should have been reduced by one-third through prevention and treatment, as well as promotion of mental health and well-being. Global integrated and cooperative efforts on prevention and control of cancer lead by the WHO initiative focused breast Cancer, Cervical cancer, childhood cancer, and Third United Nations High Level meeting on NCDs including cancer. Cancer incidence is higher in developing countries, which may be due to epidemiological transitions as well as ineffective preventive and control health policies. Ethiopia has created a National Cancer Control Plan for 2016–2020, with the goal of promoting cancer prevention, early detection, improved diagnosis and treatment, palliative care, cancer surveillance, registration, and research. The Global Burden of Diseases, Injuries, and Risk Factors Study 2019 (GBD 2019) provides the most recent and concise evidence of cancer burden and trends in terms of incidence, mortality, and DALYs.

Result
In 2019, there were an estimated 53,560 new incident cases of cancer in both sexes (95% UI 52,480–55,540), with an age-standardised incidence rate of 104.3 (95% UI 98.1–113.3) per 100,000 in Ethiopia. In 2019, cancer accounted for 39,480 deaths (95% UI 32,640–46,440) in both sexes, with an age-standardised death rate of 87.5 (71.6–105) per 100,000. In 2019, there were 1.42 million (95% UI 1.16–1.68) DALYs in both sexes in Ethiopia.

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with age-standardised rates of 2300 (95% UI 1900–2700) per 100,000. Year life loss (YLL) accounted for more than 98 percent of DALYs, with YLD accounting for the remainder (Table 1). Between 2010 and 2019, cancer incident cases, death counts, and DALYs counts increased by 32% (95% UI 11–55%), 29% (95% UI 12–44%), and 19% (95% UI − 2 to 44%), respectively, while incident, death, and DALY rates changed by 5% (95% UI − 7 to 18%), 2% (95% UI − 9 to 14%), and − 2% (95% UI 15–12%), respectively (Table 2). Between 2010 and 2019, the absolute number of years lived with disability (YLD) and years of life lost (YLL) increased by 36% (95% UI 12–64%) and 19% (95% UI − 4 to 44%), respectively. However, the age standardized rate of YLD increased by 9% (95% UI − 4 to 24%), while the age standardized rate of YLL decreased by − 2% (95% UI 15–12%). We made comparisons with neighboring countries as well as at the global level (Table 3).

**Burden of cancer type.** In Ethiopia, the five most common cancer incidence cases were leukemia (8310 [95% UI 4270–12440]), cervical cancer (6570 [95% UI 4470–10640]), breast cancer (5900 [95% UI 4640–7420]), colon and rectum cancer (3200 [95% UI 2400–4460]), and stomach cancer (2580 [95% UI 2100–3230]). In 2019, the highest age-standardised incidence rate was observed in breast (12.5 [95% UI 10.1–15.3]), cervical cancer (12.1 [95% UI 8.4–19.3]), leukemia (9.5 [95% UI 5.3–13.4]), CRC (7.7 [95% UI 5.8–10.7]), and prostate cancer (7.5 [95% UI 4–12.3]) per 100,000, while the lowest age-standardised incidence rate was noted in malignant skin melanoma 0.5 (95% UI 0.4–0.7), mesothelioma 0.3 (95% UI 0.1–0.8), other pharynx cancer 0.3 (95% UI 0.2–0.5), and testicular cancer 0.2 (95% UI 0.1–0.4) per 100,000 (Table 1). From 2010 to 2019, the highest percentage of change of incidence rates was recorded in testicular cancer (33% (95% UI − 12 to 104%)), kidney cancer 26% (95% UI 6–56%), ovarian cancer 24% (95% UI − 10 to 68%), and CRC 21% (95% UI − 1 to 42%), while the lowest changes of incidence cases were observed in leukemia 11% (95% UI − 6 to 31%), Hodgkin lymphoma 14% (95% UI − 28 to 5%), and stomach cancer 16% (95% UI − 26 to 4%) (Table 2). In 2019, leukemia (5270 [95% UI 2910–7250]), breast cancer (4110 [95% UI 3300–4960]), cervical cancer (3870 [95% UI 2680–6290]), CRC (2850 [95% UI 2130–4000]), and stomach cancer (2640 [95% UI 2160–3370]) were the four most lethal cancers in Ethiopia in 2019. In 2019, breast cancer 9.7 (95% UI 8–11.6), cervical cancer 8.2 (95% UI 5.7–13.3), leukemia 7.7 (95% UI 4.5–10.9), and CRC 7.7 (95% UI 5.5–10.4) per 100,000 had the highest age-standardised death rates in Ethiopia (Table 1). From 2010 to 2019, the highest percentage change of death counts was observed in ovarian cancer 61% (95% UI 20–117%), pancreatic cancer 59% (95% UI 32–102%), CRC 56% (95% UI 30–83%), and non-melanoma skin cancer 55% (95% UI 32–83%), while the lowest death count changes were seen in stomach cancer 12% (95% UI − 3 to 27%), Hodgkin's lymphoma 6% (95% UI − 12 to 31%), and leukemia 3% (95% UI − 23 to 38%) (Table 2).

In 2019, leukemia, breast cancer, cervical cancer, colorectal cancer, and stomach cancer had the highest age-standardised DALYS rate (Table 1). From 2010 to 2019, the highest DALY's count changes were observed in ovarian cancer 60% (95% UI 16–123%), pancreatic cancer 56% (95% UI 27–81%), colon and rectum cancer 54% (95% UI 27–81%), non-melanoma skin cancer 47% (95% UI 23–76%), while the lowest changes of DALYs counts documented in stomach cancer 8% (95% UI − 8 to 26%), Hodgkin's lymphoma 4% (95% UI − 16 to 32%), and leukemia 6% (95% UI − 33 to 37%). The highest age-standardised death rates of DALY's change from 2010 to 2019 has been seen in pancreatic cancer 18% (95% UI − 5 to 35%), and colon and rectum cancer 15% (95% UI − 5 to 35%), while the lowest changes have been seen in Hodgkin's lymphoma 2% (95% UI − 24 to 27%), and leukemia 19% (95% UI − 33 to −1) (Table 2).

**Burden of cancer in females.** In 2019, the leading incident cases of cancer in females were cervical cancer (6570 [95% UI 4470–10640]), breast cancer (5450 [95% UI 4210–6860]), leukemia (3980 [95% UI 1890–6390]), thyroid (1990 [95% UI 1360–2790]), and CRC (1440 [95% UI 1020–2120]), while the lowest incident cases were larynx cancer (60 [95% UI 50–80]), mesothelioma (60 [95% UI 20–90]) and other pharynx cancer (50 [95% UI 40–80]). Cervical cancer 24.6 (95% UI 17.1–39.2), breast cancer 23 (95% UI 18.4–28.1), leukemia 8.7 (95% UI 4.9–12.4), and CRC 7.7 (95% UI 5.5–10.4) per 100,000 had the highest age-standardised incidence rate in 2019. From 2010 to 2019, the highest percentage of change of incidence cases in females was observed in pancreatic cancer 79% (95% UI 42–128%), kidney cancer 72% (95% UI 33–115%), tracheal, bronchus, and lung cancer 69% (95% UI 36–114), ovarian cancer 67% (95% UI 16–134%), and CRC 64% (95% UI 32–104), while the lowest change was observed in stomach cancer 15% (95% UI − 7 to 44%) and leukemia 7% (95% UI − 39 to 43%) (Fig. 1).

Stomach cancer, leukemia, larynx cancer, nasopharynx cancer, esophageal cancer, Hodgkin's lymphoma, gallbladder and biliary tract cancer, and mesothelioma have decreased age-standardised incidence rate from 2010 to 2019, ranging from − 1 to − 14%, and other malignant cancers have seen an increment in age-standardised incidence rate, ranging from 1 to 30%.

In 2019, the leading causes of cancer related mortality were cervical cancer 3870 (95% UI 2680–6290), breast cancer 3700 (95% UI 2970–4510), leukemia 2150 (95% UI 1260–3060), CRC 1270 (95% UI 900–1870), and stomach cancer 1230 (95% UI 950–2030), while the lowest causes of death were non-melanoma skin cancer 60 (95% UI 30–90), mesothelioma 50 (95% UI 20–70), and other pharynx cancer 50 (95% UI 30–70). From 2010 to 2019, the highest percentage change of death was observed in pancreatic cancer at 81% (95% UI 43–128), tracheal, bronchus, and lung cancer 70% (95% UI 39–112), kidney cancer 66% (95% UI 33–100), ovarian cancer 61% (95%, and CRC 59% (95% UI 30–93%), while the lowest change of death was seen in Hodgkin's lymphoma 19% (95% UI − 10 to 58%), stomach cancer 17% (95% UI − 4 to 43%), and leukemia 1% (95% UI − 28 to 46%) (Fig. 2).

**Burden of cancer in males.** In 2019, the leading causes of incident cases of cancer among males were leukemia (4330 [95% UI 2110–6470]), prostate cancer (2570 [95% UI 1350–4300]), CRC (1760 [95% UI 1230–2690]), tracheal, bronchial, and lung cancer (1690 [95% UI 1160–2280]). In 2019, the highest age-standardised...
| Cancer type | Incidence case | Age-standardised incidence rate | Death counts | Age standardised death rate | DALYs counts | Age-standardised DALYs rate |
|-------------|----------------|-------------------------------|--------------|----------------------------|--------------|---------------------------|
| Bladder cancer | 1060 740 1380 | 2.9 2 3.7 | 850 570 1110 | 2.5 1.7 3.3 | 18,470 12,520 24,100 | 47 31.7 61.5 |
| Brain and central nervous system cancer | 1380 1070 2040 | 1.9 1.5 2.5 | 1130 890 1590 | 1.7 1.3 2.2 | 59,910 44,210 91,080 | 65 51.5 90.3 |
| Breast cancer | 5900 4640 7420 | 12.5 10.1 15.3 | 4110 3300 4960 | 9.7 8 11.6 | 129,580 101,090 161,690 | 251.9 201.6 306.7 |
| Cervical cancer | 6570 4470 10,640 | 12.1 8.4 19.3 | 3870 2680 6290 | 8.2 5.7 13.3 | 133,580 90,860 219,610 | 244.9 169 398.1 |
| Colon and rectum cancer | 3200 2400 4460 | 7.7 5.8 10.7 | 2850 2130 4000 | 7.3 5.5 10.4 | 79,050 58,530 109,670 | 168.6 124.8 236 |
| Esophageal cancer | 1080 850 1500 | 2.7 2.1 3.7 | 1120 870 1570 | 2.9 2.2 4 | 29,770 22,790 41,210 | 67.1 51.8 93.4 |
| Gallbladder and biliary tract cancer | 520 390 670 | 1.4 1 1.8 | 520 390 670 | 1.4 1.1 1.8 | 12,740 9480 16,360 | 30.1 22.5 38.2 |
| Hodgkin lymphoma | 650 490 880 | 0.8 0.6 1.1 | 470 370 640 | 0.7 0.5 0.9 | 24,450 18,500 34,140 | 26.9 21 36.3 |
| Kidney cancer | 740 430 1010 | 1.5 0.9 2.2 | 520 290 740 | 1.3 0.7 1.8 | 15,940 9490 22,070 | 30.1 16.9 43.5 |
| Larynx cancer | 410 330 550 | 1 0.8 1.3 | 380 300 510 | 0.9 0.7 1.3 | 10,870 8590 14,420 | 23.6 18.8 31.5 |
| Leukemia | 8310 4270 12,440 | 9.5 5.3 13.4 | 5270 2910 7250 | 7.7 4.5 10.9 | 305,610 159,470 444,030 | 290.1 163.5 397.2 |
| Lip and oral cavity cancer | 1170 830 1530 | 2.5 1.8 3.3 | 780 530 1010 | 1.8 1.3 2.4 | 24,130 16,440 31,410 | 48.1 32.6 62.6 |
| Liver cancer | 1160 930 1480 | 2.7 2.2 3.5 | 1230 970 1550 | 3 2.4 3.8 | 36,980 29,050 46,870 | 69.8 55.1 88.6 |
| Malignant skin melanoma | 290 220 400 | 0.5 0.4 0.7 | 230 170 310 | 0.5 0.4 0.6 | 8260 6390 11,770 | 13.8 10.5 19 |
| Mesothelioma | 110 40 350 | 0.3 0.1 0.8 | 90 30 290 | 0.2 0.1 0.7 | 2640 990 8100 | 5.3 2 17.2 |
| Multiple myeloma | 350 220 470 | 0.9 0.6 1.2 | 330 210 420 | 0.9 0.5 1.1 | 8380 5300 10,930 | 19.3 12.2 25 |
| Nasopharynx cancer | 530 340 700 | 1 0.6 1.4 | 510 320 670 | 1 0.6 1.4 | 18,450 11,650 24,530 | 31.8 19.9 42.1 |
| Non-Hodgkin lymphoma | 480 350 690 | 0.9 0.7 1.4 | 490 350 690 | 1 0.7 1.5 | 17,280 12,670 23,620 | 28.3 20.4 40 |
| Non-melanoma skin cancer | 2150 1730 2690 | 4.8 3.9 5.8 | 210 100 290 | 0.7 0.3 0.9 | 4620 2250 6120 | 11.4 5.3 15.1 |
| Other malignant neoplasms | 4790 3990 5770 | 7.4 6.1 8.6 | 4330 3660 5130 | 7.2 6 8.2 | 214,780 171,450 268,160 | 245.3 206.3 289.5 |
| Other pharynx cancer | 160 100 230 | 0.3 0.2 0.5 | 150 100 220 | 0.3 0.2 0.5 | 4620 3120 6780 | 9.5 6.3 13.9 |
| Ovarian cancer | 1300 720 2120 | 2.6 1.4 4.1 | 910 490 1500 | 2 1.1 3.3 | 29,770 16,110 49,910 | 57.5 30.8 94.5 |
| Pancreatic cancer | 570 380 820 | 1.5 1 2.1 | 600 410 870 | 1.6 1.1 2.3 | 14,860 9860 21,500 | 34.6 23.1 50.2 |
| Prostate cancer | 2570 1350 4300 | 7.5 4 12.3 | 2290 1210 3740 | 7.1 3.8 11.3 | 43,410 22,750 72,730 | 121.3 64.2 200.3 |
| Stomach cancer | 2580 2100 3230 | 6.2 5.1 7.7 | 2640 2160 3370 | 6.6 5.4 8.3 | 73,970 59,220 95,580 | 155.4 126.2 196.8 |
| Testicular cancer | 270 180 440 | 0.2 0.2 0.4 | 90 50 110 | 0.1 0.1 0.1 | 5110 3250 6670 | 5 3 6.5 |

Continued
The incidence rate was observed in prostate cancer (14.5 [95% UI 7.7–23.9]), leukemia (10.3 [95% UI 5.3–15.6]), tracheal, bronchus, and lung cancer (8.6 [95% UI 5.9–11.6]), and CRC (8.4 [95% UI 5.9–12.7]) per 100,000, while the lowest age-standardised incidence rate was observed in testicular cancer (0.5 [95% UI 0.3–0.7]), other pharynx cancer (0.4 [95% UI 0.3–0.7]), and mesothelioma (0.2 [95% UI 0.1–0.3]) per 100,000.

Table 1. National incidence, deaths and DALYs of cancer in Ethiopia, 2019.

| Cancer type                | Incidence case | Age-standardised incidence rate | Death counts | Age-standardised death rate | DALYs counts | Age-standardised DALYs rate |
|----------------------------|----------------|---------------------------------|--------------|-----------------------------|--------------|----------------------------|
| Thyroid cancer             | 2500           | 1790                             | 3370         | 4                           | 3            | 5.3                        |
| Tracheal, bronchus, and lung cancer | 2170         | 1510                             | 2920         | 5.6                         | 3.9          | 7.5                        |
| Uterine cancer             | 590            | 420                              | 870          | 1.4                         | 1            | 2.1                        |
| Total                      | 53,560         | 52,480                           | 55,540       | 104.3                       | 98.1         | 113.3                      |

Table 2. Percentage changes of national incidence cases, deaths and DALYs in Ethiopia from 2010 to 2019.

| Cancer type                                  | Incidence case change (%) | ASIR change (%) | Death counts change (%) | ASDR change (%) | DALYs counts change (%) | Age standardised DALYs rate change (%) |
|----------------------------------------------|---------------------------|----------------|-------------------------|-----------------|-------------------------|----------------------------------------|
| Bladder cancer                               | 46                        | 24             | 75                      | 9               | −7                      | 30                                     |
| Brain and central nervous system cancer      | 23                        | −7             | 65                      | 1               | −18                     | 25                                     |
| Breast cancer                                | 60                        | 28             | 99                      | 19              | −5                      | 42                                     |
| Cervical cancer                              | 33                        | 1              | 73                      | 1               | −22                     | 27                                     |
| Colon and rectum cancer                      | 62                        | 33             | 92                      | 21              | −1                      | 42                                     |
| Esophageal cancer                            | 24                        | 4              | 46                      | −6              | −20                     | 11                                     |
| Gallbladder and biliary tract cancer         | 30                        | 9               | 57                      | −1              | −16                     | 18                                     |
| Hodgkin lymphoma                             | 13                        | −8             | 43                      | −14             | −28                     | 5                                      |
| Kidney cancer                                | 60                        | 33             | 99                      | 26              | 6                       | 56                                     |
| Larynx cancer                                | 20                        | −2             | 49                      | −9              | −25                     | 12                                     |
| Leukemia                                     | −3                       | 32             | 38                      | −11             | −18                     | 11                                     |
| Lip and oral cavity cancer                   | 47                        | 23             | 76                      | 10              | −6                      | 31                                     |
| Liver cancer                                 | 30                        | 8              | 57                      | 1               | −16                     | 19                                     |
| Malignant skin melanoma                      | 44                        | 11             | 83                      | 8               | −14                     | 34                                     |
| Mesothelioma                                 | 36                        | 5              | 72                      | 4               | −18                     | 28                                     |
| Multiple myeloma                             | 42                        | 16             | 70                      | 7              | −12                     | 28                                     |
| Nasopharynx cancer                           | 27                        | 6               | 51                      | −4              | −19                     | 13                                     |
| Non-Hodgkin lymphoma                         | 46                        | 17             | 77                      | 10              | −10                     | 32                                     |
| Non-melanoma skin cancer                     | 35                        | 32             | 39                      | 0               | −3                      | 55                                     |
| Other malignant neoplasms                    | 39                        | 19             | 70                      | 5               | −9                      | 21                                     |
| Other pharynx cancer                         | 47                        | 19             | 78                      | −9              | −33                     | 46                                     |
| Ovarian cancer                               | 67                        | 16             | 134                     | 24              | −10                     | 68                                     |
| Pancreatic cancer                            | 59                        | 32             | 99                      | 20              | 0                       | 51                                     |
| Prostate cancer                              | 57                        | 28             | 90                      | 16              | −4                      | 40                                     |
| Stomach cancer                               | 11                        | −4             | 28                      | −16             | −26                     | −4                                     |
| Testicular cancer                            | 67                        | −2             | 180                     | 33              | −12                     | 104                                    |
| Thyroid cancer                               | 54                        | 17             | 107                     | 14              | −8                      | 44                                     |
| Tracheal, bronchus, and lung cancer           | 38                        | 13             | 70                      | 4               | −16                     | 29                                     |
| Uterine cancer                               | 53                        | 22             | 91                      | 16              | −7                      | 43                                     |
| Total                                       | 32                        | 11             | 55                      | 5               | −7                      | 18                                     |

The incidence rate was observed in prostate cancer (14.5 [95% UI 7.7–23.9]), leukemia (10.3 [95% UI 5.3–15.6]), tracheal, bronchus, and lung cancer (8.6 [95% UI 5.9–11.6]), and CRC (8.4 [95% UI 5.9–12.7]) per 100,000, while the lowest age-standardised incidence rate was observed in testicular cancer (0.5 [95% UI 0.3–0.7]), other pharynx cancer (0.4 [95% UI 0.3–0.7]), and mesothelioma (0.2 [95% UI 0.1–0.3]) per 100,000. Testicular cancer (67% [95% UI 24–180]), colon and rectum cancer (61% [95% UI 19–105]), prostate cancer (57% [95% UI 28–90]), and thyroid cancer (53% [95% UI 19–103]) had the highest percentage change in incident cases from 2010 to 2019, while Hodgkin’s lymphoma (8% [95% UI 14–36%]), stomach cancer (7% [95% UI 14 to 32%]), and leukemia (2% [95% UI 29 to 51%]) had the lowest change of incident cases (Fig. 3).
In 2019, the five most lethal cancers in Ethiopian males were leukemia (3120 [95% UI 1540–4540]), prostate cancer (2290 [95% UI 1210–3740]), tracheal, bronchus, and lung cancer (1820 [95% UI 1240–2480]), colon and rectum cancer (1580 [95% UI 1090–2450]), and stomach cancer (1410 [95% UI 1050–1840]). Prostate cancer had the highest age-standardised death rate in Ethiopia in 2019, with 13.8 (95% UI 7.5–22), tracheal, bronchus, and lung cancer (9.5 [95% UI 6.5–12.90]), leukemia (9 [95% UI 4.7–14]), and colon and rectum cancer (17 [95% UI 4 to 41%]). Other pharynx cancer (15% [95% UI 13 to 50%]), and pancreatic cancer (15% [95% UI 14 to 59%]) had the greatest percentage change in age-standardised death rate in males between 2010 and 2019, while decreased age-standardised death rate in males was observed in breast cancer (− 3% [95% UI − 27 to 27%]), esophageal cancer (− 4% [95% UI − 26 to 25%]), leukemia (− 7% [95% UI −

### Table 3. Percentage changes of incidence cases, deaths and DALYs in global and neighbor countries from 2010 to 2019.

| Country     | Change of incidence cases (%) | Change of ASIR (%) | Change of deaths counts (%) | Change of ASDR (%) | Change of DALYs (%) | Change of ASDALYsR (%) |
|-------------|-------------------------------|-------------------|----------------------------|-------------------|---------------------|-----------------------|
| Global      | Value  26 20 32  21 14 38 16 9 23  7 16 17 | Value  95% UI 3 11 3  2 11 17  0 11 17  3 11 17 | Value  95% UI 3 11 3  2 11 17  0 11 17  3 11 17 | Value  95% UI 3 11 3  2 11 17  0 11 17  3 11 17 | Value  95% UI 3 11 3  2 11 17  0 11 17  3 11 17 | Value  95% UI 3 11 3  2 11 17  0 11 17  3 11 17 |
| Djibouti    | 58 26 99 54 23 92 43 10 82 0 19 24 | 6 12 28 2 14 23  | 7 12 28 4 14 23  | 8 12 28 4 14 23  | 10 12 28 4 14 23  | 12 12 28 4 14 23  |
| Eritrea     | 35 14 62 32 11 56 27 5 53 1 16 17 | 3 12 20 3 12 20  | 3 12 20 3 12 20  | 3 12 20 3 12 20  | 3 12 20 3 12 20  | 3 12 20 3 12 20  |
| Ethiopia    | 32 11 55 29 12 48 19 2 44 2 15 12 | 5 7 18 2 9 14  | 5 7 18 2 9 14  | 5 7 18 2 9 14  | 5 7 18 2 9 14  | 5 7 18 2 9 14  |
| Kenya       | 40 21 64 36 18 56 31 12 53 4 16 11 | 2 11 17 1 12 12  | 2 11 17 1 12 12  | 2 11 17 1 12 12  | 2 11 17 1 12 12  | 2 11 17 1 12 12  |
| Somalia     | 32 10 58 30 9 55 28 6 54 5 20 13 | 3 18 15 9 55 28  | 3 18 15 9 55 28  | 3 18 15 9 55 28  | 3 18 15 9 55 28  | 3 18 15 9 55 28  |
| South Sudan | 16 2 38 16 3 40 10 9 33 2 18 19 | 0 14 17 0 13 17  | 0 14 17 0 13 17  | 0 14 17 0 13 17  | 0 14 17 0 13 17  | 0 14 17 0 13 17  |
| Sudan       | 38 17 66 30 11 55 26 3 54 2 14 23 | 11 5 30 5 9 23  | 11 5 30 5 9 23  | 11 5 30 5 9 23  | 11 5 30 5 9 23  | 11 5 30 5 9 23  |

Figure 1. Percentage change of incidence, death, and DALYs in each cancer type among females in Ethiopia from 2010 to 2019.

In 2019, the five most lethal cancers in Ethiopian males were leukemia (3120 [95% UI 1540–4540]), prostate cancer (2290 [95% UI 1210–3740]), tracheal, bronchus, and lung cancer (1820 [95% UI 1240–2480]), colon and rectum cancer (1580 [95% UI 1090–2450]), and stomach cancer (1410 [95% UI 1050–1840]). Prostate cancer had the highest age-standardised death rate in Ethiopia in 2019, with 13.8 (95% UI 7.5–22), tracheal, bronchus, and lung cancer (9.5 [95% UI 6.5–12.90]), leukemia (9 [95% UI 4.7–14]), and colon and rectum cancer (17 [95% UI 4 to 41%]). Other pharynx cancer (17% [95% UI 13 to 50%]), and pancreatic cancer (15% [95% UI 14 to 59%]) had the greatest percentage change in age-standardised death rate in males between 2010 and 2019, while decreased age-standardised death rate in males was observed in breast cancer (− 3% [95% UI − 27 to 27%]), esophageal cancer (− 4% [95% UI − 26 to 25%]), leukemia (− 7% [95% UI
− 28 to 23%]), larynx cancer (− 9% [95% UI − 29 to 14%]), stomach cancer (− 16% [95% UI − 33 to 2%]), and Hodgkin's lymphoma (− 19% [95% UI − 35 to 0%]) (Fig. 4).

In 2019, the leading causes of highest DALYs counts and age-standardised DALYs rates in males were leukemia, prostatic cancer, CRC, and tracheal, bronchus, and lung cancer, while the lowest DALYs counts were non-melanoma skin cancer, other pharynx cancer, and mesothelioma. From 2010 to 2019, the most significant percentage change in DALYs counts was observed in colon and rectum cancer (53% [95% UI 13–97%]), non-melanoma skin cancer (49% [95% UI 19–85%], other pharynx cancer (49% [95% UI 12–97%]), pancreatic cancer (47% [95% UI 10–103%]), testicular cancer (45% [95% UI 10–91%]), and prostate cancer (15% [95% UI 15–74%]) (Fig. 3). From 2010 to 2019, a decreased age-standardised DALYs rate was identified in lip and oral cavity cancer, nasopharynx cancer, gallbladder and biliary tract cancer, brain and central nervous system cancer, breast cancer, esophageal cancer, larynx cancer, leukemia, stomach cancer, and Hodgkin lymphoma, ranging from −1 to −22% (Fig. 4).

Discussion

Between 2010 and 2019, the absolute number of cancer incidence cases, mortality, and DALYs increased significantly in Ethiopia. However, the age-standardised rate of cancer incidence, death, and DALYs shows erratic trends. From 2010 to 2019, we found that the trends in the age-standardised cancer incidence rate were fairly stable. Similarly, neighboring countries such as Djibouti, Eritrea, Kenya, Somalia, South Sudan, and Sudan have seen similar trends. However, there were contrast trend in high income countries and global4. Cancer is becoming more prevalent around the world, particularly in low and middle-income countries. According to WHO projections, low and middle income (LMIC) countries will bear two-thirds of the cancer burden in 20405. The main reasons for the rapid rise in cancer in low and middle income countries are population growth, aging, sociodemographic, and epidemiological transitions (LMICs)4.

The change in the incidence of cancer cases in Ethiopia, on the other hand, was primarily driven by population growth and aging. The stable age-standardised cancer incidence rate suggests that epidemiological and sociodemographic transitions play a minor role in cancer pathogenesis in Ethiopia. In 2019, behavioral risks, metabolic, occupational exposure, and air pollutions were attributed to approximately 20% (17–26%) of cancer in Ethiopia; however, changes in overall risk factors were less than 10% between 2010 and 2019. From 2010 to 2019, the age-standardised rate of cancer death in Ethiopia increased. The findings of this study stand in stark contrast to the age-standardised cancer rates in high-income countries16 and global trends6.

The increased age-standardised cancer death rate calls into question national policy in terms of progress in treatment and management, primary prevention, and secondary prevention modality implementation. Cancer is
responsible for one out of every six deaths worldwide, according to a WHO report. Many global initiatives have been launched to address the cancer burden. However, global, regional, and national efforts for cancer prevention in low and middle-income countries remain insufficient and inequitable. In high-income countries, a strong health-care system, a large human resource capacity, and effective primary and secondary prevention methods are responsible for lower mortality whereas the main causes of increased cancer related mortality are a lack of workforce capacity, poor cancer care infrastructure, a lack of cancer centers for diagnosis and treatment, a lack of financial security, and a lack of universal health coverage.

Despite an increase in the age-standardised death rate of overall cancer, some cancer types had decreased age-standardised death rates, such as thyroid cancer, gall bladder and biliary tract cancer, cervical cancer, Nasopharynx cancer, esophageal cancer, leukemia, larynx cancer, stomach cancer, and Hodgkin lymphoma, which ranged from −1 to −18% over the last one decades. The main agent for lowering mortality rates will be progress in human resource capacity building, adoption of diagnostic imaging and pathological laboratories, early detection and treatment, surgical advancement, and adaptation of an effective cervical cancer screen. Most infection-related cancers, such as cervical, stomach, nasopharynx, and Hodgkin lymphoma, have steadily declined in Ethiopia over the last one decade.

Cancer trends and outcomes are disproportionately high in low and middle-income countries. Low health care budgets, overburdened health-resources with communicable diseases, child and maternal health, low universal health coverage, and an increased burden of cancer all contribute to significant universal health-care disparities and inequity in low and middle-income countries. According to current evidence, primary and secondary prevention strategies could prevent more than half of all cancers. A screening program based on guidelines has shown a reduction in cancer-related mortality in cervical, breast, prostate, and colorectal cancer. Screening has been primarily responsible for lower rates of death and disability-adjusted life years (DALYs) for cervical cancer in Ethiopia. Currently, evidence-based modification of primary risk factors such as smoking (lung, kidney, pancreatic, and larynx cancer), H.pylori (stomach cancer), reduced alcohol consumption (liver cancer), and salted and western diets (colorectal and other GI malignancy) have aided in cancer prevention.

Global organizations advocate for and implement National Cancer Control Plans (NCCP) to address the cancer burden in low-income countries. WHO leads the Global Action Plan for the Prevention and Control of NCDs.
2013–2020, which aims to reduce overall mortality from cardiovascular diseases, cancer, diabetes, or chronic respiratory diseases by 25% by 2025, as well as premature mortality from noncommunicable diseases between the ages of 30 and 70\textsuperscript{19}. Ethiopia has one cancer center that offers chemoradiotherapy with few oncologists and radiotherapy wait times of 15–17 months and surgery wait times of 6–12 months. Ethiopia's cancer health policy in terms of prevention and control is deplorable. Ethiopia should have adopted WHO recommendations for cancer prevention, diagnosis, and management, as well as for strength national cancer control plan\textsuperscript{3}. Low setting countries like Ethiopia should have learnt a lesson on cancer care policy development, cancer care infrastructure development, human resource capacity building, and principle of cancer prevention and control program from Rwanda\textsuperscript{13}.

**Limitation**

Although GBD studies provide qualitative and compressive evidence for policymakers, researchers, and planners, the quality and quantity of data sources available for estimation is dependent on the quality and quantity of data sources available for estimation. Cancer mortality is primarily estimated using the cancer registry, vital registration, and, to a lesser extent, other data sources. Ethiopia has only one population-based cancer registry, which only covers 3–5 percent of the total population.

**Conclusion**

Overall cancer related mortality and incidence rates increased in Ethiopia. Disparities in cancer prevention, care, and control are the primary causes of these trends. Researchers, health care professionals, and policymakers must work together to develop screening guidelines and protocols, improve cancer care infrastructure, capacity building, surgical and chemoradiotherapy policy, and maximize primary cancer prevention, secondary cancer prevention, early diagnosis, treatment, and rehabilitative care to reduce cancer-related mortality and disability.
Methods
We extracted data from the GBD 2019 results too (http://ghdx.healthdata.org/gbd-results-tool). The method and data sources are described in detail in GBD 2019 publications and previous GBD publications10,18,20. The Guideline for Accurate and Transparent Health Estimated Reporting (GATHER) statement was used to create GBD 2019. In summary, the 2019 Global Burden of Disease, Injury, and Risk Factors Study reported national estimates of cancer incidence, mortality, and DALY’s from 1990 to 2019. Estimates for GBD 2019 were analyzed and evidence for 363 non-fatal diseases, 302 deaths, and 87 risk factors were reported in 204 countries and 21 regions11. To calculate disease incidence, mortality, and DALY’s, the GBD study collects data from vital registration, verbal autopsy, cancer registry, sample vital registry, censes, demographic and health surveys, published and unpublished health data, and other sources. GBD produced sound and up-to-date evidence of trends at the global, regional, and national levels as a result of the shift in the global agenda and increased focus on noncommunicable disease and injury. GBD studies used three main standardised modelling tools to process data, model, and generate each estimation of disease by age, location, sex, and year-Cause of Death Ensemble (CODEm), DisMod-MR, and Spatiotemporal Gaussian Process Regression (ST-GPR). Cancer registry incidence data were used to calculate the mortality rate. The first model was MIR, which is based on a cancer registry and includes both mortality and incidence. MIR is a linear-step mixed-effects model that includes a logit link function, HAQ, age, and gender as covariates. Spatiotemporal Gaussian process regression was used to smooth and adjust the final model. The final model CODEm was built using observed mortality data and MIR model estimated mortality. To estimate cancer incidence, the final cancer specific mortality estimates are divided by MRI. DisMod-MR is a Bayesian meta-regression tool that uses all available data to estimate the incidence and prevalence of each disease over time. Years lived with disability (YLDs) are calculated by dividing 10-year cancer prevalence into four categories: (1) diagnosis/treatment, (2) remission, (3) metastasis/dissemination, and (4) terminal phase. Years of life lost (YLLs) are calculated by multiplying the estimated number of deaths by age by the age's standard life expectancy. The sum of YLDs and YLLs yields disability-adjusted life-years (DALYs). For age standardised rates and all rates reported per 100,000, the GBD world population is used. All estimates have 95 percent confidence intervals (UI). The GBD2019 publications contain detailed descriptions of methodology, modeling, and data sources. The GBD2019 publications contain detailed descriptions of methodology, modeling, and data sources11,20,21. We focused on the national burden of cancer in Ethiopia, estimating the burden in terms of incidence, DALYs, and mortality for 29 cancer categories.

Data availability
Data available in GBD2019 result tool (http://ghdx.healthdata.org/gbd-results-tool).

Received: 12 September 2021; Accepted: 20 July 2022
Published online: 26 July 2022

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Author contributions
A.F. and Z.A. conceptualized of the study, A.F. and W.B. drafted the manuscript, A.F. generate all data from GBD 2019 tools, A.F., Z.A., W.B. write the result, Z.A. and A.F. write discussion, A.F. and W.B. table and Figure preparation, A.F., Z.A., W.B. finalized the final paper. All authors approved the final version of manuscript.

Competing interests
The authors declare no competing interests.

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