Burden and trend of colorectal cancer in 54 countries of Africa 2010–2019: a systematic examination for Global Burden of Disease

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Abstract
Background: Colorectal cancer plays significant role in morbidity, mortality and economic cost in Africa.
Objective: To investigate the burden and trends of incidence, mortality, and disability-adjusted life-years (DALYs) of colorectal cancer in Africa from 2010 to 2019.
Methods: This study was conducted according to Global Burden of Disease (GBD) 2019 analytic and modeling strategies. The recent GBD 2019 study provided the most updated and comprehensive epidemiological evidence of cancer incidence, mortality, years lived with disability (YLDs), years of life lost (YLLs), and DALYs.
Results: In 2019, there were 58,000 (95% UI: 52,000–65,000), 49,000 (95% UI: 43,000–54,000), and 1.3 million (95% UI: 1.14–1.46) incident cases, deaths and DALYs counts of colorectal cancer respectively in Africa. Between 2010 and 2019, incidence cases, death, and DALY counts of CRC were significantly increased by 48% (95% UI: 34–62%), 41% (95% UI: 28–55%), and 41% (95% UI: 27–56%) respectively. Change of age-standardised rates of incidence, death and DALYs were increased by 11% (95% UI: 1–21%), 6% (95% UI: −3 to 16%), and 6% (95% UI: −5 to 16%) respectively from 2010 to 2019. There were marked variations of burden of colorectal cancer at national level from 2010 to 2019 in Africa.
Conclusion: Increased age-standardised death rate and DALYs of colorectal cancer indicates low progress in CRC standard care-diagnosis and treatment, primary prevention of modifiable risk factors and implementation of secondary prevention modality. This serious effect would be due to poor cancer infrastructure and policy, low workforce capacity, cancer center for diagnosis and treatment, low financial security and low of universal health coverage in Africa.
Keywords: Colorectal, Cancer, Africa, Burden

Background
Colorectal cancer plays significant role in morbidity, mortality and economic cost. In 2019, Global Burden Disease study reported that CRC accounted for 1.8 million incidence cases, 0.9 million deaths, and 19 million DALYs worldwide [1]. According to GLOBACAN reported in 2020, colorectal cancer was responsible for more than 1.9 million new incident cases and 0.94 million deaths, making third and second rank for overall cancer incidence and mortality globally [2]. Global incidence cases of CRC doubled or more than doubled in 157 of 204 countries, and mortality due to CRC doubled of more doubled in 129 of 204 countries, pronounced increases were observed in low and Middle SDI countries from 1990 to 2019 [3]. Due to the rapid rising of global population size, aging and human economic development, burden of CRC is predicted to be 2.2 million new cases and 1.1 million cancer deaths by 2030 [4] and 3.2 million new incidence cases in 2040 [5]. This trend alarms all concern bodies
to stand for prevention and control of CRC. CRC is the indicator of socioeconomic transition, epidemiological and demographic change. The current global evidence ascertains that trend of CRC has three patterns—rapidly rising in many LMICs which is associated with socioeconomic transition, stabilizing or decreasing in middle high and high income countries [1, 2, 4]. Development of CRC has associated with males and older age. Lifetime risk of CRC estimated approximately 4.4% of men (1 in 23) and 4.1% of women (1 in 25) [6]. Approximately 70% of CRC cases occur sporadic, whereas the remaining 12–35% and 5–7% are linked with familiar and genetic respectively [7, 8]. More than half (55%) of all CRCs have attributed to lifestyle factors, including an unhealthy diet, insufficient physical activity, high alcohol consumption, and smoking [6]. Global efforts have tried to alleviate serious effect of cancer, specifically major cancers such as CRC, breast, and cervical cancer. In 2012, World Health Assembly members agreed to reduce premature death from noncommunicable diseases (NCDs) by 25% by 2025 [9]. In 2015, United Nations (UN) Sustainable Development Goals planned to reduce NCD related premature mortality by one-third by 2030 [10]. Understanding the trend and variation in incidence, DALYs and mortality of colorectal cancer helps for public health experts, professional experts, national policy makers and cancer prevention advocacy groups to bring evidence based decision in their countries and to evaluate the effective, accessibility, affordability, and efficiency of interventions. GLOBACAN and GBD are the two studies that provide national, regional and global burden of cancers. Despite this evidence, burden of CRC in Africa and nations are not well narrated due to their compressive report. Therefore, considering the aforementioned issues, the present study provides regional and national incidence, mortality and DALYs for colorectal cancer in terms of counts, age-standardised rates, and percentage change for 54 countries from 2010 to 2019.

Methods
The data used for analysis of this study was obtained from GBD2019 data tools (http://ghdx.healthdata.org/gbd-results-tool). The study conducted based on GBD2019 methodology framework and tools. The GBD study provides a standardised approach for estimating incidence, prevalence, and DALYs by cause, age, sex, year, and location for global, regions and countries. The incidence, DALYs and mortality for CRC reported as part of the Global Burden of Disease, injury, and risk factors study 2019. The GBD 2019 estimates provided evidences for 363 causes of non-fatal burden, 302 causes of deaths, and 87 risk factors in 204 countries and territories, 21 regions and 7 supper regions. The main sources of data used for GBD estimation were obtained from cancer registry, vital registration, sample registration system, and verbal autopsy [11]. There are three main standardised tools: Cause of Death Ensemble model (CODEm), spatiotemporal Gaussian process regression (ST-GPR), and DisMod-MR [11]. Cause of Death Ensemble model (CODEm) developed after stepwise data transformation of raw data. First, incidence and morality data obtain from different sources are transformed into standardised format, categorize and registered. After standardised, cancer registry incidence data and cancer registry mortality data are mapped to GBD causes and standardized to the GBD age groups. Incidence and mortality data from cancer registries were processed before matching the same by cancer, age, sex, year, and location to generate crude mortality-to-incidence (MI) ratio. Finally, MI ratios estimates were estimated using a linear step mixed-effects model using the logit link function, in which healthcare access and quality (HAQ) index served as a covariate. The ST-GPR model has three main hyperparameters that control for smoothing across time, age, and geography. The final mortality estimates were produced using the Cause of Death Ensemble Model (CodeM) using crude mortality estimates as inputs along with other variables taken as covariates. DALYs of CRC was estimated using DisMod-MR 2.1 proportion model. The input of data for DisMod-MR 2.1 was procedure-related disability (ostomies) for all locations by age, sex, and year. Evidence from literature review narrated that an average of 58% of all ostomies are for colorectal cancer, so we multiplied all-cause ostomies by 0.58 [12].

Result
Colorectal burden of Africa
In 2019, estimated incident new cases of colorectal cancer in Africa were 58,000 (95% UI: 52,000–65,000), with age-standardised 8.7 (95% UI: 8.1–9.4) per 100,000 in both sexes. The incidence cases increased significantly from 40,000 (95% UI: 36,000–43,000) in 2010 to 58,000 (95% UI: 52,000–65,000) in 2019, which represented a percentage change of 48% (95% UI: 34–62%) and AAPC 4.4% (95% UI: 4.3–4.5%). Change of age-standardised incidence rate of CRC between 2010 and 2019 was 11% (95% UI: 1–21%) and AAPC was 1.1% (95% UI: 1–1.2%).

In 2019, estimated absolute number of deaths due to colorectal cancer in Africa was 49,000 (95% UI: 43,000–54,000), with age-standardised 8.1 (95% UI: 7.4–8.8) per 100,000. Between 2010 and 2019, deaths due to colorectal cancer increased from 35,000 (95% UI: 31,000–38,000) to 49,000 (95% UI: 43,000–54,000), which represented 41% (95% UI: 28–55%) and AAPC was 3.9% (95% UI: 3.8–4%). Change of age-standardised death rate of CRC between
2010 and 2019 was 6% (95% UI: −3 to 16%) and AAPC was 0.7% (95% UI: 0.4–1%).

In 2019, estimated DALYs counts of colorectal cancer in Africa were 1.3 million (95% UI: 1.14–1.46), with age-standardised 180 (95% UI: 160–200) per 100,000. The DALYs counts of colorectal increased significantly from 0.92 million (95% UI: 0.84–1.01) in 2010 to 1.3 million (95% UI: 1.1–1.6) in 2019, which represented 41% (95% UI: 27–56%) and AAPC was 3.7% (95% UI: 3.6–3.8%). Change of age-standardised DALYs rate of CRC between 2010 and 2019 was 6% (95% UI: −5 to 16%) and AAPC was 0.7% (95% UI: 0.4–1%). For comparing purpose, we explored the trends of CRC in Europe, America, Asia and Global (Table 1).

**Distribution of Burden of CRC among sexes in Africa**

In 2019, CRC accounted for 31,000 (95% UI: 27,000–36,000), 2500 (95% UI: 22,000–29,000), and 6.9 million (95% UI: 6–7.9) incidence cases, deaths and DALYs counts among males in Africa respectively. In Africa, CRC accounted for 27,000 (95% UI: 24,000–30,000), 2300 (21,000–26,000), and 6.1 million (95% UI: 5.2–7) incidence cases, deaths and DALYs counts respectively among females in 2019. In 2019, age-standardised rates of incidence cases, deaths, and DALYs counts of CRC were 10.6 (95% UI: 9.4–11.9), 9.2 (95% UI: 8.2–10.3), and 210 (95% UI: 180–230) per 100,000 in African males respectively, and 8.7 (95% UI: 7.7–9.7), 8 (95% UI: 7.1–9), and 170 (95% UI: 150–200) per 100,000 in African females respectively.

In Africa, between 2010 and 2019, percentage change of incidence cases, death and DALYs counts of CRC were 48% (95% UI: 31–65%), 40% (95% UI: 23–56%), and 40% (95% UI: 23–57%) in males, respectively, and 47% (95% UI: 31–64%), 42% (95% UI: 27–58%), and 42% (95% UI: 26–60%) in females, respectively. From 2010 to 2019 in Africa, changes of age-standardised rate of incidence, death and DALYs were 12% (95% UI: 0–25%), 7% (95% UI: −5 to 19%), and 6% (95% UI: −6 to 18%) respectively in males, and 10% (95% UI: −1 to 21%), 6% (95% UI: −4 to 17%), and 6% (95% UI: −6 to 18%) respectively in females. From 2010 to 2019 in Africa, the average annual percentage change (AAPC) of incidence cases was 4.4% (95% UI: 4.3–4.5) in males and 4.4% (95% UI: 4.3–4.5) in females while AAPC of age-standardised DALYs was 1.3% (95% UI: 1.1–1.4%) in males and 1% (95% UI: 0.9–1.1%) in females.

**Age specific distribution of burden of CRC in Africa**

In 2019, age specific incidence CRC was peaking at 60–69 years in both males and females. Age specific death counts were peaking at 60–69 years while 65–79 years in females. Most DALYs counts were recorded in 55–64 years in both male and female (Figs. 1, 2, 3).

**National burden**

There were marked variations of burden of colorectal cancer at national level from 2010 to 2019 in Africa. In 2019, highest estimated new incident cases of colorectal cancer observed in Nigeria 7080 (5310–8960), Egypt 6520 (4680–9010), South Africa 5570 (5000–6290), Algeria 3410 (2670–4280), Morocco 3210 (2390–4070), and Ethiopia 3200 (2400–4460) while lowest new incident cases observed in Sao Tome and Principe 16 (11–22), Seychelles 38 (34–44), Comoros 40 (30–60), and Gambia 50 (50–90). In 2019, highest age-standardised new
incidence rate of colorectal recorded in Seychelles 35.7 (31.4–40.6), Mauritius 19.8 (16.1–24.2), Botswana 18.8 (13.5–24.5), and Libya 17 (12.4–21.8) per 100,000 while lowest age-standardised rate saw in Central African Republic 6.3 (4.6–8.7), Malawi 6.3 (4.9–7.8), Niger 5.6 (4.2–7.6), and Somalia 5 (3.1–9.2) per 100,000 (Table 2).

From 2010 to 2019, highest percentage change of incidence cases of CRC have seen in Djibouti 77% (40–125), Cabo Verde 77% (39–112%), Rwanda 72% (42–109%), Angola 68% (36–114%), and Democratic Republic of the Congo 63% (29–104%) while lowest changes observed Eswatini 20% (−7 to 61%), Guinea 19% (−2 to 19%) and Central African Republic 16% (−8 to 45%). From 2010 to 2019, highest increased age-standardised incidence rate of CRC has seen in Cabo Verde 48% (15–78), Morocco 25% (1–54%), Sao Tome and Principe 22% (2–42%), Sudan 22% (0–48), Ethiopia 21% (−1 to 28%), South Africa−5% (−15 to 8%), Central African Republic−8% (−25 to 13%), Libya−8% (−33 to 19%) (Table 3).

In terms of death counts in both sexes, Nigeria, South Africa, Egypt, and Ethiopia were the leading four countries with 6380 (4880–8140), 4600 (4160–52), 4560 (3300–6270), and 2850 (2130–4000) deaths respectively in 2019. Comoros 40 (30–50), Seychelles 26 (23–30), and Sao Tome and Principe 14 (10–19) had lowest death counts in 2019. In 2019, Seychelles 25.3 (22.2–28.7), Botswana 15.8 (11.6–20.5), Sao Tome and Principe 15.2 (11.2–20.6), and Gabon 14.9 (11.3–18.2) per 100,000 had a highest age-standardised death rate whereas Democratic Republic of the Congo 6.2 (4.1–9.5), Malawi 6.1 (4.7–7.5), Niger 5.6 (4.2–7.5), and Somalia 5 (3.2–9.3) per 100,000 had a lowest age-standardised death rate (Table 2). From 2010 to 2019, highest percentage change of death counts due to CRC observed in Djibouti 71% (35–115%), Rwanda 67% (38–100%), Cabo Verde 65% (28–100%), Angola 63% (31–105%), Democratic Republic of the Congo 58% (26–97%), and Ethiopia 56% (30–83%) while lowest change observed in Eswatini 16% (−9 to 55%), Guinea 16% (−4 to 40%), Central African Republic 16% (−8 to 45%), and South Africa 16% (4–32%). Cabo Verde 41% (8–70%), Democratic Republic of the Congo 17% (−5 to 45%), Morocco 17% (−4 to 44%) had highest percentage change of age-standardised death rate, while Burundi−1% (−17 to 18%), Somalia−2% (−18 to 17%), Eswatini−6% (−25 to 13%), Central African Republic−8% (−25 to 13%), Libya−8% (−32 to 18%), and South Africa−9% (−17 to 3%) had decreased age-standardised death rate from 2010 to 2019 (Table 3).

In 2019, DALYs counts due to CRC in Africa were ranging from 400 to 157, 300. The four leading countries in terms of DALYs counts in both sexes were Nigeria 157,300 (116,500–205,200), Egypt 133,000 (95,300–183,300), South Africa 111,500 (100,300–126,600), and Ethiopia 79,000 (58,500–109,700) while Comoros, Seychelles, and Sao Tome and Principe had lowest DALYs counts with 1000 (700–1300), 600
| Location                          | Incidence case counts | Age-standardised incidence rate | Death counts |
|----------------------------------|-----------------------|---------------------------------|--------------|
|                                  | 2019  95% UI  2019  95% UI | 2019  95% UI  2019  95% UI | 2019  95% UI |
| Africa                           | 58,000  52,000  65,000 | 8.7  8  9.4 | 49,000  43,000  54,000 |
| Algeria                          | 3410  2670  4280 | 10.5  8.3  13 | 2380  1890  2950 |
| Angola                           | 1080  830  1390 | 10  8.1  12.5 | 950  740  1210 |
| Benin                            | 360  280  470 | 7.8  6.3  9.8 | 330  260  420 |
| Botswana                         | 250  170  330 | 18.8  13.5  24.5 | 190  130  250 |
| Burkina Faso                     | 640  500  820 | 7.4  5.9  9.4 | 580  460  740 |
| Burundi                          | 330  240  480 | 7.3  5.3  10.4 | 300  220  440 |
| Côte d'Ivoire                    | 950  720  1200 | 9.6  7.6  11.9 | 850  660  1070 |
| Cabo Verde                       | 60  50  70 | 13.4  10.7  15.7 | 50  40  60 |
| Cameroon                         | 1270  930  1680 | 11.2  8.6  14.6 | 1110  840  1460 |
| Central African Republic         | 140  100  190 | 6.3  4.6  8.7 | 130  90  180 |
| Chad                             | 390  300  510 | 7.3  5.7  9.4 | 370  290  480 |
| Comoros                          | 40  30  60 | 9  6.6  11.4 | 40  30  50 |
| Congo                            | 300  220  400 | 11.9  9.1  15.4 | 270  200  350 |
| Democratic Republic of the Congo | 2190  1480  3260 | 6.4  4.2  9.6 | 2000  1340  2960 |
| Djibouti                         | 70  50  100 | 11.9  9.1  15.8 | 60  40  80 |
| Egypt                            | 6520  4680  9010 | 9.8  7.1  13.4 | 4560  3300  6270 |
| Equatorial Guinea                | 70  50  110 | 15.6  9.8  22.4 | 60  40  90 |
| Eritrea                          | 280  210  370 | 10.3  8.1  13.2 | 250  190  320 |
| Eswatini                         | 80  50  110 | 14.4  9.8  19.7 | 70  50  100 |
| Ethiopia                         | 3200  2400  4460 | 7.7  5.8  10.7 | 2850  2130  4000 |
| Gabon                            | 170  120  210 | 16.4  12.1  20.3 | 140  100  180 |
| Gambia                           | 60  50  90 | 6.8  5  9.2 | 60  40  80 |
| Ghana                            | 1490  1160  1900 | 9.5  7.6  11.9 | 1270  1000  1610 |
| Guinea                           | 390  300  510 | 7.3  5.6  9.4 | 370  280  480 |
| Guinea-Bissau                    | 70  50  80 | 9.3  7.1  11.7 | 60  40  70 |
| Kenya                            | 1780  1420  2210 | 8.2  6.7  10 | 1630  1280  2040 |
| Lesotho                          | 150  100  190 | 12  8.8  15.5 | 130  100  170 |
| Liberia                          | 130  90  190 | 6.8  4.7  9.7 | 120  80  170 |
| Libya                            | 900  660  1180 | 17  12.4  21.8 | 620  450  800 |
| Madagascar                       | 800  580  1080 | 7.3  5.4  9.7 | 710  530  960 |
| Malawi                           | 440  340  560 | 6.3  4.9  7.8 | 400  310  510 |
| Mali                             | 680  530  850 | 8.1  6.4  10.1 | 610  490  770 |
| Mauritania                       | 170  130  220 | 8.8  6.8  11.1 | 160  120  200 |
| Mauritius                        | 340  280  420 | 19.8  16.1  24.2 | 210  180  260 |
| Morocco                          | 3210  2390  4070 | 10.3  7.7  13 | 2480  1860  3110 |
| Mozambique                       | 900  650  1190 | 8.7  6.4  11.4 | 830  610  1090 |
| Namibia                          | 130  100  170 | 9.7  7.7  12.3 | 110  90  140 |
| Niger                            | 410  290  560 | 5.6  4.2  7.6 | 370  280  510 |
| Nigeria                          | 7080  5310  8960 | 8.9  6.9  11 | 6380  4880  8140 |
| Rwanda                           | 550  420  700 | 9.3  7.4  11.7 | 480  380  610 |
| Sao Tome and Principe            | 16  11  22 | 16.5  12  22.2 | 14  10  19 |
| Senegal                          | 630  500  800 | 8.9  7.2  11.1 | 590  470  730 |
| Seychelles                       | 38  34  44 | 35.7  31.4  40.6 | 26  23  30 |
| Sierra Leone                     | 240  190  320 | 7.1  5.5  9.1 | 220  170  290 |
| Somalia                          | 330  210  620 | 5  3.1  9.2 | 310  200  580 |
| South Africa                     | 5570  5000  6290 | 12.9  11.6  14.5 | 4600  4160  5200 |
| South Sudan                      | 370  240  550 | 9.9  6.6  14.7 | 350  220  530 |
| Location                          | Incidence case counts | Age-standardised incidence rate | Death counts |
|----------------------------------|-----------------------|----------------------------------|--------------|
|                                  | 2019 | 95% UI | 2019 | 95% UI | 2019 | 95% UI |
| Sudan                            | 1560| 1110 | 2340 | 8.2 | 6 | 12.3 |
| Togo                             | 280 | 200 | 370 | 8.2 | 6.1 | 10.5 |
| Tunisia                          | 1800 | 1300 | 2440 | 14.5 | 10.5 | 19.5 |
| Uganda                           | 1740 | 1350 | 2150 | 12.3 | 9.8 | 14.8 |
| United Republic of Tanzania      | 2460 | 1930 | 3180 | 10.1 | 8.1 | 12.7 |
| Zambia                           | 920 | 670 | 1200 | 13.6 | 10.1 | 17.4 |
| Zimbabwe                         | 930 | 710 | 1180 | 13.8 | 10.6 | 17.2 |

| Location                          | Age-standardised death rate | DALYs counts | Age-standardised DALYs rate |
|----------------------------------|-----------------------------|--------------|-----------------------------|
|                                  | 2019 | 95% UI | 2019 | 95% UI | 2019 | 95% UI |
| Africa                           | 8.1 | 7.4 | 8.8 | 1,300,000 | 1,140,000 | 1,460,000 | 180 | 160 | 200 |
| Algeria                          | 8 | 6.4 | 9.8 | 57,600 | 45,200 | 72,400 | 170 | 130 | 210 |
| Angola                           | 9.7 | 7.8 | 12 | 27,800 | 20,700 | 35,900 | 220 | 170 | 280 |
| Benin                            | 7.6 | 6.2 | 9.5 | 8500 | 6500 | 11,300 | 160 | 130 | 210 |
| Botswana                         | 15.8 | 11.6 | 20.5 | 5200 | 3500 | 7100 | 350 | 240 | 460 |
| Burkina Faso                     | 7.3 | 5.8 | 9.1 | 15,400 | 11,900 | 19,900 | 160 | 120 | 200 |
| Burundi                          | 7.2 | 5.2 | 10.1 | 8900 | 6200 | 12,900 | 170 | 120 | 240 |
| Côte d’Ivoire                    | 9.4 | 7.6 | 11.5 | 23,400 | 17,400 | 30,300 | 200 | 160 | 250 |
| Cabo Verde                       | 11.4 | 9 | 13.4 | 1000 | 800 | 1100 | 220 | 180 | 260 |
| Cameroon                         | 10.6 | 8.3 | 13.8 | 30,000 | 21,600 | 40,900 | 230 | 170 | 300 |
| Central African Republic         | 6.4 | 4.7 | 8.8 | 4000 | 2800 | 5600 | 160 | 110 | 220 |
| Chad                             | 7.4 | 5.8 | 9.3 | 9800 | 7400 | 13,000 | 160 | 120 | 210 |
| Comoros                          | 8.6 | 6.4 | 10.8 | 1000 | 700 | 1300 | 190 | 140 | 250 |
| Congo                            | 11.4 | 8.8 | 14.5 | 7500 | 5300 | 10,200 | 260 | 190 | 340 |
| Democratic Republic of the Congo | 6.2 | 4.1 | 9.5 | 56,300 | 38,100 | 83,800 | 140 | 100 | 210 |
| Djibouti                         | 11.2 | 8.7 | 14.7 | 1700 | 1200 | 2500 | 250 | 180 | 350 |
| Egypt                            | 7.4 | 5.4 | 10.1 | 133,000 | 95,300 | 183,300 | 180 | 130 | 250 |
| Equatorial Guinea                | 14.2 | 9.1 | 20 | 1700 | 1000 | 2500 | 310 | 190 | 450 |
| Eritrea                          | 10 | 7.9 | 12.7 | 7600 | 5700 | 10,100 | 240 | 180 | 310 |
| Eswatini                         | 13.5 | 9.3 | 18.2 | 1900 | 1300 | 2700 | 300 | 200 | 430 |
| Ethiopia                         | 7.3 | 5.5 | 10.4 | 79,000 | 58,500 | 109,700 | 170 | 120 | 240 |
| Gabon                            | 14.9 | 11.3 | 18.2 | 3700 | 2600 | 4800 | 330 | 240 | 420 |
| Gambia                           | 6.6 | 4.8 | 8.8 | 1500 | 1000 | 2000 | 140 | 100 | 190 |
| Ghana                            | 8.8 | 7 | 10.9 | 34,900 | 26,500 | 45,100 | 190 | 150 | 250 |
| Guinea                           | 7.2 | 5.5 | 9.2 | 9400 | 7000 | 12,400 | 160 | 120 | 210 |
| Guinea-Bissau                    | 9.1 | 6.9 | 11.3 | 1700 | 1200 | 2200 | 210 | 150 | 260 |
| Kenya                            | 8.1 | 6.5 | 10 | 45,300 | 35,300 | 57,200 | 180 | 140 | 230 |
| Lesotho                          | 11.7 | 8.7 | 15.1 | 3600 | 2500 | 4800 | 270 | 190 | 350 |
| Liberia                          | 6.7 | 4.6 | 9.5 | 3200 | 2100 | 4500 | 140 | 100 | 200 |
| Libya                            | 12.5 | 9.1 | 15.8 | 17,100 | 12,300 | 22,500 | 300 | 220 | 390 |
| Madagascar                       | 7.1 | 5.3 | 9.3 | 21,600 | 15,500 | 29,000 | 170 | 120 | 220 |
| Malawi                           | 6.1 | 4.7 | 7.5 | 10,700 | 7900 | 13,900 | 130 | 100 | 170 |
| Mali                             | 7.8 | 6.3 | 9.7 | 16,300 | 12,500 | 21,000 | 170 | 140 | 220 |
| Mauritania                       | 8.3 | 6.5 | 10.3 | 3600 | 2600 | 4700 | 170 | 120 | 210 |
| Mauritius                        | 12.8 | 10.5 | 15.5 | 5100 | 4100 | 6200 | 290 | 240 | 360 |
| Morocco                          | 8.5 | 6.3 | 10.5 | 63,600 | 47,400 | 81,100 | 190 | 150 | 250 |
| Mozambique                       | 8.7 | 6.5 | 11.2 | 22,400 | 15,800 | 29,800 | 190 | 140 | 250 |
| Namibia                          | 8.7 | 7 | 10.8 | 2800 | 2100 | 3700 | 190 | 150 | 240 |
(500–700) and 400 (200–500) respectively in 2019. In 2019, Seychelles 550 (490–630), Botswana 350 (240–460), Gabon 330 (240–420), Sao Tome and Principe 320 (230–430), and Equatorial Guinea 310 (190–450) per 100,000 had highest DALYs counts, whereas Malawi 130 (100–170), Niger 120 (90–160), and Somalia 120 (80–230) per 100,000 had lowest DALYs counts in Africa (Table 2). From 2010 to 2019, Djibouti 66% (28–116%), Rwanda 63% (32–100%), Cabo Verde 62% (30–94%), Burkina Faso 61% (34–98%), and Democratic Republic of the Congo 60% (25–102) had highest percentage change DALYs counts, while Central African Republic 15% (−9 to 45%), South Africa 13% (0–30%), and Eswatini 11% (−15 to 51%) lowest percentage of DALYs counts in Africa. From 2010 to 2019, Decreased age-standardised DALYs rate was observed in Algeria—1% (−23 to 26%), Equatorial Guinea—1% (−30 to 45%), Gabon—4% (−27 to 27%), Central African Republic—8% (−32 to 23%), Eswatini—9% (−36 to 34%), Libya—10% (−38 to 18%), and South Africa—10% (−24 to 7%) (Table 3).

Discussion

From 2010 to 2019, age-standardised rates and counts of incidence cases, deaths, and DALYs of colorectal cancer in Africa increased with heterogeneous trend across the nations. The absolute numbers of incidence cases of CRC have increased in Asia, America, and Europe as well as worldwide. In addition to this, age standardised incidence rate of CRC also raised from 2010 to 2019 globally and in all regions except in Europe. Changes of incidence cases ranged from 16% in Central African Republic to 77% in Djibouti. More than 90% of countries had increased age-standardised incidence rate, however, decreased age-standardised incidence rate observed in Somalia, Eswatini, South Africa, Central African Republic, and Libya. This trend of CRC has attributed to population growth, aging, changing risk factors, adopting screening, increasing diagnosis, and registration of colorectal cancer mainly in Africa and Asia. Increased absolute incident cases and age-standardised incidence rate of CRC indicates that change in environmental, demographic, epidemiological, and sociodemographic have played a significant role in rising of burden of colorectal cancer in Africa. More than 55% [6] of colorectal cancer can be prevented with evidence based modification of strong modifiable risk factors such as smoking [13], weight gain [14], alcohol consumption [15], and lack of physical inactivity [16] and unhealthy diet. Change of living standards in transition countries in North Africa has exposed new risk factors such as sedentary life and metabolic syndrome. The colorectal cancer has a male predestination with peaking 60–69 years; however, the disparity is not much as western. This might be due to males have higher prevalence rates of modifiable risk factors such as smoking [17], alcohol consumption [18] and protective effect of estrogen for CRC in females [19].

From 2010 to 2019, we found that death counts and age-standardised death rates of CRC have increased in

### Table 2 (continued)

| Location                      | Age-standardised death rate | DALYs counts | Age-standardised DALYs rate |
|-------------------------------|-----------------------------|--------------|----------------------------|
|                               | 2019 | 95% UI | 2019 | 95% UI | 2019 | 95% UI |
| Niger                         | 5.6  | 4.2   | 7.5  |        | 10,100 | 7200 | 14,000 | 120 | 90 | 160 |
| Nigeria                       | 8.6  | 6.7   | 10.8 |        | 157,300 | 116,500 | 205,200 | 170 | 130 | 220 |
| Rwanda                        | 8.8  | 7.1   | 10.8 |        | 13,300 | 10,000 | 17,500 | 200 | 150 | 250 |
| Sao Tome and Principe         | 15.2 | 11.2  | 20.6 |        | 400    | 200   | 500    | 320 | 230 | 430 |
| Senegal                       | 8.7  | 7.1   | 10.8 |        | 14,400 | 11,000 | 18,600 | 180 | 140 | 230 |
| Seychelles                    | 25.3 | 22.2  | 28.7 |        | 600    | 500   | 700    | 550 | 490 | 630 |
| Sierra Leone                  | 7    | 5.4   | 8.9  |        | 5800   | 4300  | 7600   | 150 | 110 | 190 |
| Somalia                       | 5    | 3.2   | 9.3  |        | 9600   | 6100  | 17,900 | 120 | 80 | 230 |
| South Africa                  | 11.2 | 10.1  | 12.6 |        | 111,500 | 100,300 | 126,600 | 240 | 220 | 270 |
| South Sudan                   | 10   | 6.6   | 14.8 |        | 9500   | 5900  | 14,700 | 220 | 140 | 340 |
| Sudan                         | 7.1  | 5.3   | 10.6 |        | 34,700 | 24,000 | 50,900 | 160 | 120 | 240 |
| Togo                          | 7.9  | 5.9   | 10   |        | 6700   | 4800  | 9000   | 170 | 120 | 220 |
| Tunisia                       | 9.7  | 7.2   | 13   |        | 26,500 | 19,100 | 36,100 | 210 | 150 | 280 |
| Uganda                        | 11.6 | 9.2   | 13.8 |        | 43,100 | 32,500 | 54,500 | 270 | 210 | 330 |
| United Republic of Tanzania   | 9.5  | 7.7   | 11.8 |        | 59,000 | 45,100 | 78,200 | 220 | 170 | 280 |
| Zambia                        | 12.6 | 9.5   | 16   |        | 23,300 | 16,600 | 30,700 | 300 | 220 | 380 |
| Zimbabwe                      | 12.9 | 9.9   | 16.2 |        | 22,800 | 17,100 | 29,300 | 300 | 220 | 370 |
Table 3  Percentage changes of national incidence cases, deaths and DALYs in Africa from 2010 to 2019

| Location                                | Incidence cases | ASIR | Death counts |
|-----------------------------------------|-----------------|------|--------------|
|                                         | Value (%)       | 95% UI (%) | Value (%)   | 95% UI (%) | Value (%)   | 95% UI (%) |
| Africa                                  | 48              | 34    | 62           | 11           | 1           | 21          |
| Algeria                                 | 57              | 24    | 98           | 10           | -12         | 38          |
| Angola                                  | 68              | 36    | 114          | 14           | -4          | 43          |
| Benin                                   | 42              | 19    | 70           | 3            | -12         | 21          |
| Botswana                                | 51              | 19    | 92           | 9            | -11         | 36          |
| Burkina Faso                            | 59              | 35    | 92           | 18           | 2           | 39          |
| Burundi                                 | 40              | 15    | 73           | 0            | -17         | 21          |
| C’te d’Ivoire                           | 39              | 11    | 73           | 4            | -14         | 25          |
| Cabo Verde                              | 77              | 39    | 112          | 48           | 15          | 78          |
| Cameroon                                | 47              | 18    | 83           | 6            | -14         | 29          |
| Central African Republic                | 16              | -8    | 45           | -8           | -25         | 13          |
| Chad                                    | 40              | 15    | 68           | 6            | -11         | 27          |
| Comoros                                 | 44              | 17    | 75           | 10           | -10         | 32          |
| Congo                                   | 53              | 23    | 90           | 9            | -11         | 33          |
| Democratic Republic of the Congo       | 63              | 29    | 104          | 20           | -4          | 49          |
| Djibouti                                | 77              | 40    | 125          | 13           | -8          | 39          |
| Egypt                                   | 59              | 18    | 110          | 20           | -9          | 56          |
| Equatorial Guinea                       | 60              | 20    | 120          | 13           | -13         | 52          |
| Eritrea                                 | 47              | 21    | 79           | 9            | -8          | 32          |
| Eswatini                                | 20              | -7    | 61           | -2           | -22         | 28          |
| Ethiopia                                | 62              | 33    | 92           | 21           | -1          | 42          |
| Gabon                                   | 37              | 9     | 72           | 7            | -13         | 32          |
| Gambia                                  | 47              | 15    | 81           | 13           | -10         | 39          |
| Ghana                                   | 53              | 26    | 86           | 14           | -5          | 35          |
| Guinea                                  | 19              | -2    | 46           | 7            | -11         | 29          |
| Guinea-Bissau                           | 29              | 6     | 57           | 2            | -15         | 22          |
| Kenya                                   | 53              | 29    | 79           | 9            | -7          | 27          |
| Lesotho                                 | 25              | -2    | 57           | 12           | -11         | 40          |
| Liberia                                 | 34              | 8     | 68           | 3            | -16         | 27          |
| Libya                                   | 35              | -3    | 76           | -8           | -33         | 19          |
| Madagascar                              | 47              | 17    | 84           | 5            | -15         | 30          |
| Malawi                                  | 38              | 11    | 67           | 3            | -15         | 22          |
| Mali                                    | 42              | 18    | 70           | 7            | -10         | 28          |
| Mauritania                              | 41              | 10    | 71           | 8            | -14         | 29          |
| Mauritius                               | 54              | 23    | 90           | 16           | -6          | 43          |
| Morocco                                 | 61              | 31    | 99           | 25           | 1           | 54          |
| Mozambique                              | 44              | 12    | 82           | 15           | -8          | 44          |
| Namibia                                 | 47              | 18    | 81           | 18           | -4          | 44          |
| Niger                                   | 57              | 30    | 91           | 9            | -8          | 28          |
| Nigeria                                 | 41              | 6     | 84           | 8            | -17         | 38          |
| Rwanda                                  | 72              | 42    | 109          | 17           | -2          | 39          |
| Sao Tome and Principe                   | 50              | 23    | 74           | 22           | 2           | 42          |
| Senegal                                 | 46              | 19    | 78           | 13           | -7          | 36          |
| Seychelles                              | 49              | 29    | 69           | 15           | 0           | 31          |
| Sierra Leone                            | 48              | 20    | 82           | 10           | -9          | 34          |
| Somalia                                 | 35              | 8     | 66           | -1           | -19         | 19          |
| South Africa                            | 22              | 8     | 39           | -5           | -15         | 8           |
| South Sudan                             | 24              | 1     | 55           | 1            | -16         | 25          |
Table 3  (continued)

| Location                          | Incidence cases | ASIR | Death counts |
|-----------------------------------|-----------------|------|--------------|
|                                   | Value (%)       | 95% UI (%) | Value (%)       | 95% UI (%) | Value (%)       | 95% UI (%) |
| Sudan                             | 57              | 28 93 | 22 0 48 | 45 20 80 |
| Togo                              | 53              | 25 88 | 7 −12 27 | 49 22 81 |
| Tunisia                           | 53              | 18 101 | 13 −12 48 | 38 8 79 |
| Uganda                            | 54              | 25 88 | 12 −7 34 | 51 23 81 |
| United Republic of Tanzania       | 50              | 22 79 | 12 −7 33 | 46 21 74 |
| Zambia                            | 63              | 29 101 | 11 −11 36 | 53 22 90 |
| Zimbabwe                          | 29              | 4 61 | 4 −15 29 | 27 3 58 |

| Location                          | ASDR | DALYS counts | Age-standardised DALYS rate change |
|-----------------------------------|------|--------------|-----------------------------------|
|                                   | Value (%)       | 95% UI (%) | Value (%)       | 95% UI (%) | Value (%)       | 95% UI (%) |
| Africa                            | 6 −3 16 | 41 27 56 | 6 −5 16 |
| Algeria                           | 1 −19 24 | 39 9 76 | −1 −23 26 |
| Angola                            | 11 −8 36 | 59 25 101 | 7 −17 41 |
| Benin                             | 2 −12 19 | 41 16 71 | 5 −14 27 |
| Botswana                          | 3 −16 27 | 40 8 80 | 5 −23 45 |
| Burkina Faso                      | 16 0 35 | 61 34 98 | 21 0 50 |
| Burundi                           | −1 −17 18 | 40 14 74 | 0 −20 26 |
| Côte d’Ivoire                     | 3 −14 22 | 36 6 71 | 7 −14 34 |
| Cabo Verde                        | 41 8 70 | 62 30 94 | 19 −4 47 |
| Cameroon                          | 2 −16 24 | 41 12 81 | 3 −20 33 |
| Central African Republic          | −8 −25 13 | 15 −9 45 | −8 −32 23 |
| Chad                              | 5 −11 25 | 38 14 68 | 8 −12 34 |
| Comoros                           | 7 −11 28 | 45 12 78 | 10 −16 36 |
| Congo                             | 7 −13 30 | 47 15 87 | 0 −24 31 |
| Democratic Republic of the Congo  | 17 −5 45 | 60 25 102 | 16 −9 49 |
| Djibouti                          | 9 −11 32 | 66 28 116 | 8 −17 38 |
| Egypt                             | 10 −15 41 | 46 9 92 | 6 −20 37 |
| Equatorial Guinea                 | 9 −15 46 | 53 11 114 | −1 −30 45 |
| Eritrea                           | 7 −10 29 | 41 14 72 | 9 −15 38 |
| Eswatini                          | −6 −25 22 | 11 −15 51 | −9 −36 34 |
| Ethiopia                          | 16 −4 36 | 54 27 81 | 13 −8 38 |
| Gabon                             | 3 −15 25 | 31 2 68 | −4 −27 27 |
| Gambia                            | 11 −11 34 | 44 11 80 | 13 −14 45 |
| Ghana                             | 10 −8 29 | 46 18 81 | 7 −14 31 |
| Guinea                            | 5 −12 25 | 22 −1 49 | 6 −15 32 |
| Guinea-Bissau                     | 1 −15 21 | 26 3 57 | 2 −18 28 |
| Kenya                             | 5 −9 21 | 44 23 71 | 7 −13 35 |
| Lesotho                           | 9 −13 35 | 23 −5 56 | 9 −23 47 |
| Liberia                           | 3 −15 24 | 36 7 72 | 4 −17 30 |
| Libya                             | −8 −32 18 | 35 −5 77 | −10 −38 18 |
| Madagascar                        | 4 −15 27 | 45 15 82 | 6 −17 35 |
| Malawi                            | 2 −15 20 | 36 7 68 | 4 −20 30 |
| Mali                               | 5 −11 24 | 41 15 73 | 4 −16 27 |
| Mauritania                        | 4 −15 24 | 31 0 64 | 0 −22 23 |
| Mauritius                         | 10 −10 34 | 38 11 71 | 11 −10 37 |
| Morocco                           | 17 −4 44 | 45 17 78 | 5 −16 31 |
| Mozambique                        | 13 −9 41 | 42 9 82 | 15 −15 57 |
Increased death counts were also observed in America, Asia, Europe and globally. However, trend of age-standardised death rate of CRC has decreased in America, Europe and global as whole with slight stable change in Asia. From 2010 to 2019, heterogeneity trend and burden of CRC mortality has noticed across nations of Africa. Mortality CRC related has increased significantly, ranging from 16 to 71% with more than 90% of countries had increased age-standardised death rate, however, decreased age-standardised incidence rate was observed only in Burundi, Somalia, Eswatini, South Africa, Central African Republic, and Libya. Increased absolute colorectal cancer related mortality and age-standardised death rate have associated to increased population size and change age structure, decreasing mortality from other disease, increased risk factors, low rate of screening, diagnosis, and, treatment in Africa. There are a strong evidence described that mortality and incidence of colorectal cancer can be reduced through screening. Apply primary, secondary and tertiary prevention modality such as reduction of modifiable risk factors and adopting evidence based screening modality are key steps to achieve sustainable development goals [10] and 25 by 25 targets [9] of colorectal cancer.

DALYs measurement is an important indicator of quality of CRC cares. Results from this study revealed that absolute DALYs counts and age-standardised rates of CRC have increased between 2010 and 2019 in Africa. Increased DALYs counts of colorectal cancer is a global phenomenon, however, change in Africa as compared with Asia, America, Europe, and global as a whole was invariably significant. Despite regions and global have increased DALYs counts of CRC between 2010 and 2019, trend of age-standardised DALYs rate of CRC was decreasing in America, Europe and global as whole with slight stable in Asia. Most of DALYs was contributed from YLL in Africa, which indicates low survival rate. Increased age-standardised rate of death and DALYs of colorectal cancer indicates low efforts and progresses for CRC standard and qualitative care-early diagnosis and treatment, primary prevention of modifiable risk factors and implementation of secondary prevention modality in Africa and across most nations. This serious effect would be due to poor cancer infrastructure and policy, low workforce capacity, cancer center to diagnosis and treatment, low financial security and low of universal health coverage in Africa. Geographical variation of screening of CRC has attributed to geographic variation in CRC incidence, ability to identify the target population at risk, economic resource, human resource capacity, health care structure, infrastructure, and health care policy and direction [20]. Evidence from mathematical modeling study recommended that colonoscopy screen in Africa begins at age of 50 years [21].

| Location                | ASDR  Value (%) | 95% UI (%) | DALYS counts | Value (%) | 95% UI (%) | Age-standardised DALYS rate change | Value (%) | 95% UI (%) |
|-------------------------|-----------------|------------|--------------|-----------|------------|-----------------------------------|-----------|------------|
| Namibia                 | 11              | −8         | 35           | 37        | 8          | 72                                | 10        | −18        | 45         |
| Niger                   | 8               | −9         | 25           | 55        | 26         | 90                                | 10        | −9         | 34         |
| Nigeria                 | 7               | −16        | 37           | 39        | 4          | 91                                | 9         | −25        | 62         |
| Rwanda                  | 14              | −4         | 34           | 63        | 32         | 100                               | 13        | −8         | 39         |
| Sao Tome and Principe   | 17              | −1         | 35           | 48        | 20         | 75                                | 9         | −11        | 30         |
| Senegal                 | 10              | −8         | 32           | 43        | 13         | 78                                | 13        | −12        | 42         |
| Seychelles              | 8               | −5         | 22           | 40        | 22         | 60                                | 6         | −13        | 28         |
| Sierra Leone            | −2              | −10        | 29           | 45        | 17         | 83                                | 10        | −12        | 38         |
| Somalia                 | −9              | −17        | 3            | 13        | 0          | 30                                | −10       | −24        | 7          |
| South Africa            | 0               | −17        | 23           | 22        | −3         | 58                                | 2         | −17        | 34         |
| South Sudan             | 15              | −5         | 39           | 47        | 17         | 86                                | 10        | −14        | 40         |
| Sudan                   | 4               | −13        | 24           | 46        | 17         | 82                                | 8         | −14        | 33         |
| Tunisia                 | 2               | −20        | 32           | 35        | 4          | 79                                | 0         | −25        | 33         |
| Uganda                  | 10              | −9         | 30           | 51        | 19         | 87                                | 14        | −11        | 46         |
| United Republic of Tanzania | 10           | −7         | 29           | 47        | 17         | 81                                | 14        | −8         | 40         |
| Zambia                  | 6               | −15        | 29           | 55        | 19         | 97                                | 7         | −18        | 38         |
| Zimbabwe                | 3               | −16        | 28           | 29        | 3          | 64                                | 3         | −23        | 40         |
coloscopy every 10 years, or annual fecal occult blood test and sigmoidoscopy every 5 years) [21]. However, recommendation of population based CRC screen in Africa is questionable due high burden of communicable disease, low human capacity, availability of colonoscopy, and relatively low burden of CRC as compared as other health condition [22]. Several factors might have contributed to low rate of quality of CRC care in Africa such as inaccessibility of screening [20], early detection, low quality and skill in oncological surgery, inaccessibility of radiotherapy, chemotherapy, target therapy and palliative therapy [23].

Limitation

GBD studies provide qualitative, compressive, and updated evidence of global, regional and national burden of diseases for policy maker, researcher and planner. This study has played a great and invaluable role, particularly for Africa. The main limitation of this study is unavailability and quality of data sources. Therefore, African nation should have improved cancer registration, collaborated and provided data to IHME, and follow the prediction and give feedback.

Conclusion

Increased age-standardised rate of incidence, death and DALYs have been observed in Africa and across a nations. Evidence from this analysis showed that there is fast rising burden of colorectal cancer due to increased prevalence of modifiable risk factors such as smoking, alcohol, unhealthy diet, sedentary lifestyle, and metabolic syndrome. Observation indicates that there are low efforts and progresses in CRC standard and qualitative care-evidence based early diagnosis and treatment, primary prevention of modifiable risk factors and implementation of secondary prevention modality. This alarm all nations and global community to call integrated, comparative and resilience measures for prevention, awareness creation, adopting screening, and evidence based treatments and rehabilitations.

Abbreviations

AAPC: Annual average percentage change; ASDR: Age-standardized death rate; ASIR: Age-standardized incidence rate; CRC: Colorectal cancer; GBD: Global Burden of Disease; IHME: Institute of Health Metrics and Evaluation; WHO: World Health Organization.

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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.

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Availability of data and materials

Data are available in GBD 2019 tools (http://ghdx.healthdata.org/gbd-results-tool).

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

Authors declare that they have no competing interests.

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