Colorectal cancer survival rates in Ghana: A retrospective hospital-based study

Francis Agyemang-Yeboah
Joseph Yorke
Christian Obirikorang
Emmanuella Nsenbah Batu
Emmanuel Acheampong

Edith Cowan University

See next page for additional authors

Follow this and additional works at: https://ro.ecu.edu.au/ecuworkspost2013

Part of the Diseases Commons, and the Health Services Research Commons

10.1371/journal.pone.0209307
Agyemang-Yeboah, F., Yorke, J., Obirikorang, C., Batu, E. N., Acheampong, E., Frimpong, E. A., ... & Amankwa, B. (2018). Colorectal cancer survival rates in Ghana: A retrospective hospital-based study. PloS one, 13(12), e0209307.
Available here.
This Journal Article is posted at Research Online.
https://ro.ecu.edu.au/ecuworkspost2013/5481
RESEARCH ARTICLE

Colorectal cancer survival rates in Ghana: A retrospective hospital-based study

Francis Agyemang-Yeboah¹, Joseph Yorke², Christian Obirikorang¹, Emmanuella Nsenbah Batu¹, Emmanuel Acheampong¹, Emmanuel Amankwa ¹

¹ Department of Molecular Medicine, School of Medical Science, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi, Ghana, ² Department of Surgery, Komfo Anokye Teaching Hospital, Kumasi, Ghana, ³ School of Medical and Health Sciences, Edith Cowan University, Joondalup, Western Australia, Australia, ⁴ Oncology Unit, Komfo Anokye Teaching Hospital, Kumasi, Ghana

* emmanuela1990@yahoo.com

Abstract

Background

Colorectal cancer (CRC) is one of the commonest cancers associated with diverse prognosis times in different parts of the world. Despite medical interventions, the overall clinical outcomes and survival remains very poor for most patients in developing countries. This study therefore investigated the survival rate of colorectal cancer and its prognostic factors among patients at Komfo Anokye Teaching Hospital, Ghana.

Methodology

In this retrospective cohort study, a total of 221 patients diagnosed with CRC from 2009 to 2015 at the Surgical and Oncological units of Komfo Anokye Teaching Hospital (KATH), Kumasi, Ghana were employed. The survival graphs were obtained using the Kaplan–Meier method and compared by the Log-rank test. Cox regression analysis was used to assess prognostic factors. All analyses were performed by SPSS version 22.

Results

The median survival time was 15 months 95% CI (11.79–18.21). The overall survival rate for CRC over the 5 years period was 16.0%. The survival rates at the 1st, 2nd, 3rd, 4th and 5th years were 64% 95% CI (56.2–71.1), 40% 95% CI (32.2–50.1), 21% 95% CI (11.4–30.6) 16% 95% CI (8.9–26.9) and 16% 95% CI (7.3–24.9). There was a significant difference in the survival rate of colorectal cancer according to the different stages (p = 0.0001). Family history [HR = (3.44), p = 0.029], Chemotherapy [HR = (0.23), p = <0.0001], BMI [HR = (1.78), p = 0.017] and both chemo/radiotherapy (HR = (3.63), p = 0.042] were the significant social and clinical factors influencing the overall survival. Pathological factors such as TNM tumour stage (p = 0.012), depth of tumour invasion (p = 0.036), lymph node metastasis (p = 0.0001), and distance metastasis (p = 0.001) were significantly associated with overall survival.
Conclusion
The study has clearly demonstrated that survival rate for CRC patients at KATH, Ghana is very low in a 5 years period. This is influenced by significant number of clinical and pathological prognostic factors. Identification of prognostic factors would be a primary basis for early prediction and treatment of patients with colorectal cancer.

Introduction
Globally, colorectal cancer is one of the commonest cancers and in the western countries; it is the second leading cause of cancer mortality. [1]. The difference in survival rates observed in various clinical trials maybe due to the variations in patient’s characteristics and prognostic factors [2]. Survival of colorectal cancer has improved dramatically over the last decade as a result of the invention of new drugs and targeted therapies. [3]. However, enormous disparities in colorectal cancer survival exist within regions and across the global [4, 5]. These differences are not easily understood, although most of the disparities in CRC survival can be attributed to variation in the accessibility to treatment and diagnostics [5]. In addition, molecular analyses performed so far indicates that the pathogenesis of all CRCs varies at different stage tumours. Even for individual patients with same stage tumours, response to treatment and long term prognosis varies[6].

Over the past years, several research groups have suggested numerous factors associated with the survival of CRC patients.[7, 8]. However, the extent of tumour infiltration to the bowel wall, adjacent lymph node metastases and distant metastasis are the major contributing factors [9]. Although, various studies [10, 11] have reported a strong correlation between colorectal cancer stage and its prognosis, it has also been argued in other studies [10, 12] that the prognosis for a patient with colorectal cancer is much influenced by factors relating to patients characteristics and the tumour but not just the anatomical extension of the tumour.

Additionally, other studies have also showed that the initial treatment administered, body mass index (BMI), marital status, tumour grade, tumour size and pathologic stage of tumour are significantly associated with the survival of CRC patients [5, 13]. Recent studies have shown that the survival of CRC in sub-Saharan African is very low due to late presentations and lack of modern specialized systems for treatment [14]. In Ghana, the number of new cases of colorectal cancer has increased by 8-fold per year from an average of 4.1 new cases in 1960s to an average of 32.6 new cases currently [15, 16]. In 2010, Dakubo et al reported a crude incidence rate of 11.18 per 100,000 populations in both sexes. Moreover, Laryea et al., (2014) reported a crude incidence and age standardized incidence of 0.1 and 0.3 per 100,000 population [17]. Some studies have identified other factors such as helicobacter pylori infection, the dietary component of red meat, beef, lamb, pork and veal and its processed varieties as the predominant risk factors in Ghana [16, 18, 19]. There is paucity of data on the survival rate of CRC as well as its associated factors in Ghana. Knowledge of prognostic factors in our population will be the foundation for planning treatment and predicting the outcome of patients with colorectal cancer. It is thus, against this background that this study investigated the survival rate of colorectal cancer and its prognostic factors among patients at Komfo Anokye Teaching Hospital, Ghana.

Methodology
Study design/setting
This was a retrospective cohort study, conducted among CRC patients at the Surgical and Oncological (S&O) Department of the Komfo Anokye Teaching Hospital, Komfo Anokye
Teaching Hospital (KATH) is the second largest and a referral teaching hospital located in Kumasi, the regional capital of the Ashanti region in Ghana. The region has an average total population of 4,780,380 (Ghana Statistical Service, 2010).

**Study population and participants’ selection**

A total of 221 cases of CRC, recorded from 2009 to 2015 were retrospectively retrieved from the medical records of the S & O Department database with a 100% rate of accuracy. Information on socio-demographics characteristics, clinical and pathological variables including histological type, grade of tumour and TNM staging were recorded. Data on type of treatments was also reviewed. Moreover, BMI based on the patient’s current recorded weight and height since been diagnosed was also calculated. Smoking history comprised of patients who indicated that, they had ever smoked or was currently smoking, and alcohol intake also refers to patients who were currently alcoholics and those who used to be alcoholic.

**Inclusion criteria**

Records showing complete clinical examination, indicating the presence of malignant tumour in the large bowel were included.

**Exclusion criteria**

Patients with other large bowel conditions and histopathological confirmed non-malignant tumours were excluded.

**Follow-up**

Patients were contacted during their follow-up visits to the hospital and those who could not report for review in the hospital were contacted via telephone. Deaths of subjects were confirmed via contact with their families and relatives. Survival periods were calculated from the date of diagnosis to the date of either last follow-up or death. Patients alive at the end of the follow-up and those lost to follow-up were censored either at the last contact or at death. Fig 1 shows the procedure for the selection of cases for the study.

**Statistical analysis**

Data entry and analysis were performed using SPSS version 20. Survival analysis was done using Kaplan–Meier method and the differences in patient survival periods were determined by employing the log-rank test in relation to socio-demographic and lifestyle characteristics, and clinical and pathological parameters [Tables 1 and 2]. To determine the prognostic factors for survival, all variables were tested for their relationship in the Cox-regression model. Proportional hazard (PH) assumptions were initially tested for each model [Tables 3–5] based on the scaled Schoenfeld residuals. The PH test was not significant for each of the covariates in each model and the global Schoenfeld test (GST) was not statistically significant for each model [Table 3; GST: p = 0.481, Table 4; GST: p = 0.186, Table 5; GST: p = 0.216], we therefore assumed the proportional hazards. Multicollinearity test was done for covariates in each model, and the variation inflation factor (VIF) value obtained for covariates in each model was within a range of 1–5 suggesting that there is no multicollinearity. Multivariable Cox regression analysis was carried using the force entry procedure. The Chi-square value obtained for the regression model for Table 4 ($\chi^2 = 42.7, p<0.0001$) and Table 5 ($\chi^2 = 28.8, p = 0.017$) were statistically significant, however Chi-square value for regression model for Table 3 did not show significance ($\chi^2 = 15.8, p = 0.328$). There were no statistically significant differences
between patients who were follow-up and those who were not followed in relation to socio-demographic and lifestyle characteristics, clinical and pathological parameters [S1 Table]. A p < 0.05 was accepted as statistically significant.

Ethical consideration

Ethical Approval for the study was obtained from the Committee on Human Research, Publication and Ethics (CHRPE/AP/286/15) of the School of Medical Sciences (SMS), Kwame Nkrumah University of Science and Technology (KNUST) as well as the Research and Development (R&D) Unit of the KATH.

Results

As shown in Fig 2, the median survival time was 15 months 95% CI (11.79–18.21). The survival rates at the 1st, 2nd, 3rd, 4th and 5th years were 64% 95% CI (56.2–71.1), 40% 95% CI (32.2–50.1), 21% 95% CI (11.4–30.6) 16% 95% CI (8.9–26.9) and 16% 95% CI (7.3–24.9).

The survival rate was high among patient in stage I: 90% [95% CI (75.5–104.5)], compared to stage II: 34% [95% CI (5.6–62.4)], stage III: 12% [95% CI (11.9–13.1)] and stage IV (0.0%).
The differences in survival rates among the different cancer stages were statistically significant (p = 0.0001) [Fig 3].

**Table 1** shows the association between socio-demographic and lifestyle characteristics and CRC survival. There was no statistically significant association between survival and age (p = 0.241), gender (p = 0.996), marital status (p = 0.464), presence of comorbidities (p = 0.250), hypertension (p = 0.232), diabetes (p = 0.588), alcohol intake (p = 0.717) and smoking (p = 0.696). Meanwhile, family history was significantly associated with survival (p = 0.036).

As shown in **Table 2**, chemotherapy as a treatment modality was significantly associated with survival (p = 0.0001). The median survival time of patients who underwent chemotherapy was higher (30 months) compared to those who did not undergo chemotherapy (11 months). Body mass index (BMI) was also significantly associated with survival (p = 0.036) with
underweight patients having the least median survival time (11 months). For the pathological parameters, there was significant difference in the stage of tumour, lymph node metastasis and distance metastasis with survival \( (p < 0.05) \). Stage III and IV tumours had low median survival time (Stage III = 14 months, IV = 11 months) compared to early stage tumours (36 months). Other parameters such as histological grade \( (p = 0.332) \), depth of tumour invasion \( (p = 0.070) \) and tumour location \( (p = 0.405) \) were not significantly associated with survival.

Table 3 shows the association of socio-demographic and lifestyle characteristics with survival. Using cox regression analysis, family history was the only variable that was significantly associated with survival on both univariate \[ HR = 0.37, 95\% CI (0.14–0.99); p = 0.049 \] and multivariate analysis \[ HR = 3.44, 95\% CI (0.09–0.88) \]. Age, gender, marital status, alcoholic intake and smoking history were statistically not associated with survival \( (p > 0.05) \). The odds of survival decreased as age advanced as shown in the hazard ratios but was not statistically significant \( (p > 0.05) \). Male gender, being widowed, presence of comorbidities and having hypertension had increased hazard ratios but not statistically significant on both univariate and multivariate analysis.

**Table 2. Association of clinical and pathological parameters with survival using log rank test.**

| Variable                          | Frequency (n, %) | Median OS (95%CI) (Months) | P-value | Variables                          | Frequency (n, %) | Median OS (95%CI) (Months) | P-value |
|-----------------------------------|-----------------|----------------------------|---------|------------------------------------|-----------------|----------------------------|---------|
| **Duration of Symptoms (months)** |                 |                            | 0.567   | Tumour Location                    |                 |                            | 0.405   |
| < 6                               | 95(43.0%)       | 19(13.4–24.6)              |         | Colon                              | 75(33.9%)       | 14(7.3–20.7)               |         |
| 6 to 12                           | 85(38.5%)       | 14(11.6–16.4)              |         | Rectum                             | 108(48.9%)      | 17(11.2–22.8)              |         |
| > 12                              | 41(18.6%)       | 14(10.2–17.7)              |         | Anorectum                          | 18(8.1%)        | 18(8.0–37.9)               |         |
| **Surgery**                       |                 |                            | 0.640   | Anal                               | 13(5.9%)        | 12(10.6–13.4)              |         |
| No                                | 76(34.4%)       | 15(9.9–20.1)               |         | More than one site                 | 7(3.2%)         | 19(6.6–31.4)               |         |
| Yes                               | 145(65.6%)      | 14(8.8–19.2)               |         | Histological Grade                 |                 |                            | 0.332   |
| **Nature of Operation**           |                 |                            | 0.741   | Well differentiated                | 51(23.1%)       | 14(0.9–29.8)               |         |
| Emergency                         | 49(33.8%)       | 14(8.8–19.2)               |         | Moderately differentiated           | 104(47.1%)      | 15(11.0–18.9)              |         |
| Elective                          | 96(66.2%)       | 19(12.6–25.4)              |         | Poorly differentiated               | 25(11.3%)       | 30(4.0–73.9)               |         |
| Chemotherapy                      |                 |                            | 0.0001  | Undifferentiated                   | 41(18.6%)       | 18(15.6–20.4)              |         |
| No                                | 118(53.4%)      | 11(8.0–14.0)               |         | TNM Tumour Stage                   |                 |                            | 0.0001  |
| Yes                               | 103(46.6%)      | 30(18.0–42.0)              |         |                                    |                 |                            |         |
| **Radiotherapy**                  |                 |                            | 0.402   | Stage I                            | 13(6.0%)        | 48(41–56.5)                |         |
| No                                | 166(75.1%)      | 14(9.8–18.2)               |         | Stage II                           | 64(29.0%)       | 36(15.2–56.7)              |         |
| Yes                               | 55(24.9%)       | 17(13.1–20.8)              |         | Stage III                          | 89(40.3%)       | 14(11.1–16.9)              |         |
| **Chemo-radiotherapy**            |                 |                            | 0.587   | Stage IV                           | 55(24.9%)       | 11(6.0–16.0)               |         |
| No                                | 173(80.1%)      | 15(11.0–19.0)              |         | Lymph Node Metastasis              |                 |                            | 0.0001  |
| Yes                               | 43(19.9%)       | 15(11.8–18.2)              |         |                                    |                 |                            |         |
| **BMI Categories**                |                 |                            | 0.036   | N0                                 | 78(35.3%)       | 36(21.4–50.6)              |         |
| Underweight                       | 77(34.8%)       | 11(5.3–16.7)               |         | N1                                 | 88(39.9%)       | 12(9.5–14.5)               |         |
| Normal                            | 90(40.7%)       | 18(9.7–26.3)               |         | N2                                 | 55(24.9%)       | 15(10.1–19.9)              |         |
| Overweight                        | 32(14.5%)       | 26(15.2–36.8)              |         | Distant Metastasis                 |                 |                            | 0.0001  |
| Obese                             | 22(10.0%)       | 23(11.3–34.7)              |         | M0                                 | 68(21.7%)       | 19(12.0–25.9)              |         |
| **Depth of Tumour Invasion**      |                 |                            |         | M1                                 | 173(78.3%)      | 11(6.0–15.9)               |         |
| T2                                | 18(8.2%)        | 28(15.1–40.9)              |         |                                    |                 |                            |         |
| T3                                | 84(38.0%)       | 14(5.2–22.8)               |         |                                    |                 |                            |         |
| T4                                | 119(53.8%)      | 14(10.7–18.7)              |         |                                    |                 |                            |         |

OS = Overall Survival, BMI = Body Mass Index, \( p<0.05 \) = statistically significant.

https://doi.org/10.1371/journal.pone.0209307.t002
Table 4 shows the association between clinical factors and survival using cox regression analysis. In both univariate and multivariate analysis chemotherapy (p = 0.0001) and being underweight (p < 0.05) were significant prognostic factors in colorectal cancer survival. Chemotherapy was associated with high odds of survival (HR: 0.38 (0.25–0.57) whereas having chemo radiotherapy (HR: 3.63 (1.05–12.59) and being underweight (HR: 1.74 (1.11–2.72) were associated with decrease odds of surviving. Meanwhile, treatment with both chemo and radiotherapy (p = 0.042) were significant prognostic factors for CRC survival after multivariate analysis. Duration of symptoms, surgery, nature of operation and having radiotherapy were not statistically associated with survival (p > 0.05).

The association between pathological factors and survival using cox regression analysis is shown in Table 5. Stage of tumour, depth of tumour invasion, lymph node metastasis and
distant metastasis were significant prognostic factors on univariate analysis (p < 0.05). Late stage tumours, Stage III [HR: 9.41 (1.29–68.58), p = 0.027] and stage IV [HR: 12.89 (1.74–95.24), p = 0.012] were associated with poor survival. Similarly, T3 [(HR: 3.42 (1.05–11.11), p = 0.041)] and T4 [(HR: 3.51 (1.09–11.33) p = 0.036)], N stages, N1 [(HR: 2.65 (1.58–4.43), p = 0.0001)] and N2 [(HR: 2.42 (1.24–4.73), p = 0.009)] and M1 [(HR: 12.16 (1.37–3.40), P = 0.001)] were associated with poor survival. Tumour location and histological grade were not statistically significant.

**Discussion**

Globally, there has been great improvement in colorectal cancer survival over the past decade partly due to early detection and more effective treatments [20]. However, CRC still remains a major cause of mortality in developing countries. This study therefore investigated the survival rate of colorectal cancer and its prognostic factors among patients at the Komfo Anokye Teaching Hospital, in Ghana.

In this study, the overall five year survival rate was 16%, which is extremely lower than the typically reported survival rate in developed countries. A study by sankaranarayanan et al., (2011) on cancer survival in Africa, Asia, and Central America reported that, colorectal cancer survival in Sub-Saharan African countries was extremely poor compared to Asian and central countries.

**Table 4. Association of clinical parameters with survival using cox regression analysis.**

| Variables                  | Univariate Analysis | Multivariate Analysis |
|----------------------------|---------------------|-----------------------|
|                            | HR                  | 95% CI                | P-value   | HR                  | 95% CI                | P-value   |
| **Duration of Symptoms**   |                     |                       |           |                     |                       |           |
| < 6                        | 1                   |                       |           |                     |                       |           |
| 6–12                       | 1.18                | (0.671–2.057)         | 0.573     | 1.23                | (0.78–1.93)           | 0.380     |
| > 12                       | 1.34                | (0.759–2.379)         | 0.311     | 1.23                | (0.62–2.26)           | 0.491     |
| **Surgery**                |                     |                       |           |                     |                       |           |
| No                         | 1                   |                       |           |                     |                       |           |
| Yes                        | 1.11                | (0.72–1.69)           | 0.648     | 3.82                | (0.16–91.51)          | 0.408     |
| **Nature of Operation**    |                     |                       |           |                     |                       |           |
| Emergency                  | 0.99                | (0.63–1.58)           | 0.985     | 3.41                | (0.14–82.49)          | 0.451     |
| Elective                   | 1                   |                       |           |                     |                       |           |
| **Chemotherapy**           |                     |                       |           |                     |                       |           |
| No                         | 1                   |                       |           |                     |                       |           |
| Yes                        | 0.38                | (0.25–0.57)           | **0.0001**| 0.23                | (0.13–0.41)           | <0.0001   |
| **Radiotherapy**           |                     |                       |           |                     |                       |           |
| No                         | 1                   |                       |           |                     |                       |           |
| Yes                        | 0.82                | (0.51–1.32)           | 0.413     | 0.56                | (0.20–1.60)           | 0.282     |
| **Both Chemo and Radiotherapy** |                 |                       |           |                     |                       |           |
| No                         | 1                   |                       |           |                     |                       |           |
| Yes                        | 0.87                | (0.52–1.46)           | 0.596     | 3.63                | (1.05–12.59)          | **0.042** |
| **BMI Categories**         |                     |                       |           |                     |                       |           |
| Normal                     | 1                   |                       |           |                     |                       |           |
| Underweight                | 1.74                | (1.11–2.72)           | **0.016**| 1.78                | (1.11–2.86)           | **0.017** |
| Overweight                 | 0.95                | (0.51–1.75)           | 0.860     | 0.93                | (0.48–1.78)           | 0.817     |
| Obese                      | 0.94                | (0.46–1.89)           | 0.852     | 0.95                | (0.46–1.98)           | 0.894     |

HR = Hazard ratio, CI = confidence interval, BMI = body mass Index, P < 0.05 = statistically significant.

https://doi.org/10.1371/journal.pone.0209307.t004
American countries. In sub-Saharan countries like the Gambia and Uganda, the survival was less than 8% compared to 60% survival rate in Korea and this shows the huge variation in cancer survival between these two continents [21]. Lack of modernised infrastructure for cancer care and unavailability of curative treatment for patients were some of the factors identified for the poor cancer survival in Sub Saharan Africa. In Asian countries like China, colorectal cancer patients have 60.8% survival rate after surgery. Studies from other developing countries like Iran reported that the 5-year survival rates of colorectal cancer falls between 27.2% and 61% [22] which are comparatively higher than our current finding.

Mostly, the stage of a cancer at diagnosis influences survival. For colorectal cancer stage, the five-year survival rates varies from 90% for localized cancers, 70% for regional cancers, and 10% for distant metastatic cancers [1]. In this study, the overall survival rates based on CRC TNM staging were 90% for stage I, 34% for stage II, 12% for stage III and 0.0% for stage IV (Fig 3). The difference in survival rate among the different cancer stages using log rank test was statistically significant (p = 0.0001). A study by Al-Ahwal et al., (2013) in Suadi Arabia recorded 63.3% for patients with stage 1 cancers, 50.2% for those with stage 2&3 cancers, and 14.7% for patients stage 4 cancers which are slightly comparable to our findings [23].

Table 5. Association of pathological parameters with survival using cox regression analysis.

| Variables                  | Univariate Analysis | Multivariate Analysis |
|----------------------------|---------------------|-----------------------|
|                            | HR                  | 95% CI                | P-value   | HR                  | 95% CI                | P-value   |
| Tumour Location            |                     |                       |           |                     |                       |           |
| Colon                      | 1                   |                       |           |                     |                       |           |
| Rectum                     | 0.99                | (0.64–1.53)           | 0.965     | 0.86                | (0.50–1.48)           | 0.592     |
| Anorectum                  | 0.41                | (0.14–1.14)           | 0.088     | 0.40                | (0.12–1.37)           | 0.144     |
| Anal                       | 1.12                | (0.49–2.5)            | 0.79      | 2.15                | (0.69–6.62)           | 0.183     |
| More than one site         | 1.28                | (0.49–3.28)           | 0.612     | 0.76                | (0.22–2.64)           | 0.660     |
| Histological Grade         |                     |                       |           |                     |                       |           |
| Well differentiated        | 1                   |                       |           |                     |                       |           |
| Moderately differentiated  | 1.62                | (0.94–2.80)           | 0.085     | 1.33                | (0.70–2.52)           | 0.377     |
| Poorly differentiated      | 1.58                | (0.77–3.55)           | 0.229     | 1.01                | (0.35–2.91)           | 0.986     |
| Undifferentiated           | 1.66                | (0.75–3.33)           | 0.193     | 1.56                | (0.63–3.85)           | 0.338     |
| Tumour Stage               |                     |                       |           |                     |                       |           |
| Stage I                    | 1                   |                       |           |                     |                       |           |
| Stage II                   | 4.12                | (0.55–30.84)          | 0.168     | 2.00                | (0.16–25.79)          | 0.595     |
| Stage III                  | 9.41                | (1.29–68.58)          | 0.027     | 4.97                | (0.28–87.64)          | 0.274     |
| Stage IV                   | 12.89               | (1.74–95.24)          | 0.012     | 13.34               | (0.49–359.01)         | 0.123     |
| Depth of Tumour Invasion   |                     |                       |           |                     |                       |           |
| T2                         | 1                   |                       |           |                     |                       |           |
| T3                         | 3.42                | (1.05–11.11)          | 0.041     | 1.67                | (0.37–7.61)           | 0.508     |
| T4                         | 3.51                | (1.09–11.33)          | 0.036     | 1.93                | (0.43–8.59)           | 0.389     |
| Lymph Node Metastasis      |                     |                       |           |                     |                       |           |
| N0                         | 1                   |                       |           |                     |                       |           |
| N1                         | 2.65                | (1.58–4.43)           | 0.0001    | 1.01                | (0.25–4.08)           | 0.991     |
| N2                         | 2.42                | (1.24–4.73)           | 0.009     | 0.71                | (0.17–2.95)           | 0.641     |
| Distant Metastasis         |                     |                       |           |                     |                       |           |
| M0                         | 1                   |                       |           |                     |                       |           |
| M1                         | 2.16                | (1.37–3.40)           | 0.001     | 0.49                | (0.11–2.18)           | 0.352     |

HR = Hazard Ratio, CI = confidence Interval, T = tumour depth, N = lymph node metastasis, M = distant metastasis, P<0.05 = statistically significant

https://doi.org/10.1371/journal.pone.0209307.t005
lower survival rates observed in this study could be due to the lack of interventions such as screening programmes and public education on cancer prevention, inaccessibility to specialised centers and lack of effective modernised diagnostic techniques for efficient diagnosis and prognosis. Improved life expectancy accompanied with the adoption of sedentary lifestyle and unhealthy dietary habits among Ghanaians have resulted in the rise in the incidence of various cancer including colorectal cancer leading to the high demand for quality cancer care. Studies have also shown that patients mostly present with late stage cancers that are mostly incurable [16] therefore resulting in poorer treatment outcome for patients with colorectal cancers. Late presentation could be due to lack of education on the signs and symptoms of colorectal cancer among the populace, lack of screening programmes for early detection and the fact that most people might be oblivious of the importance of early reporting to hospital for diagnosis and treatment. With colorectal cancer, prognosis is mostly determined by the characteristics of the tumour and some patients related factors. Knowledge of these prognostic factors could help physicians immensely to improve clinical outcomes [24]. Family history was significantly associated with improved survival (p = 0.036) in both the log rank test and the cox regression model (Tables 1 and 3). This is consistent with findings from [25] who reported that patients who have family history of colorectal cancer have overall improved survival compared to those who developed that cancer due to lifestyle factors but not necessarily due to heredity. The reason could be that, patients with family history of the disease are aware of their risk factor, and thus seek early medical intervention and treatments which improves their live expectancy as compared to sporadic cases.
Numerous studies report on the role of patient’s gender as a prognostic factor in colorectal cancer, but in most of these studies, gender played no significant role in predicting survival [26–28] which is consistent with findings from our current study. In this study, age was not identified as a prognostic factor for survival. This agrees with several other studies [29–31]. However, some other studies found age as prognostic factor for poor survival in older patients than younger ones. [26, 28, 32]. In keeping with Akhood et al., (2011), our study could not approve a significant relationship between survival rate and marital status [33].

Chemotherapy as a treatment modality was significantly related to improved survival whereas having chemo-radiotherapy or radio-chemotherapy was associated with poor survival (Table 4). Most patients with stage III disease are administered chemotherapy after surgery [34]. Such treatment mostly classified as “adjuvant” helps to improve disease outcome by destroying microscopic cancer cells which could have accumulated and developed into larger tumours. This combined therapy has been proven to be effective in enhancing survival by 15–20%. [35]. This explanation supports our finding that chemotherapy is associated with improved survival. A study by Kumar et al., (2015) in Oman found BMI and chemotherapy as independent risk factors of CRC, this supports the findings in this study [36]. There have been conflicting findings on the association between BMI and colorectal cancer survival. A recent meta-analysis reported that being obese before diagnosis of CRC (BMI ≥30 kg/m²) was significantly associated with poorer survival [37]. A retrospective study by Tang et al (2016) also found that, being underweight before treatment was associated with an increase risk of death whereas overweight and obesity were favourable prognostic factors for overall survival in metastatic cancer patients [38]. Similarly, our study found that being underweight after diagnosis was significantly associated with poor survival whereas being overweight or obese was more favourable. On the contrary, Boyle et al., (2013) reported, post diagnostic overweight or obesity was associated with poorer survival in colorectal cancer patients [39]. There is a link between obesity and numerous cancer incidences, but in terms of survival, studies have proposed that increasing levels of insulin and insulin-like growth factors as well as increasing insulin...
resistance in obesity may negatively influence colorectal cancer survival. [40]. It is therefore advisable that colorectal cancer patients maintain a healthy normal weight which will help to improve their survival.

In this present study, the stage of tumor was associated with worse survival (Table 5). This is consistent with several studies [13, 41] that have demonstrated that advanced tumour stage is a prognostic factor associated with poor survival in patients with CRC. Findings from this study showed that, the state of regional lymph node metastasis was a significant prognostic factor for poor survival, which concurs with findings observed by other studies [42, 43]. Cox proportional hazard model in this current study revealed that, distant metastasis was significantly associated with poor survival (Table 5). This finding is supported by many other studies [44, 45] which also identified distance metastasis as a significant factor for poor survival. Other studies have observed a significant relationship between extent of tumour infiltration and prognosis [44, 46], this trend was also observed in this current study. The extent of tumour infiltration into the intestinal wall, lymph nodes and distant organs strongly influences the survival prospects of colorectal cancer patients and also forms the basis for staging as well as treatment options for patients. [9].

Information on some of the study subjects were unavailable because of the retrospective nature of the study. Patients who were diagnosed and treated only at KATH were included in this study, hence this may not be a true reflection of the situation in the entire population, although almost all oncological cases from the Northen and Central sectors of Ghana are refer-
erd to KATH for management. Inspite of these limitations, the study has provided useful information that can help to direct Ghana cancer control strategy inorder to improve cancer survival and help health practitioners in the management of patients with colorectal cancer.

**Conclusion**

The survival rate of colorectal cancer is very low in Ghana. Significant clinical and pathological prognostic factors were; family history, chemotherapy, both chemo and radiotherapy, BMI, TNM tumour stage, Depth of tumour invasion, lymph node metastasis, distance metastasis. Therefore, this study highlights the need for intensified public health education to promote awareness about the signs and symptoms of colorectal cancer and comprehensive screening programmes which will greatly improve survival through early detection. Furthermore, molecular studies should be done to identify potential molecular markers for an improved and effective treatment in the Ghanaian population.

**Supporting information**

S1 Dataset. Excel sheet of dataset on which conclusions of this manuscript were made. (XLSX)

S1 Table. Analyses comparing characteristics of patients who were follow-up to those who were not followed. (DOCX)

S1 File. STROBE checklist cohort. (DOC)

**Acknowledgments**

Gratitude goes to workers at the records unit and authorities at the Department of Surgery and Oncology, Komfo Anokye Teaching Hospital and Department of Molecular Medicine, KNUST, Kumasi-Ghana
Author Contributions

Conceptualization: Francis Agyemang-Yeboah, Joseph Yorke, Christian Obirikorang, Emma-nuella Nsenbah Batu.

Data curation: Francis Agyemang-Yeboah, Joseph Yorke, Christian Obirikorang, Emma-nuella Nsenbah Batu, Emmanuel Acheampong, Emmanuel Amankwaa Frimpong.

Formal analysis: Francis Agyemang-Yeboah, Christian Obirikorang, Emma-nuella Nsenbah Batu, Emmanuel Acheampong, Enoch Odame Anto, Bright Amankwaa.

Investigation: Joseph Yorke, Emma-nuella Nsenbah Batu, Emmanuel Amankwaa Frimpong.

Methodology: Emma-nuella Nsenbah Batu, Emmanuel Acheampong, Emmanuel Amankwaa Frimpong, Enoch Odame Anto.

Software: Christian Obirikorang, Emma-nuella Nsenbah Batu, Emmanuel Acheampong.

Supervision: Francis Agyemang-Yeboah, Joseph Yorke, Christian Obirikorang, Emma-nuella Nsenbah Batu.

Validation: Christian Obirikorang, Emma-nuella Nsenbah Batu, Emmanuel Acheampong.

Visualization: Emma-nuella Nsenbah Batu.

Writing – original draft: Francis Agyemang-Yeboah, Joseph Yorke, Christian Obirikorang, Emma-nuella Nsenbah Batu, Emmanuel Acheampong, Enoch Odame Anto, Bright Amankwaa.

Writing – review & editing: Francis Agyemang-Yeboah, Joseph Yorke, Christian Obirikorang, Emma-nuella Nsenbah Batu, Emmanuel Acheampong, Emmanuel Amankwaa Frimpong, Enoch Odame Anto, Bright Amankwaa.

References

1. Haggar FA, Boushey RP: Colorectal cancer epidemiology: incidence, mortality, survival, and risk factors. *Clinics in colon and rectal surgery* 2009, 22(4):191. https://doi.org/10.1055/s-0029-1242458 PMID: 21037809

2. Köhne C-H, Kretzschmar A, Wils J: First-Line chemotherapy for colorectal carcinoma—we are making progress. *Oncology Research and Treatment* 1998, 21(4):280–289.

3. El Zouhairi M, Charabaty A, Pishvaian MJ: Molecularly targeted therapy for metastatic colon cancer: proven treatments and promising new agents. *Gastrointestinal cancer research: GCR* 2011, 4(1):15. PMID: 21464866

4. Jackson-Thompson J, Lai SM, Friedman C: Descriptive epidemiology of colorectal cancer in the United States, 1998–2001. *Cancer* 2006, 107(S5):1103–1111.

5. Boyle P, Langman J: ABC of colorectal cancer: Epidemiology. *BMJ: British Medical Journal* 2000, 321(7264):805. PMID: 11009523

6. De Divitiis C, Nasti G, Montano M, Fisichella R, Iaffaioli RV, Berretta M: Prognostic and predictive response factors in colorectal cancer patients: between hope and reality. *World Journal of Gastroenterology: WJG* 2014, 20(41):15049. https://doi.org/10.3748/wjg.v20.i41.15049 PMID: 25386053

7. Marzouk O, Schofield J: Review of histopathological and molecular prognostic features in colorectal cancer. *Cancers* 2011, 3(2):2767–2810. https://doi.org/10.3390/cancers2022767 PMID: 24212832

8. Amersi F, Agustin M, Ko CY: Colorectal cancer: epidemiology, risk factors, and health services. *Clinics in colon and rectal surgery* 2006, 18(03):133–140. https://doi.org/10.1055/s-2005-916274 PMID: 20011296

9. Compton CC, Greene FL: The staging of colorectal cancer: 2004 and beyond. *CA: a cancer journal for clinicians* 2004, 54(6):295–308.

10. Roncucci L, Fante R, Losi L, Di Gregorio C, Micheli A, Benatti P, et al.: Survival for colon and rectal cancer in a population-based cancer registry. *European Journal of Cancer* 1996, 32(2):295–302.
27. Saha A, Smith K, Sue-Ling H, Sagar P, Burke D, Finan P: Prognostic factors for survival after curative resections. *Diseases of the colon & rectum* 1988, 31(1):33–41.

28. Griffin MR, Bergstralh EJ, Coffey RJ, Beart RW, Melton LJ: Predictors of survival after curative resection of carcinoma of the colon and rectum. *Cancer* 1987, 60(9):2318–2324. PMID: 3440238

29. Ghazali AK, Musa KL, Naing NN, Mahmood Z: Prognostic factors in patients with colorectal cancer at Hospital Universiti Sains Malaysia. *Asian Journal of Surgery* 2010, 33(3):127–133. https://doi.org/10.1016/S1015-9584(10)60022-X PMID: 21163410

30. Chalya PL, Mchembe MD, Mabula JB, Rambau PF, Jaka H, Koy M, et al.: Clinico-pathological patterns and challenges of management of colorectal cancer in a resource-limited setting: a Tanzanian experience. *World J Surg Oncol* 2013, 11(2).

31. Badoe E: Malignant disease of gastrointestinal tract in Korle Bu Hospital, Accra, Ghana, 1956–65. *The West African medical journal* 1966, 15(5):181. PMID: 5977809

32. Dakubo J, Naaeder S, Tettey Y, Gyasi R: Colorectal carcinomas: an update of current trends in Accra. *West African journal of medicine* 2010, 29(3).

33. Laryea DO, Awuah B, Amoako YA, Osei-Bonsu E, Dogbe J, Larsen-Reindorf R, et al.: Cancer incidence in Ghana, 2012: evidence from a population-based cancer registry. *BMC Cancer* 2014, 14(1):1.

34. Naaeder S, Archampong E: Cancer of the colon and rectum in Ghana: A 5-year prospective study. *British journal of surgery* 1994, 81(3):456–459. PMID: 8173933

35. McArdle C, Hole D, Hansell D, Blumgart L, Wood C: Prospective study of colorectal cancer in the West of Scotland: 10-year follow-up. *British Journal of Surgery* 1990, 77(3):280–282. PMID: 1691033

36. Faivre-Finn C, Bouvier-Benhamiche A, Phelp J, Manfredi S, Dancourt V, Faivre J: Colon cancer in France: evidence for improvement in management and survival. *Gut* 2002, 51(1):60–64. PMID: 12077093

37. Laryea DO, Awuah B, Al-Ahwal MS, Shafik YH, Al-Ahwal HM: First national survival data for colorectal cancer among Saudis with colorectal cancer family history. *World J Gastrointest Oncol* 2010, 2(4):71–75. https://doi.org/10.4251/wjgo.v2.i4.71 PMID: 22532879

38. Mehdinibeni D, Almasi-Hashiani A, Moshfeghi K, Khedmati E: Survival rate and its predictors in colorectal cancer patients, Southern Iran. *Middle East J Sci Res* 2012, 12(8):1072–1077.

39. Al-Ahwal MS, Shafik YH, Al-Ahwal HM: First national survival data for colorectal cancer among Saudis between 1994 and 2004: what’s next? *BMC Public Health* 2013, 13(1):1.

40. Alici S, Kaya S, Izmirli M, Tuncer I, Ozbek H, Sayarioglu H: Analysis of survival factors in patients with advanced-stage gastric adenocarcinoma. *Medical science monitor* 2006, 12(5):CR221–CR229. PMID: 16641880

41. Zell JA, Honda J, Ziegas A, Anton-Culver H: Survival after colorectal cancer diagnosis is associated with colorectal cancer family history. *Cancer Epidemiology Biomarkers & Prevention* 2008, 17(11):3134–3140.

42. Mehrabani D, Almasi-Hashiani A, Moshtfeghi K, Khedmati E: Survival rate and its predictors in colorectal cancer patients, Southern Iran. *Middle East J Sci Res* 2012, 12(8):1072–1077.

43. Al-Ahwal MS, Shafik YH, Al-Ahwal HM: First national survival data for colorectal cancer among Saudis between 1994 and 2004: what’s next? *BMC Public Health* 2013, 13(1):1.

44. Alici S, Kaya S, Izmirli M, Tuncer I, Ozbek H, Sayarioglu H: Analysis of survival factors in patients with advanced-stage gastric adenocarcinoma. *Medical science monitor* 2006, 12(5):CR221–CR229. PMID: 16641880

45. Zell JA, Honda J, Ziegas A, Anton-Culver H: Survival after colorectal cancer diagnosis is associated with colorectal cancer family history. *Cancer Epidemiology Biomarkers & Prevention* 2008, 17(11):3134–3140.

46. Rosenberg R, Friederichs J, Schuster T, Gertler R, Maak M, Becker K, et al.: Prognosis of patients with colorectal cancer is associated with lymph node ratio: a single-center analysis of 3026 patients over a 25-year time period. *Annals of surgery* 2008, 248(6):968–978. https://doi.org/10.1097/SLA.0b013e318190eddc PMID: 19092341

47. Saha A, Smith K, Sue-Ling H, Sagar P, Burke D, Finan P: Prognostic factors for survival after curative resection of Dukes’ B colon cancer. *Colorectal Disease* 2011, 13(12):1390–1394. https://doi.org/10.1111/j.1463-1318.2010.02507.x PMID: 21073847

48. Moghimi-Dehkordi B, Safaei A, Zali MR: Prognostic factors in 1,138 Iranian colorectal cancer patients. *International journal of colorectal disease* 2008, 23(7):683–688. https://doi.org/10.1007/s00384-008-0463-7 PMID: 18330578

49. Moghimi-Dehkordi B, Safaei A, Zali MR: An overview of colorectal cancer survival rates and prognosis in Asia. *World J Gastrointest Oncol* 2012, 4(4):71–75. https://doi.org/10.4251/wjgo.v4.i4.71 PMID: 22532879

50. Gharbi O, Chabchoub I, Limam S, Hochleif M, Ben FL, Landolsi A, et al.: [Prognostic factors and survival of metastatic colorectal cancer in the Sousse University Hospital (Tunisia): comparative study of two treatment period of 200 patients]. *Bulletin du cancer* 2010, 97(4):445–451. https://doi.org/10.1684/bdc.2010.1083 PMID: 20385519

51. Zhang S, Gao F, Luo J, Yang J: Prognostic factors in survival of colorectal cancer patients with synchronous liver metastasis. *Colorectal Disease* 2010, 12(8):754–761. https://doi.org/10.1111/j.1463-1318.2009.01911.x PMID: 19508508

52. Mehrkhani F, Nasiri S, Donboli K, Meysamie A, Hedayat A: Prognostic factors in survival of colorectal cancer patients after surgery. *Colorectal Disease* 2009, 11(2):157–161. https://doi.org/10.1111/j.1463-1318.2008.01556.x PMID: 18462239
33. Akhoond M, Kazemnejad A, Hajizadeh E, Fatemi S, Motlagh A: Investigation of Influential Factors Affecting Survival Rate of Patients with Colorectal Cancer using Copula Function. *Iranian Journal of Epidemiology* 2011, 6(4):40–49.

34. Ragnhammar P, Hafstrom L, Nygren P, Glimelius B: A systematic overview of chemotherapy effects in colorectal cancer. *Acta oncologica (Stockholm, Sweden)* 2001, 40(2–3):282–308.

35. Glimelius B, Dahl O, Cedermark B, Jakobsen A, Bentzen SM, Starkhammar H, et al.: Adjuvant chemotherapy in colorectal cancer: a joint analysis of randomised trials by the Nordic Gastrointestinal Tumour Adjuvant Therapy Group. *Acta oncologica* 2011.

36. Kumar S, Burney IA, Zahid KF, Souza PCD, Belushi MA, Meki TDMWA, et al.: Colorectal cancer patient characteristics, treatment and survival in Oman—a single center study. *Asian Pac J Cancer Prev* 2015, 16:4853–4858. PMID: 26163603

37. Lee J, Meyerhardt JA, Giovannucci E, Jeon JY: Association between body mass index and prognosis of colorectal cancer: a meta-analysis of prospective cohort studies. *PloS one* 2015, 10(3):e0120706. https://doi.org/10.1371/journal.pone.0120706 PMID: 25811460

38. Tsang NM, Pai PC, Chuang CC, Chuang WC, Tseng CK, Chang KP, et al.: Overweight and obesity predict better overall survival rates in cancer patients with distant metastases. *Cancer medicine* 2016.

39. Boyle T, Fritschi L, Platell C, Heyworth J: Lifestyle factors associated with survival after colorectal cancer diagnosis. *British journal of cancer* 2013, 109(3):814–822. https://doi.org/10.1038/bjc.2013.310 PMID: 2378918

40. Vrieling A, Kampman E: The role of body mass index, physical activity, and diet in colorectal cancer recurrence and survival: a review of the literature. *The American journal of clinical nutrition* 2010;ajcn. 29005.

41. Bufalari A, Giustozzi G, Burattini MF, Servili S, Bussotti C, Lucaroni E, et al.: Rectal cancer surgery in the elderly: a multivariate analysis of outcome risk factors. *Journal of surgical oncology* 2006, 93(3):173–180. https://doi.org/10.1002/jso.20300 PMID: 16482596

42. Liang J, Wan D, Pan Z, Zhou Z, Chen G, Li L, et al: Multivariate regression analysis of recurrence following curative surgery for colorectal cancer. *Ai zheng = Aizheng = Chinese journal of cancer* 2004, 23(5):564–567. PMID: 15142455

43. Compton CC, Fielding LP, Burgart LJ, Conley B, Cooper HS, Hamilton SR, et al.: Prognostic factors in colorectal cancer: College of American Pathologists consensus statement 1999. *Archives of pathology & laboratory medicine* 2000, 124(7):979–994.

44. He W, Wang L, Hu H, Kang S, Qian H, Xu F: Correlation of invasion, metastasis, and prognosis in low and middle rectal cancer. *Ai zheng = Aizheng = Chinese journal of cancer* 2002, 21(11):1222–1225. PMID: 12526220

45. Oya M, Takahashi S, Okuyama T, Yamaguchi M, Ueda Y: Synchronous colorectal carcinoma: clinicopathological features and prognosis. *Japanese journal of clinical oncology* 2003, 33(1):38–43. PMID: 12604723

46. Safaei A, Moghimi_dehkordi B, Fatemi S, Ghiasi S, Zali M: Pathology and prognosis of colorectal cancer. *Iranian Journal of cancer prevention* 2012, 2(3):137–141.