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Dietary patterns and colorectal cancer risk in Zimbabwe: A population based case-control study

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ABSTRACT

Background: The rising incidence of colorectal cancer in sub-Saharan Africa may be partly caused by changing dietary patterns. We sought to establish the association between dietary patterns and colorectal cancer in Zimbabwe.

Methods: One hundred colorectal cancer cases and 200 community-based controls were recruited. Data were collected using a food frequency questionnaire, and dietary patterns derived by principal component analysis. Generalised linear and logistic regression models were used to assess the associations between dietary patterns, participant characteristics and colorectal cancer.

Results: Three main dietary patterns were identified: traditional African, urbanised and processed food. The traditional African diet appeared protective against colorectal cancer (Odds Ratio (OR) 0.35; 95% Confidence Interval (CI), 0.21 – 0.58), which had no association with the urban (OR 0.68; 95% CI, 0.43–1.08), or processed food (OR 0.91; 0.58–1.41) patterns. The traditional African diet was associated with rural domicile, (OR 1.26; 95% CI, 1.00–1.59), and a low income (OR1.48; 95% CI, 1.06–2.08). The urbanised diet was associated with urban domicile (OR 1.70; 95% CI, 1.38–2.10), secondary (OR 1.30; 95% CI, 1.07–1.59) or tertiary education (OR 1.48; 95% CI, 1.11–1.97), and monthly incomes of $201–500 (OR 1.30; 95% CI, 1.05–1.62), and the processed food pattern with tertiary education (OR 1.42; 95% CI, 1.05–1.92), and income > $1000/month (OR 1.48; 95% CI, 1.02–2.15).

Conclusion: A shift away from protective, traditional African dietary patterns may partly explain the rising incidence of colorectal cancer in sub-Saharan Africa.

1. Introduction

Colorectal cancer is the 3rd most common cancer globally, and the 6th most common in Africa [1,2]. The age standardised incidence of colorectal cancer in sub-Saharan Africa per 100,000 ranges from 3.1 in men and 2.9 in women in Malawi, to 14.9 in men and 14.2 in women in Zimbabwe [3]. There has been a gradual temporal increase in the incidence of colorectal cancer in Zimbabwe over the past two decades [4,5]. Despite this increase, the incidence of colorectal cancer is still significantly lower than in the developed world, where the rate is approximately three times higher [6]. An increase in the burden of colorectal cancer has also been described in other parts of sub-Saharan Africa, including Mozambique, Kenya and Nigeria [7–9]. This rising incidence has been attributed to changes in diet and lifestyle, and to improved diagnosis [10]. However, the role of dietary changes in the rising incidence of colorectal cancer is not supported by solid empirical

Abbreviations: OR, odds ratio; CI, confidence interval; FAO, Food and Agriculture Organization of the United Nations; BMI, body mass index

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data.

It is generally accepted that dietary factors account for the majority of sporadic colorectal cancers [11]. This link is strongest for a high intake of red meat and processed meat products, which are now classified by the International Agency for Research on Cancer (IARC) as 'probably carcinogenic', and 'carcinogenic' to humans respectively [12]. Other dietary factors associated with an increased risk of colorectal cancer include a high intake of alcohol, animal fat and sugar [11]. In contrast, a high intake of dietary fibre, non-starchy vegetables, fruits, milk, calcium, and vitamin D is associated with a reduced risk [11]. However, the causative role of diet on colorectal cancer is more complex than implied by the degree of risk attributed to individual components. There is considerable interplay between the different nutritive and non-nutritive components, underscoring the importance of considering the overall dietary pattern. Furthermore, the overall diet has a major impact on gut microbiota composition and function, which plays a key role in the development of colorectal cancer [13].

Nonetheless, previous studies on the effect of diet in sub-Saharan Africa focussed on the putative protective role of individual constituents [10]. Another limitation of earlier studies was the absence of individuals with colorectal cancer as the comparator. The studies invariably recruited healthy people only, who were all assumed to have a uniformly low risk. There is need to evaluate the role of dietary patterns on the risk of colorectal cancer in sub-Saharan Africa using neoplasia as the end-point. This is particularly relevant now, given the on-going changes in dietary practices in the region. There is rising intake of meat, processed animal products and high energy foods, and decreasing intake of traditional grains and plants [14]. Therefore, we sought to establish whether there is an association between dietary patterns and colorectal cancer risk in an African population in Zimbabwe.

2. Materials and methods

2.1. Study population

The study design and population have been described previously [15]. Briefly, a population based case-control study of adult black Zimbabweans with colorectal cancer and community based controls was carried out. The cases were recruited through all the private and public tertiary level clinical, endoscopic and pathology services within Harare. These provide tertiary referral services for the northern two thirds of Zimbabwe. Only histologically confirmed cases of colorectal cancer were considered for inclusion, and they were recruited within six months of diagnosis. Individuals with recurrent colorectal cancer, or cognitive impairment were excluded. The controls were selected from households in the areas where the cases ordinarily lived, using enumeration maps from the 2012 Zimbabwe national census. Two controls were selected for each case, and they were matched for sex, and age to within 5 years. Ethical approval was obtained from the institutional review committees of the University of Zimbabwe College of Health Sciences and the Medical Research Council of Zimbabwe.

2.2. Data collection

Informed consent was obtained from all participants, who were then interviewed using a validated semi-quantitative food frequency questionnaire containing [16]. The questionnaire contained 110 items, after adjustments to account for foods suspected to represent distinct dietary patterns, or to affect the risk of colorectal cancer. Data on medical history, demographic and socio-economic characteristics was also collected. This included age, sex, domicile at different stages of life, level of education, employment status, income, use of non-steroidal anti-inflammatory drugs, smoking, alcohol consumption, and family history of all cancers, and of colorectal cancer in particular. For the cases, data on the tumour location was obtained from pathology reports and clinical notes. The anatomic sites were defined as follows: proximal colon (caecum to transverse colon), distal colon (splenic flexure to sigmoid colon), and rectum (recto-sigmoid junction and rectum). The controls were interviewed at home, and the cases were seen in hospital or at home.

2.3. Statistical analysis

It was estimated that a sample size of 100 cases and 200 controls would give at least 80% power to detect an absolute difference of 20% in exposure rates using a two-sided α of 0.05. Baseline demographic and clinical characteristics were compared between cases and controls using a chi-squared or fisher's exact test for categorical variables, and a student *t*-test for continuous variables. A p value of < 0.05 was regarded as statistically significant. The 110 different foods were grouped *a posteriori* into 31 groups using the dietary diversity score instrument from the Food and Agriculture Organization of the United Nations (FAO) [17], with adjustments to reflect Zimbabwean culinary practice. Principal component analysis was used to derive dietary patterns from these food groups. An eigenvalue > 1 and scree plots were used to determine the factors responsible for most of the variability. These factors were retained, and orthogonal rotation was performed to enhance interpretability. Rotated factors loadings greater than 0.35 were used to select meaningful associations of food groups. The Kaiser-Meyer-Olkin test was used to assess sampling adequacy. The retained factors were named according to the predominant food groups, taking into account the authors' understanding of Zimbabwean dietary practices. The association between these dietary patterns and participant characteristics was assessed using generalised linear models. Initially, univariate analysis for participant characteristics influencing each dietary pattern was performed. These characteristics included alcohol, smoking status, diabetes mellitus, family history of colorectal cancer and cancer, income and level of education. Multivariate analysis was then performed to assess participant characteristics that were independently associated with each dietary pattern. Logistic regression models, adjusted for these significant participant characteristics, were used to determine the association between the different dietary patterns and colorectal cancer. Odds ratios and 95% confidence intervals for the association between the dietary patterns and colorectal cancer were determined. Multinomial logistic regression was used to determine the association between anatomic site and dietary patterns, and relative risk ratios, (with one site as a reference) and 95% confidence intervals computed. All the statistical analysis was performed using Stata MP Version 12.0® (College Station, Texas).

3. Results

3.1. Characteristics of cases and controls

One hundred cases of colorectal cancer and 200 controls were recruited between November 2012 and December 2015. The tumour location in the cases was as follows: proximal colon 21, distal colon 20, unspecified colon 3, rectum 55, and synchronous colon and rectum 1. The gender distribution and mean age were comparable between cases and controls, and the majority of participants, 71%, lived in urban areas (Table 1). A higher proportion of cases had a tertiary education compared to controls (32% versus 14%, $p < 0.001$), and more cases earned more than $1000 per month (18% versus 6.5% $p = 0.01$). The average monthly salary in Zimbabwe is estimated to be $298 per month [18]. Cases were also more likely to have diabetes mellitus, and to have a history of cancer, or colorectal cancer among first degree relatives (Table 1).

3.2. Characteristics of the dietary patterns

Table 2 shows the 31 different food groups used for principal component analysis. Three meaningful factors were identified after