IOSR Journal of Nursing and Health Science (IOSR-JNHS)
e- ISSN: 2320–1959.p- ISSN: 2320–1940 Volume 7, Issue 5 Ver. II (Sep.-Oct. 2018), PP 80-85
www.iosrjournals.org

Dietary Patterns are not associated with Colorectal Cancer Etiology: a case study of MERU County, Kenya

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Abstract: *Colorectal cancer (CRC) is the fourth leading cause of death and third most commonly diagnosed cancer around the globe. Although diet plays an essential role in the development of colorectal cancer, there is little information on the role of diet in the rising CRC cases observed in Meru. The study sortto determine whether there was a connection between dietary patterns and colorectal cancer etiology in Meru County, Kenya.We used a retrospective case control study design involving 25 CRC patients and 50 CRC undiagnosed participants as controls. EachCRC patient was identified and matched with two persons from the general population according to similarity by sex, date of birth, and place of residence. A food frequency questionnaire was used to collect data which was then averaged to daily consumptions. The data was analyzed using t-test, Chi-square and Odds Ratio. The study revealed that dietary patterns of Meru County residents includemoderate intake of Fruits (2.5 servings), vegetables (4.0 servings) , and starch staples (9.2 servings), low intake of pulses (1.5 servings , white meat (1.2), milk and its products(1.3) , and nuts and seeds (0.3) , and high intake of red meat (5.1 servings for daily pattern intakes with no significant statistical difference between dietary patterns of CRC and CRC undiagnosed (NC) persons (p- values > 0.05). No statistical association was established between dietary patterns of red meat and risk of developing CRC (p- values > 0.05) on chi-square test and Odds ratio (within the 95% CI) for Meru County residents. Our study indicates that there is no conclusive evidence associating dietary patterns and colorectal cancer etiology and incidences in residents of Meru County.*

Date of Submission: 2-09-2018 Date of acceptance: 17-09-2018

I. Introduction

Cancer is the leading cause of death worldwide, colorectal cancer is ranked as the forth cancer after lung, liver, stomach. According to the Nairobi Cancer Registry, the incidence of colorectal cancer is 9.1/100,000, According to Kenya network of cancer organization (2016), cancer is the third cause of deaths with estimates of 39,000 new cases each year and 27,000 deaths each year. Meru Hospice, Palliative Care Centre program (2016), reported that there was an increase in cases of cancer being reported in Meru County which is alarming since were recording the highest number of cancer cases every month compared to others Hospice centers in Kenya, with most of the cases referred from Meru County. Meru Hospice served over 3,000 cancer patients in 2003 to 2016, but had 428 active patients in February 2016 and a registration of 22 patients in January, 2016 alone.

Though there is a rising trend of all cancers in Meru County, no reliable data has been published to explain the rise in incidence. Secondly, there are no studies or published data relating to dietary patterns of Meru residents, and no studies have been published linking dietary patterns and cancer development in Meru County. Thirdly, no studies have been published linking nutrition and colorectal cancer etiology in Meru County. However, Studies done elsewhere show that there is a close relationship between colorectal cancer and diet than there is with any form of cancer and diet. Up to 90% of colorectal cancer is related to dietary factors. This could be related to the fact that Kenya is one of the countries undergoing rapid social, economic transition just like many parts of the world, , which is associated with a nutrition transition, and changes to poor dietary habits, resulting to rise rates of obesity and chronic diseases including cancer.

This study therefore, to identify evidence linking dietary patterns to colorectal cancer etiology in Meru County which is useful in stepping up awareness on causes of colorectal cancer, and in creating effective cancer related dietary prevention interventions.

II. Methods

This study adopted case control study design and used a structured questionnaire to get quantitative information. Twenty five colorectal cancer patients from Meru County were identified from Meru Teaching and Referral Hospital palliative care center, Meru Hospice Palliative Care Treatment Centre which are located in Meru town, and Maua Methodist Hospital Palliative Care Centre located in Maua town, Kenya. For each colorectal cancer patient interviewed, two other persons who had not been diagnosed with cancer, not related by blood to the patient, and had the characteristics of the respective cancer patient in terms of age bracket and gender were interviewed.

Food consumption data was obtained using a modified Food Frequency Questionnaire designed in a modified model similar to the National Cancer Institute as used in Epidemiology and Genomics Research program. To obtain frequency data, respondents were posed with the question; over a period of you adult life, how many times per month, week or day (prior to diagnosis for the CRC respondents) did you eat the foods below? Think in terms of never, 1-3 times per month, 1-3 times a week, 5-6 times per week, once a day, more than once in a day. This data was then entered in Excel sheet. To be able to score the food frequency questionnaire a model similar to that used in scoring the all-day screener as used in Epidemiology and Genomics research program was used (National Cancer Institute, 2015). Each reported frequency was expressed as a daily frequency average. To do this, the midpoints of each frequency category were standardized to the number of times per day the food was eaten. The frequency of each food type considered were; never (given a score of 0), one to three times a month (a score of 0.067), one to two times a week (a score of 0.214), three to six times a week (a score of 0.643), once a day (a score of 1), and more than once a day (a score of 2).

The average daily food group intake was computed by multiplying daily frequency of each food (mid-point) by the number of pyramid servings for the portion size for that food. To estimate the total daily servings for each food group, summation across all foods in a food group was done. This followed the model used to score the All Day Screener as used in Eat at America's Table Study (EATS) (National Cancer Institute, 2015). The Data was then exported to SPSS Statistics templates where it was analyzed.

This study sought to establish the relationship between risk of development of colorectal Cancer and level of intake of food groups. Rather than providing a measure of absolute intake, individuals were ranked according to their relative intakes, and then further categorized as low intake (below the recommendations), moderate intake (within the usual recommendations), and high intake (above the usual intake).

Respondents with risky dietary patterns of High red meat intake, low fruit intake, low vegetable intake, and low pulses intake were considered to be at risk of colorectal cancer development. Statistical tests (Chi-square, T-tests, fisher's exact test and Odds ratio) were done to identify any link between risky dietary habits of cancer and non-cancer respondents to establish any link leading to development of colorectal cancer.

III. Results

Dietary patterns of Meru residents

Published WHO/FAO report recommends a minimum of 400g of fruit and vegetables per day (excluding potatoes and other starchy tubers) with 2-3 servings of fruit and 3-4 servings of vegetables for the prevention of chronic diseases especially in less developed countries. For pulses, the recommendation for prevention of non-communicable diseases according to FAO/WHO is an intake of above 400g per week eaten in at least 3-4 days in a week. A serving of pulses is considered to be 30g of pulses which is an equivalent of ½ cup cooked pulses. This means that the daily intake of pulses is at least 2 servings a day.

From the research findings, it was established that dietary patterns of residents of Meru County were; moderate intake of Fruits (2.5), vegetables (4.0) , and starch staples (9.2), low intake of pulses (1.5) , white meat (1.2), milk and its products(1.3) , and nuts and seeds (0.3) , and high intake of red meat (5.1) for daily pattern intakes.

Table No 1: Dietary Patters For All Respondents

	Minimum	Maximum	Mean	SD
Fruits	.47	11.40	2.5	1.6
Vegetables	.83	9.87	4.0	2.2
Milk and milk products	.00	6.00	1.3	1.3
Staple starch	1.60	17.00	9.2	3.1
Pulses	.03	4.80	1.5	0.9
White meat and eggs	.00	1.20	0.28	0.3
Red meat and meat products	.40	24.93	5.1	4.6
Nuts and seeds	.00	1.60	0.3	0.4
Fats	.10	32.47	4.5	4.7

When food intake means between the colorectal patients and the non-cancer persons were analyzed and compared, it was revealed that intake means of fruits (NC=2.6, CRC=2.3), vegetables(NC=4.1,CRC=3.9),starch staple (NC=9.4, CRC=8.9), white meat (NC=0.3,CRC=4.8) and eggs, red meat and meat products (NC=5.3, CRC=4.1), and nuts and seeds (NC=0.3 CRC0.2) were slightly higher for the non – cancer persons. Contrariwise, the quantities for milk and milk products (NC1.3, CNC=1.4), the intake means were slightly higher for the colorectal cancer patients while pulse intake was equal at1.5. This is illustrated in Table 2.

An independent-samples t-test was then conducted to comparefood intake means between the CRC patients and the Non CRC (NC) respondent. No statistical significance was established for the intake means of the eight food groups between the colorectal patients and the non – cancer persons since the p – values in all the instances was greater than the significant level of 0.05.From this study therefore, there is no significant statistical difference identified between dietary patterns for CRC cancer respondents and non-CRC respondents. This implies that the dietary patterns for the respondents are similar. This is illustrated in table 2

Table No 2: Dietary Patterns of CRC Patients versus Non-CRC Respondents

Food Categories	Means		t-test (2tailed)
	NC	CRC	(*p<0.05*)
Fruits	2.58	2.25	0.40
Vegetables	4.06	3.85	0.40
Milk & milk products	1.26	1.43	0.58
Staple starch	9.41	8.92	0.53
Pulses	1.48	1.54	0.78
White meat & eggs	0.31	0.23	0.27
Red meat & meat products	5.29	4.81	0.67
Nuts & seeds	0.31	0.23	0.43
Fats and oils	2.59	2.91	0.36

We sought to determine the degree to which respondents were deviating from recommendations of food intake for cancer and other chronic disease prevention. Individuals were ranked according to their relative average daily intakes. Respondents eating below the recommendation (below 2 servings of meat, below 3 servings of vegetables below 2 servings of fruits below 2 serving of pulses and below 3 servings of fats and oils per day) were considered as low intake while those within the usual recommendations (2 to 3 servings of meat, 3to 5 servings of vegetables and 2 to 3 servings of fruits, 1 to 2 servings of pulses and 3-6 servings of oils per day) were moderate intake and those above the usual intake (above 3 servings of meat, above 5 servings of vegetables and above 3 servings of fruits above 2 servings of pulses and above 6 servings of oils per day) were grouped as high intake.

It was revealed that more than half (56%) of CRC respondents and (40%) of NC respondents were consuming fruits at lower than the recommended levels, while a whooping majority had similar intake of milk and products (80 and 84 %) and white meat (96 and 96%). Majority of the respondents were consuming the staple starches in moderation (58% and 64% for NC and CRC respectively). A significant number of respondents 60% of NC and 40% of CRC were consuming red meat at higher than the recommended. More CRC respondents (52%) registered lower levels of nuts than the NC respondents (34%)

Table No 3*:* Distribution of Respondents according to Food Intake Levels

	Low intake		Moderate intake		High intake	
Food Categories	NC (%)	CRC (%)	NC (%)	CRC (%)	NC (%)	CRC (%)
Fruits	20 (40)	14 (56)	24 (48)	8 (32)	6 (12)	3 (12)
Vegetables	17 (34)	9 (36)	21 (42)	9 (36)	12 (24)	7 (28)
Milk & milk products	40 (80)	21 (84)	5 (10)	1 (4)	5 (10)	3 (12)
Staple starch	7 (14)	3 (12)	29 (58)	16 (64)	7 (28)	6 (24)
Pulses	16 (32)	9 (36)	21 (42)	8 (32)	13 (26)	8 (32)
White meat & eggs	48 (96)	24 (96)	2 (4)	1 (4)	0 (0)	0 (0)
Red meat & products	16 (32)	11 (55)	4 (8)	4 (16)	30 (60)	10 (40)
Nuts & seeds	17 (34)	13 (52)	21 (42)	6 (24)	12 (24)	6 (24)

Association between Dietary Patterns of Red Meat, Vegetables, Fruits and Pulses and Risk of Cancer Development in Meru County

We sought to examine the association between risky dietary patterns ofthe respondents and risk of development of colorectal cancer in Meru County. First, respondents were distributed as either having a risk or not. Respondents with dietary patterns of High red meat intake, low fruit intake, low vegetable intake, and low pulses intake (Table 3) were considered to be at risk of colorectal cancer development. Statistical tests (Chi-square, T-tests, and Odds ratio) were done to identify any link between risky dietary habits of cancer and development of colorectal cancer.

When Chi square tests were performed to examine the relationship between risk dietary pattern intake and colorectal cancer development it was established that there is no significant relationship between the risk dietary pattern intake and colorectal cancer development among the respondents (*p<0.05*).

Similar when odds ratio was done it was established that the odds of developing CRC for respondents with risky dietary pattern of intake was 1.9 times higher than when consuming meat within or lower than the recommendations, while no statistical significance (p<0.05) was observed with risky dietary patterns of pulses, vegetables and fruits.

Table No 4: Association between Risky Dietary Patterns and CRC

Food Categories	Respondents with risky dietary patterns		Respondents with acceptable dietary patterns		χ-test	Odds Ratio	
	NC n (%)	CRC n (%)	NC n (%)	CRC n (%)	*p-value*	Value (95% CI)	
Fruits	20 (40)	14 (56)	30 (68)	11 (44)	0.864	0.916	(0.335-2.501)
Vegetables	17 (34)	9 (36)	33 (66)	16 (64)	0.189	0.837	(0.837-3.05)
Pulses	16 (32)	9 (36)	33 (68)	16 (64)	0.729	0.524	(0.198-1.384)
Red meat	0.31	10 (40)	20 (40)	15 (71)	0.189	1.919	(0.723-5.043)

IV. Discussion

From the above analysis, it emerges that there is a pattern of low intake of white meat, pulse, nuts and seed groups. White meat is consumed at 0.3 servings (9gm) a day with some members of the population consuming no white meat at all. Fish specifically was consumed rarely in this population. There is a low mean daily consumption of pulses (1.5servings), with a majority (72%) consuming pulses below the recommended daily levels of 2 serving (6ogm). Though there a moderate intake of starch staples, fruit, vegetable, milk and milk products, several individuals have cancer risk with almost half (45.3%) consuming below the recommendation of fruit, 34.7% (26) below the required levels of vegetables. Of greatest concern in this population is the high intake pattern of red meat with an average of 5.1 (153gm) and as high as 24.9 (747 gm) servings per day against the recommended 3 servings (90g). More than half of the population (57.4%) was shown to consume meat above the recommendations. There was however no direct association noted between the cancer status and dietary patterns through a chi square-test. The red meat intake among the colorectal cancer patient prior to diagnosis was noted to be significantly high with a mean of 4.8 servings per day. There is however no significant difference in quantity or frequency of daily food intake between the colorectal cancer patients and the control group as shown by the t-test.

Evidence for association of CRC with fruit and vegetables isinconsistent, weak, or inverse which could be due to protective effect of dietary fiber. These findings are in line with findings of (Key, 2010)who concluded that epidemiological studies suggest little or no association between total fruit and vegetable consumption and risk for common cancers; including colorectal cancer. However, in another study, Epidemiologic evidence of the protective effect of fruit and vegetables on cancer risk (Riboli, E, 2003) s concluded that there is a moderate but significantly decreased risk of colorectal cancer with high intake of vegetables and fruit.

There may be several reasons why this study and some earlier studies provide different results. The difference may result from recall bias in this retrospective study. There could also be effects of the various dietary patterns, such that patterns in of foods such as fruit and vegetables which have very varied composition. Other nutrition components such as obesity, alcohol intake, level of activity and smoking which were not assessed in this study may affect the variables of this study, giving a different perspective

According to (Key, 2010) studies have shown that effects of foods cannot be analyzed separately and conclusions made as nutrients in different foods have effects on each other. He concludes that diet should include the recommendation to consume adequate amounts of fruit and vegetables, but should put most emphasis on the well-established adverse effects of obesity and high alcohol intakes.

The estimation of portion size and frequency of consumption of a wide range of specific foods is rather difficult, and misclassification of any food may result in bias of the relative risk estimate toward the null value(Riboli, E, 2003). In a situation in which the association between any single dietary component and cancer might be relatively weak, the empirical relative risk estimates will be even weaker because of random measurement error, and the failure of a cohort study to show an association with disease may not negate an important relation.

Moreover, some studies suggest that people who eat a diet low in fruits and vegetables may have a higher risk of colorectal cancer (Martinez, M. E, 2008). Other studies have attributed risk reductions up to 26% to high intakes of vegetables and fruits (Key, 2010). Other data on cancer incidence in different populations suggests that a 20% increase in vegetable intake above the recommended would result in a 20% decrease in cancer incidence in a particular population and a higher intake would beget even greater benefits (GLOBOCAN, 2012).

Since nutritional principles indicate that healthy diets should include at least moderate amounts of fruit and vegetables, moderate pulses, and moderate meat intake, it is still possible that there is risk associated to high risk dietary patterns identified. Therefore, one cannot discard the possibility that the lack of association could be indicative of a lack of statistical power of the study because of random error in the measurement of diet and not because of a lack of biological association. There could thus be benefits in this populations with low and average intakes of pulses, fruit and vegetables, such that that increase in fruit, vegetable and pulses, nuts and seeds intake may result to lower incidence of cancer cases.

High meat consumption has been implicated in the development of colorectal cancer (World Health Organization, 2015). The pattern of meat consumption identified in this study is high red meat consumption with low red meat consumption resulting to averages of moderate consumption of total meat in the population.

The findings of high red meat intake in a population where cancer is on increase is in line with earlier findings where around a quarter of bowel cancer cases in men, and around a sixth in women, are linked to eating red or processed meat. Bowel cancer risk has been shown to increases by more than a quarter (28%) for every 120g of red meat eaten per day (Parkin, D M, 2015) People who eat more than 90g (cooked weight) of red and processed meat a day should cut down to 70g or less (Sanchez, R C, 2014).

This again is in line with findings in International correlation studies which shown a strong association between per capita consumption of meat and colorectal cancer mortality. In a review of meta-analyses of prospective epidemiological studies of Red Meat and Colorectal Cancer (Aykan, 2015)analysis shown that red meat and processed meat convincingly increases CRC risk by 20-30%. Beef and pork consumption was found also to be associated with colon cancer in women, in one trial. The study also recommended amount of red meat for healthy people to be 500 g/week or 70 g/day which is about 2.4 servings of 30g per day and intake of processed meat.

Though this study show no association between high red meat consumption and development of colorectal cancer, the findings do not necessarily mean that there is no risk attached to high red meat consumption. As cited earlier, one cannot discard the possibility that the lack of association could be indicative of a lack of statistical power of the study because of random error in the measurement of diet and not because of a lack of biological association. The number of respondents was also small. There could thus be benefits in this population with high red meat intake such that increase in white meat and nuts and seeds intake and reduction of red meat intake may result to lower incidence of cancer cases.

In past studies there is no strong evidence that eating white meat, such as chicken, can increase colorectal cancer risk (Gingras, D, 2011). In another study, it is indicated that fish consumption have reduced risk for colon cancer, and that poultry consumption is associated with lower risk of rectal cancer (Ngohc, 2014). With these findings, this study recommends an increased intake of white meat in order to reduce the red meat and thus reduction of CRC risk for Meru county residents.

V. Conclusions

The study revealed that dietary patterns of Meru County residents includes high intakes of red meat,moderate intakes of fruits, vegetables, and starch staples, and a low intake of pulses, white meat, and milk products. Overall, we conclude that the dietary pattern of CRC and Non-CRC respondents was not statistically different. Inasmuch as decreasing the risk of CRC includes increased plant food intake, the consumption of whole grains, vegetables and fruits; and reduced red meat intake is recommended. However, robust studies should be undertaken to determine possible causes of CRC in Meru and its environs as well as how diet modulates the risk of developing colorectal cancer.

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Grace Safari1.. “Dietary Patterns are not associated with Colorectal Cancer Etiology: A case study of Meru County, Kenya” IOSR Journal of Nursing and Health Science (IOSR-JNHS) , vol. 7, no.5 , 2018, pp. 80-85.