The Role of Nutrition in Cervical Cancer

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Abstract

Background: Cervical cancer (CC) is the fourth most common type of cancer among women, even though it is preventable. The World Health Organization (WHO) estimated that 570,000 new cases would occur in 2018 (WHO, 2019). Programs put in place include effective detection through early screening for prevention and effective treatment options for the elimination of CC.

Method: A systematical search through independent searches from MedLine, CINAHL, Web of Medicine, Google search engine, and ProQuest dissertation database was performed for eligible articles. Quality was determined through peer-reviewed articles from reputable journals.

Results: An initial search resulted in the identification of a total of 447 published articles. However, only 15 articles were eligible for the study. Preferred articles were no more than five years old. The role of consuming whole foods plant-based foods in CC is "constitutional" due to the CC etiology that is complex, multistage, and multifactorial. Effective CC elimination requires the reduction of risk factors, mainly smoking, as well as an increase in protective factors like early screening, nutrition combined with physical activity, which requires a lifestyle change. Environmental factors and healthy behaviors were more significant than family history.

Conclusion: A holistic clinical trial for a more conclusive contribution is the next best level. The use of sophisticated epidemiology methods for screening, causal prevention, and management that incorporates proper nutrition is significant in the fight to eliminate CC.

Keywords: Cervical cancer, role of nutrition, prevention, healthy behaviors, nutrition.

Introduction

Cervical cancer (CC) has unfortunately remained one of the leading causes of death around the world, and as it stands, it is the fourth most frequent cancer among women representing 6% of all cancers among women. WHO estimated 570,000 new CC cases for the year 2018 (2019). The burden of this disease is heavy on low- and middle-income countries, where 90% of the deaths occur as a result of CC. Early detection through effective screening, prevention, and treatment are strategies to eliminate CC, and while vaccinations are available to reduce the risk of disease, CC incidences and mortality persist.

According to the American Cancer Society (ACS) (2019), CC is caused by human papillomavirus (HPV), which produces two proteins, namely E6 and E7. These two proteins cause the tumor-inhibiting genes to shut off the cell activity in the body. The DNA mutation that causes genes to defect from healthy cell growth allows for the cervical lining that permits for tumors that have abnormal cell overgrowths, and this process could lead to cervical cancer. Most women with positive HPV infection do not develop CC. There are as many as 150 different types of HPV, with most being low risk and not a causal factor for CC. Seventy percent of CC is associated with high-risk HPV types, namely the HPV-16 and HPV-18 (NCCC, 2019). CC develops over a long period, making it the most preventable disease.

The risk factors associated with CC in addition to HPV developing into CC include Human Immunodeficiency Viruses (HIV) infection, which weakens the immune system. Smoking, which has many cancer-causing chemicals increases the risk by transporting the harmful substances to parts of the body, like the cervix increasing the risk for CC. Smoking has been noted to increase the chances of high-risk HPV infection, and smoking intensity has been associated with CC increase (Chatzistamatiou et al., 2018). Other factors that increase the risk for CC are chlamydia infection, low diet in fruits and vegetables, being overweight, a long term use of contraceptives especially the Intrauterine device (IUD) uses, having many full-term pregnancies, being younger than 17 years during the first full-term pregnancy, economic status, Diethylstilbestrol (DES) and family history of CC (ACS, 2019).

In Kenya, CC is the highest type of cancer among women aged 15 to 44 years old, according to Bruni et al. (2017). The Kenyan Network of Cancer Organizations (KNCO) recognizes cancer as the third-highest cause of morbidity in Kenya, after infectious diseases, and cardiovascular diseases (2018). CC is the leading cause of female deaths, with approximately 3,286 deaths annually and 5,250 new cervical cancer cases diagnosed annually as of 2017 estimates Bray et al. (n.d.). Although vaccines are available to prevent HPV types 16 and 18, their effectiveness has not been documented in Kenya (Bruni et al., 2017). Furthermore, only 10 % of women of reproductive age in Kenya have received screening in Kenya.

Some of the challenges in Kenya against the fight for CC include: the fact that although there is screening availability more than ever before screening barriers exist due to but not limited to: stigma, young male doctors not culturally acceptable to conduct

screenings of womens' reproductive organs, fear of speculum causing infertility, spousal disapproval, non-accessible services that include transportation access and cost, screening embarrassment, religious/cultural believes (Korir, Okerosi, Ronoh, Mutuma & Perkin, 2015).

A huge barrier is access to health services. In 2007/2008, the Kenyan government allocated 8.4% of its national budget to health, which translated to $8.30 per capita annually for each citizen. The National Health Insurance Fund (NHIF) is the insurance available for Kenyans, and the fees range from USD $2 to USD $25 per month. Unfortunately, less than 10% of the Kenyan population is enrolled, and although these numbers have improved through the years, there are huge growth opportunities in this area. The NHIF enrollment takes about two months to take effect, and for a patient diagnosed with cancer, this time can be critical (Strother et al., 2013).

With the Kenya government taking notice of the high rates of cancer, and addressing the limited resources of cancer registries, with women not aware of symptoms and risk factors, hence not participating in screening, and most diagnosis occurring in late stages (Wamburu, Busakhala, Owuor, & Nyagero, 2016), the current study is very important to the Kenyan population, as a means to establish next best steps. This study will not focus on Kenya alone, but more from a broad perspective, with information generic enough to be locally relevant in most populations, including the Kenyan people.

Scientists are now looking into risk factors and protective factors. The role of CC prevention is to reduce known risks, and the incidence of the disease (Aldohaian, Alshammari & Arafah, 2019). Early screening remains one of the best chances of prevention for CC. Increasing protective factors decrease the chances of developing CC. Such protective factors include but are not limited to HPV vaccination and avoiding unsafe sexual activity (National Cancer Institute (NCI), 2018). The Pap-smear test has been used for many years for HPV screening and found to be effective, and now it can be paired with HPV testing for those with a known higher risk (ACS, 2019). This method requires highly trained personnel and is a costly procedure for many. Another technique used in developing countries, and in Kenya, is the Visual inspection of the cervix with an acetic acid application.

This study recognizes that although there has been a tremendous amount of work in the prevention of CC, to date, there has not been a study on the role of nutrition in the prevention of CC from a systemic review viewpoint. The purpose of this study is to explore the role of nutrition in CC in its prevention. The results can be shared with others to integrate into the risk reduction, and protective factors increase against the CC fight (Del Cornò, Donninelli, Conti & Gessani, 2017).

The Study

A search was conducted through the database in MedLine, CINAHL, Web of Medicine, and Google for eligible articles. ProQuest dissertation database was also used for appropriate dissertations on this topic. The years of interest were 2014 to 2019, and since it was difficult to locate appropriate articles, some articles maybe a little older than that. The initial results yielded a total of 447 published articles. When the dates were adjusted to no more than 5-year-old articles, the total went down to 161. Of these, about 6 articles were located from the National Institute of Health (NIH) repository for research and training. Further narrowing of articles by reading abstracts yielded 33 articles, and among these, only 15 were used. Some are older than 5 years, but within the 10-year limit due to scarcity of specific content on CC and nutrition.

Study Selection

Articles that were included addressed nutrition and cancer (including other types of cancer like breast, colorectal, prostate, colon, and lung to name a few). Articles were also included if they addressed CC and some type of food as a means of prevention against cancer. The research that did not include full text was excluded, but some with really cutting-edge information was used to ensure this systemic review was up to date. These articles will not be included in the discussion for methodology and theory, but more on the introduction anddiscussion sections. Many of the articles found were systemic reviews, a few experimental, and a few on cross-sectional study designs. Most articles had a quantitative design. The key terms used for the search of the study selection included the role of nutrition, cervical cancer, healthy behaviors, nutrition, and prevention.

Findings

Theories

Causal Model Theory discussed by Campbell part 1 and 2 (2017) to assess the impact on nutrition knowledge on the theory of disease as a follow up on historical knowledge. The author advocates for the overall consumption of whole foods for less cause of CC.

Social-Ecological Model as used by Chih, Lee, Colville, Binns, and Xu, 2013), Davies, Batehup, & Thomas, 2011). Watson, Soman, Flagg, Unger, Deapen, Chen, . . . Saraiya, 2017), Su, Qin, Xue, Wei, Guan, Jiang, . . . Yu, 2018), both for behavior and including environmental attributes in a way that comprehensively conceptualizes determinants of health.

Theory of practice of clinical trials and in vitro discussed by Chatzistamatiou, Moysiadis, Vryzas, Chatzaki, Kaufmann, Koch, . . .and Agorastos (2018), and Mahata, Pandey, Shukla, Tyagi, Husain, Das and Bharti (2013), Spagnuolo, Flores, Russo, & Ruiz Del Castillo, 2016), Wei, Fried, Li, Hu, Gao, Zhang, & Xu, 2018) Zhang, Wang, Lv, & Huang, 2016) used to account for antigen properties predictions and reactions.

One article used the structural and social determinants of health framework as discussed by Park, Kim, Yang, Lee, and Park (2018) and used as a policy/change-oriented framework to design policies that intervene where a gap exists in the eradication of health inequities.

Machine learning theory used by Clarke, Cheung, Castle, et al., 2019) and Hu, Bell, Antani, Xue, Yu, Horning, . . . Schiffman, 2019) to develop a deep learning algorithm that recognizes CC and discovers the importance of reproduction of efficiency.

The health belief model as used in one study conducted by Aldohaian et al. (2019) in their examination of women's beliefs regarding pap smear and its connection to CC. The theory was also used to evaluate how socio-demographic and cervical cancer was related. Although a high perceived susceptibility, vaccination, and early detection yielded a high perception level in terms of motivation and benefits of early screening, this did not translate into practice. This study showed a high level of perception regarding benefits and motivation, and a low incidence of perceived barriers among women regarding cervical cancer screening. Ignoring nutrition as a factor in the cause of disease scientifically proven before 1940 has confused the present status on the cause, prevention, and treatment of disease.

Study Methods

The current study discovered that a multi-methodological approach was utilized by researchers to understand the role of nutrition in CC from several critical angles that included understanding the etiology of cancer, to a historical perspective on food in prevention, causation, and treatment of disease including cancer. The methods used were crucial in the assessment of different conceptual frameworks and theories discussed above. The primary research methods identified included three cross-sectional studies, one prospective and one retrospective study, six systemic review studies, with one meta-analysis study, one prospective cohort study, one population-based longitudinal cohort study, and two experimental studies.

Three main themes emerged in the results of this systemic review. There were articles on nutrition, prevention significance in early screening, and smoking as a risk factor. The themes were linear with the need for reducing risk factors and increasing protective factors, crucial for a holistic view of cancer that offers better outcomes for public health. This study shows that nutrition plays a significant role in CC prevention, and food has a crucial role in the treatment of cancer, factors that can determine survival. However, it is important to note that nutrition is one factor that does not represent the whole picture of the complicated cancer etiology and management. The following were the main findings organized by the themes that emerged in the current systemic literature review.

Role of Nutrition

Cancer has been thought of as a genetic disease, but information on its epigenetic abnormalities that alter genetics has come to light (Zam & Khadour, 2017). Cancer progresses in three stages, i) Initiation of a carcinogen into the body; ii) Initiation forms cancer-prone tumors that can either be reversed or promoted; iii) Metastasizing, or the breaking of cells from their original home and spreading, causing death (Campbell & Campbell, 2016). Food has been known to prevent, slow, or even reverse disease. Food can be both a risk reduction and a protective factor. Alteration of cellular signaling is by epigenetic changes associated with food that is high in fat, of high-calorie intake, as well as bioactive nutrients and whole foods plant-based derivatives. Consumption of red, processed meat and animal fat increases disease risk (Del Cornò, Donninelli, Conti & Gessani, 2017). A low-fat, high fiber diet could be protective against cancer promotion, growth or recurrence. Reducing animal protein from 20% to 5% has resulted in a 72% reduction in DNA binding, a 68% decrease in chromatin binding, and a 66% decrease in protein binding (Campbell & Campbell, 2016).

Cells in the body can identify proteins not needed in the body and destroy these, and this task can be accomplished effectively and timely. When unwanted proteins remain in the body for a long time, they are disruptive and defective. The consumption of proteins that the body can use is essential, and this seems to agree with the consumption of plant-based protein that the body can digest and easily assimilate. The proteasome is the system that the body uses for this process, and when this process is faulty, immune disorders, developmental disorders, cancer, and neurodegenerative diseases occur. Tumor cells cause proteasomes to work overtime to remove unwanted

proteins, and cancer highly depends on this process (NIH, n.d.).

Campbell, T. C. (2017a and b) in a systemic review study design was able to eliminate flaws and limitations from previous research in a way that revealed that the nutrient issue is significant enough in the fight against cancer. The consumption of whole foods was an essential aspect of Campbell's findings and advocacy. Historical research has identified nutrition as a great way to prevent and treat diseases, including CC. The China study conducted by the author in rural china in experimental design was able to show the importance of consuming plant-based proteins as opposed to animal proteins. (repeated in the previous page)

In a systemic review design, Chih, Lee, Colville, Binns, and Xu (2013) were able to demonstrate the benefits of eating a lot of whole nuts, fish, fruits, and vegetables in a way that combined results to clear controversies on whole food consumption. When these items were not consumed, especially whole dark green vegetables, dark orange, and dark yellow with a combination of cruciferous vegetables, tofu, yogurt, fruits, and whole meats, there was no protective action against the HPV infection or CC persistence. The authors did not have the benefits of a clinical cohort trial. However, the participants in the studies chosen were a representative that allowed for evidence of chemical reactions that showed the reduction of the risk for carcinogens in human cells.

In addition to nutrition, physical activity that reduces body weight reduces disease risks (Davies, Batehup & Thomas, 2011). These authors were able to combine systemic review results to show the importance of diet and physical activity and their association with cancer improvement in recurrence and progression. The study was limited in the types of cancer literature available, and the authors were not able to clearly define weight versus diet outcomes and differences. Due to the unavailability of many published data on cancer recurrence and events, it was hard to show mortality rates that were cancer-type specific. The samples were also small in the studies, with few mentioning physical activities.

From a systemic review, Soundararajan and Kim (2018) were able to combine the benefits of cruciferous vegetables like broccoli, cabbage, kale, Brussels sprouts, and show their effects against cancer. The authors were able to offer heterogeneity identification between different types of cancer from different studies in a way that explained how these vegetables reduced carcinogenic effects at the cell level of different types of cancers.

A well-grounded cross-sectional study based on clinical information providing an assessment of the hypothesis of suspected risk Speckle-Type Poz Protein (SPOP) and its risk effect on cancer tumor growth was identified (Wei, Fried, Li, Hu, Gao, Zhang, & Xu, 2018). The authors used a pathological setting to present a mini-review discussion to detail SPOP's role in genomic stability. Although a direct relation to CC was not made, SPOP affects many types of cancers, and the etiology of tumor development and unwanted protein effects on the body was significant.

An experimental study used by Mahata, Pandey, Shukla, Tyagi, Husain, Das, and Bharti (2013) set out to investigate the effect of fruit extract (Indian Gooseberry) and the impact on High Risk-HPV type 16 and type 18, and the authors were able to show a strong presence of anticancer activity at the cellular level by the fruit extract. The study was the first of its kind without further investigations.

Another experimental design by Spagnuolo, C., Flores, G., Russo, G. L., & Ruiz Del Castillo, M. L. (2016) enabled the authors to control exposure by pretreating pre-harvested strawberries with methyl Jasmonate (MeJA) and ethanol (EtOH) in a random assignment for its effect on cancer cells to show that strawberry fruit has a positive effect on protective ability against CC. Although the study results were from an animal trial, it was essential to note strawberry extracts are effective on human CC cells in comparison to other cancer preparations due to the fruit's significant ability to inhibit cell growth.

Preventive Screening

As stated earlier, the perception of early screening did not match adherence in a cross-sectional study by Aldohaian, Alshammari, and Arafah (2019). However, the sample of women used was from an urban city with a high concentration of highly educated women, using self-administered adjudication with recall bias.

In another cross-sectional study, health problems associated with poor nutrition, trauma, exposure to infectious diseases drew attention to the specific needs and risks of immigrant women in Korea among the North Korean Defectors (NKD) and South Korean Natives (SKN) by identifying that CC screening rates for SKN was significantly higher compared to NKD, especially for married women aged 30-39 years (Park, Kim, Yang, Lee, & Park, 2018). However, causality, level of income for analysis, length of immigration status could not be determined, nor could recall bias be ruled out.

In examining the surveillance of high-grade CC precursors, in a retrospective study, Watson, Soman, Flagg, Unger, Deapen, Chen, . . ., and Saraiya (2017) used a large population from secondary databases to unveil the burden of CC for assessment of the impact of cancer prevention and control programs implemented, finding that rates of cervical cancer varied by the registry. Limitations that included

screening and vaccination history were not available, making it hard for the authors to determine the proportion that declined from the observations concerning the screening practices that had changed or from the HPV vaccination effects. The states included in the study did not have a uniform way of coding CC, and hence, it was hard to examine the trends of each state, except for Michigan State, which had consistent data. Although the data available in the registries was population-based, race and ethnic information were not available, making it impossible for detailed outcomes.

A new deep learning-based visual evaluation algorithm has been created to automatically recognize CC and pre-cancer cells by Hu et al. (2019). In a population-based longitudinal cohort study, the authors used a poorly previously screened population sample identified as HPV positive in low and middle-income countries for a repeat screening with an available excellent follow-up triage of positive women (11% of the total 9406 women aged 18–94 years as followed in Guanacaste, Costa Rica). One hundred twenty-seven women, out of 228 aged 24 to 49 years were diagnosed cumulatively. The screening method was found to be more accurate with the automated visual evaluation of cervigrams with a 95 % confidence interval as compared to the original cervigram interpretations. The goal of the authors was to create a "deep learning" algorithm that was visual and deep learning that could recognize CC.The authors were able to show support for consideration of digital cameras for the automated visual evaluation of cervical images for effective CC screening not dependent on highly trained, costly professionals, not easily accessible to most low-income populations. Although the sample number was small and from a single cohort, the results indicate potential benefits to utilize more groups from different parts of the world. The pictures/images taken were done on the film technology that was not digitized, indicating the potential to be realized in modern digitalized camera technology.

Cigarette Smoking

In a prospective study design that examined how cigarette smoking promoted cervical cells, the authors were able to use available data from the PIPAVIR project on 1,473 women aged 30–60 years to tailor it to assess women who smoked and found them to be more prone to CC than women who did not smoke. This study was easy to read, but not without limitations like the long period needed to elapse for smoking effects to occur and that CC progresses very slowly, and the time for the two to be determined associated is lengthy (Chatzistamatiou, Moysiadis, Vryzas, Chatzaki, Kaufmann, Koch, I., . . . Agorastos, 2018).

A systemic review, distinguished as a meta-analysis as well, was used by Su, B., Qin, W., Xue, F., Wei, X., Guan, Q., Jiang, W., . . . Yu, S. (2018). The authors were able to include cohort studies from fourteen studies with a total sample of 384,995 participants. The meta-analysis was able to show a significant association of passive smoking and increased risk of cervical cancer. Due to the use of the self-reporting method of collecting data, recall bias could not be ruled out. The authors were also not able to tell the impact of the changes caused by smoking on follow up because that information was not available.

Discussion

The consumption of whole fruits, vegetables of different deep colors, tofu, fish, meat, a variety of cruciferous vegetables decreases the risk of CC. Consuming strawberries infused with balanced MeJA and EtOH gives an increased antiproliferative and antioxidant activity on malignant cells (Spagnuolo, Flores, Russo, & Ruiz Del Castillo, 2016). Consuming the Indian Gooseberry has been associated with strong anti-cancer activity (Mahata, Pandey, Shukla, Tyagi, Husain, Das, & Bharti, 2013).

Consuming foods rich in vitamin A and retinol, calcium in a bioavailable form, antioxidants, and healthy fatty acids reduces in situ CC significantly (Chih, Lee, Colville, Binns, & Xu, 2013). Cruciferous vegetables contain Glucosinolates, which is an anti-carcinogenic agent and has an antagonistic effect in preventing cancers (Soundararajan & Kim, 2018).

The malfunctioning of critical cellular processes has a clinical impact on cancer outcomes (Wei, Fried, Li, Hu, Gao, Zhang & Xu, 2018). Useful diet guidance includes the reduction of foods high in sugar, fat content and an increase in the consumption of plant-based whole vegetables and whole grains. The results indicate the recommendation in the reduction of consuming moldy cereals, high salt foods, and processed meats. Obesity is a modifiable risk factor, and following the diet guidance with the addition of physical activity is excellent for symptoms related to treatment and can lead to cancer survival (Davies, Batehup & Thomas, 2011).

The family history of CC is still perceived as the most dangerous risk especially among the less educated women and Pap smear testing is still low despite the perceived seriousness of the disease (Aldohaian, Alshammari & Arafah, 2019). The possibility of an additional more effective method of screening especially in low-to-medium income countries is revolutionary via an automated visual evaluation that can identify high-risk HPV that could result in CC within a specified time frame (Hu, Bell, Antani, Xue, Yu, Horning, . . . Schiffman, 2019). The impact of cancer prevention programs, using data from Louisiana, Kentucky, California, and Michigan cancer

registries, showed a reduction of new cases for women aged 15 -19 years old by 37%, 20- 24 years old by14% and 7% for those aged 25-29 years old. (Watson, Soman, Flagg, Unger, Deapen, Chen, . . . Saraiya, 2017).

Smokers who were high-risk HPV positive had an increased possibility for E7 positive testing results as opposed to non-smokers (Chatzistamatiou, Moysiadis, Vryzas, Chatzaki, Kaufmann, Koch, . . . Agorastos, 2018). Passive smoking was associated with a high risk of cervical cancer (Su, Qin, Xue, Wei, Guan, Jiang, . . . Yu, 2018).

The strengths of a systematic review also referred to as meta-analysis, is a means to provide a cost-effective way of reviewing the literature to avoid wasting time and money on topics already done. Systemic reviews offer a study design that eliminates flaws and limitations of previous research findings, enabling resilient information outcomes (Impellizzeri & Bizzini, 2012). The author was able to allow for the combination of the results of prior studies for a more conclusive estimate of current status, and in so doing, clarifying research controversies while offering information that can shape policy in a cost-effective study (Medtrain, 2008). Systemic reviews also guide future studies by identifying gaps, and the author of this current study was able to do just that. The author presented heterogeneity identification between studies, primarily when conducted at an individual level resulting in a comprehensive analysis. The singling out of strawberries and Indian Gooseberries gave insight to the different fruits but added significantly to the whole systemic review (Spagnuolo, Flores, Russo, & Ruiz Del Castillo, 2016) and (Mahata, Pandey, Shukla, Tyagi, Husain, Das, & Bharti, 2013). Key participant characteristics can be differentiated hence contributing considerably to the field of study. According to Shamseer et al., systemic reviews are here to stay as they provide protocol guidance for the particulars of systemic reviews (2015).

Limitations of this systemic reviews include selection and data bias, mainly because participants are different in the studies that are reviewed (Aschengrau & Seage, 2014). Publication bias occurs due to the non-publication of studies that do not find statistically significant results. Overrepresentation of statistically significant or positive results (Moher et al., 2007) can occur. More specifically, there were not many studies done on the role of nutrition in CC, although the disease was referenced as part of the other types of cancers mentioned. The author found it necessary to maintain focus to provide a coherent systemic review due to the overwhelming studies in the literature with competing priorities. Using a well-detailed outline is recommended.

Policy Implications

Clear policies that advocate for whole foods and plant-based foods as part of the cause, prevention, and treatment of CC cannot be underscored, and medical schools must adjust their education of physicians and medical professions to include this information in the curricula (Campbell, 2017). This study has demonstrated several studies that stipulate the significant role played by the nutrition of plant-based whole foods in the reduction or prevention of CC. Initiatives that include healthy eating and make healthy food available cannot be emphasized enough. Physical activity that is combined with nutritional efforts can improve health outcomes.

There is a need to educate women in an easy to read/understand the culturally appropriate campaign. Such a campaign needs to include information on reducing risk factors as well as ways to increase protective factors in the fight against CC. The media must be involved to make this campaign more widespread (Aldohaian, Alshammari & Arafah, 2019). Policies that advocate for smoking cessation must be put in place, especially in low and middle-income countries, to protect women from second-hand smoke. In developing countries, smoking cessation programs among women determined to have high-risk HPV could help to advocate for health and wellness.

Recommendations for Future Research

With such a clear uncovering of the fact that the role of nutrition has been well documented and that physical activity to reduce obesity is significant, recommendations for future research include the following:

a) Epidemiologic, clinical trials that uncover the cellular level benefits of whole food and plant-based foods with well-structured design to confirm the relationship (Campbell, 2017)
b) Longitudinal studies that help to assess the long-term pre-cancer risks (Clarke, Cheung, Castle, et al., 2019).
c) Studies that explore how obesity relates to CC survivorship (Davies, Batehup, & Thomas, 2011).
d) Studies that leverage technology and sophisticated epidemiologic methodologies in the fight for CC, especially in low and middle-income countries like Kenya (Hu, Bell, Antani, Xue, Yu, Horning, . . . Schiffman, 2019).
e) A study on how smoking is not related to the probability of E7 patterns increase
f) Tailored interventions for immigrants (Park, Kim, Yang, Lee, & Park, 2018).

g) Sophisticated genomic studies to examine how Isothiolyanates (ICTCs) regulates Cancer cells with signaling (Chatzistamatiou, Moysiadis, Vryzas, Chatzaki, Kaufmann, Koch, . . . Agorastos, 2018).
h) A study on how to link race/ ethnicity and vaccination and screening information on CC registries (Watson, Soman, Flagg, Unger, Deapen, Chen, . . . Saraiya, 2017).

Conclusion

The role of nutrition was found to be overwhelmingly beneficial in the reduction of risk factors for increasing prevention/protective factors and incorporation in management for sustainable survival. Whole foods, plant-based foods, in combination with other healthy behaviors, requires a lifestyle change that involves smoking cessation strategies, physical activity for the reduction of obesity, as well as general health and wellness. CC is preventable, and to this end, must be tackled from an individual level, as well as a community and societal levels. It was evident that lifestyle factors are more important than family history, as are environmental factors in the elimination journey of CC. Several recommendations were made for future research and for public health policies in a way that best directs lifestyle changes before cancer begins.

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