Female Prevalence of Breast Cancer: An Evolutionary Perspective

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***Abstract*— The global prevalence of breast cancer reflects a profound mismatch between the evolutionary adaptations of ancestral humans and the modern lifestyle practices of contemporary society. This discrepancy is evident in the alteration of reproductive patterns and lifestyle factors, such as earlier onset of menarche, increased ovulatory cycles, shorter lactation periods, late menopause, nulliparity, decreased physical activity levels, higher adiposity, and consumption of processed foods. These modern influences have led to unprecedented levels of estrogen exposure in women, contributing to breast cancer risk. Comparisons between traditional and modern women underscore the significant increase in menstrual cycles and reproductive cancers in the latter group. This evolutionary mismatch, characterized by changes in reproductive and lifestyle factors, poses a significant risk for the development of breast cancer in modern women.**

***Index Terms*— Breast Cancer, Evolutionary Mismatch, Lifestyle Factors, Reproductive Patterns.**

I. Introduction

Homo sapiens and their ancestors have lived in several evolutionary environments over the last 4 million years. Ancestral humans had adapted to their environments through various selective forces such as natural selection, mutation, gene flow and genetic drift. Due to long human adaptation to the past our current genome is now being exposed to novel societies and lifestyle practices which are different to how human ancestors lived during the last 2 million years. In other words, culture has outpaced our biological capacity to new lifestyles, new diets etc. Consequently, modern humans are having increasing amounts of non-communicable or "lifestyle diseases" due to this mismatch between how human ancestors lived and how current humans are living.

Nowhere is this mismatch better exemplified than in the global prevalence in breast cancer. Many modern nations have deviated from older and adaptive reproductive patterns, and that this departure has altered the rate of ovarian epithelial carcinoma in breast tissue and other female reproductive structures (Kossman et al. 2011; McPherson et al. 2000; Rossouw et al. 2002; Nelson et al. 2002; Mense et al. 2008).

It has been argued that there are a number of modern lifestyle factors which are contributing to estrogen induced breast cancer such as earlier onset of menarche, excessive ovulatory cycles, altered reproductive patterns, shorter lactation period, late menopause and nulliparity, decreased physical activity levels (PAL), higher female adiposity and increasing intake of processed foods (Kossman et al. 2011; McPherson et al. 2000; Rossouw et al. 2002; Nelson et al. 2002; Mense et al. 2008). These changes have, subsequently, increased the amount of the hormone estrogen exposure in modern women to unprecedented levels. For instance, increased estrogen exposure to epithelial breast tissue increases cell proliferation and mutagenesis (Russo & Russo 2004; Anderson et al. 1989; Eaton et al. 1994). Furthermore, it is well known that breast epithelial cells are receptive to carcinogenesis, especially where this involves alterations in endogenous estrogen levels (Key et al. 2002; Travis & Key 2003).

II. Material and Methods

A comprehensive search was conducted in the Google Scholar, NCBI, and PubMed databases to identify relevant studies about the topics of Evolution, Lifestyle Factors, and Breast Cancer. The search strategy included keywords related to these topics and was conducted up until March 11, 2023. Studies were included if they investigated the relationship between evolutionary factors, lifestyle choices, and the risk or incidence of breast cancer. Both completed and ongoing studies were considered for inclusion. Studies were excluded if they did not directly address the relationship between evolution, lifestyle factors, and breast cancer, or if they were not available in English. Key findings related to the relationship between evolutionary factors, lifestyle choices, and breast cancer risk were summarized and analyzed.

Ethical approval was not required for this review as it involved the analysis of existing literature and did not involve direct interaction with human participants.

III. Incidence and Mortality Rates of Breast Cancer

Variations in the lifetime risk of breast cancer among different countries and ethnicities are attributed to exposure to distinct risk factors. Figure 1 (A) displays the lifetime risk of

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breast cancer for women across various age groups in the United States (U.S.) demonstrating differences compared to women in developing nations (Francies FZ, 2020).

Breast cancer in economically developing continents, including those in Africa, Asia, and Central America, exhibit low incidence rates but high mortality rates, in contrast to developed countries like Western Europe and North America, where the incidence is high, and mortality is low. Limited resources, poor access to cancer screening and prevention programs, and challenges in controlling environmental factors contribute to this discrepancy. Despite the lower incidence, approximately 60% of global breast cancer-related deaths occur in economically developing nations, such as Brazil. Figure 1 (A and B) illustrate the patterns observed in global breast cancer incidence and mortality rates (Francies 2020).

IV. Comparison Between Traditional and Modern Women

A comparison between traditional and modern women provides an important point of analysis. Women in traditional hunting/foraging societies where living patterns are closely aligned with the cycles of nature, and with few technological devices tend to have menarche at an older age than in modern societies. Eaton et al. (1994) have noted that in traditional societies girls have menarche at approximately 16 years of age which is consistent with the menarcheal age of females in 19th century western societies. This is in contrast to many developing societies where menarcheal age has been steadily declining with a current mean menarche onset of 12.5 years of age (Cabanes et al. 2009; Canelón et al. 2020). The average age of menarche in females since the 19th century western societies has declined from 17 years of age to 12 years of age (Karapanou and Papadimitriou 2010; Ramraj et al. 2021; Bajpal et al. 2023). It has been argued that the trend in the decline in menarcheal age has increased the risk of several physiological and psychological disorders such as delinquency, diabetes, obesity cardiovascular disease and breast cancer (Yoo 2016; Ramraj et al. 2021). Additionally, it has been speculated that many modern women have approximately 400 menstrual cycles during their lives, whereas women in the past could expect to have had around 40 menstrual cycles due to multiparity, extended lactation, as well as, later onset of menarche and earlier menopause (Short 1976; Critchley et al. 2020).

Such a significant increase has altered selective pressures leading to approximately 400% excess estrogen in modern women with subsequent increase in reproductive cancers. A comparison between Malian Dogon women (traditional group) and American women indicates that the former experience only 100 menstrual cycles in their lifetimes while the latter have approximately 450 menstrual cycles, making them 12 times at more risk for developing breast cancer (Eaton et al. 1994; Strassmann 1997).

Conclusion

In conclusion, reproductive and lifestyle factors in women in developed and developing countries represent a mismatch in relation to reproductive patterns of ancestral and traditional women. Generally speaking, modern women have a significantly higher number of menstrual cycles, nulliparity and fewer children. Furthermore, modern women have higher levels of adipose tissue, eat more processed foods and have decreased PAL than traditional women. Higher PAL is correlated in reducing estrogen and progesterone in premenopausal women, thereby reducing the risk of breast cancer (Kossman et al. 2011). Thus, the current 'evolutionary mismatch' is likely to continue to deleteriously affect female health and serve as a major risk factor in developing breast cancer.

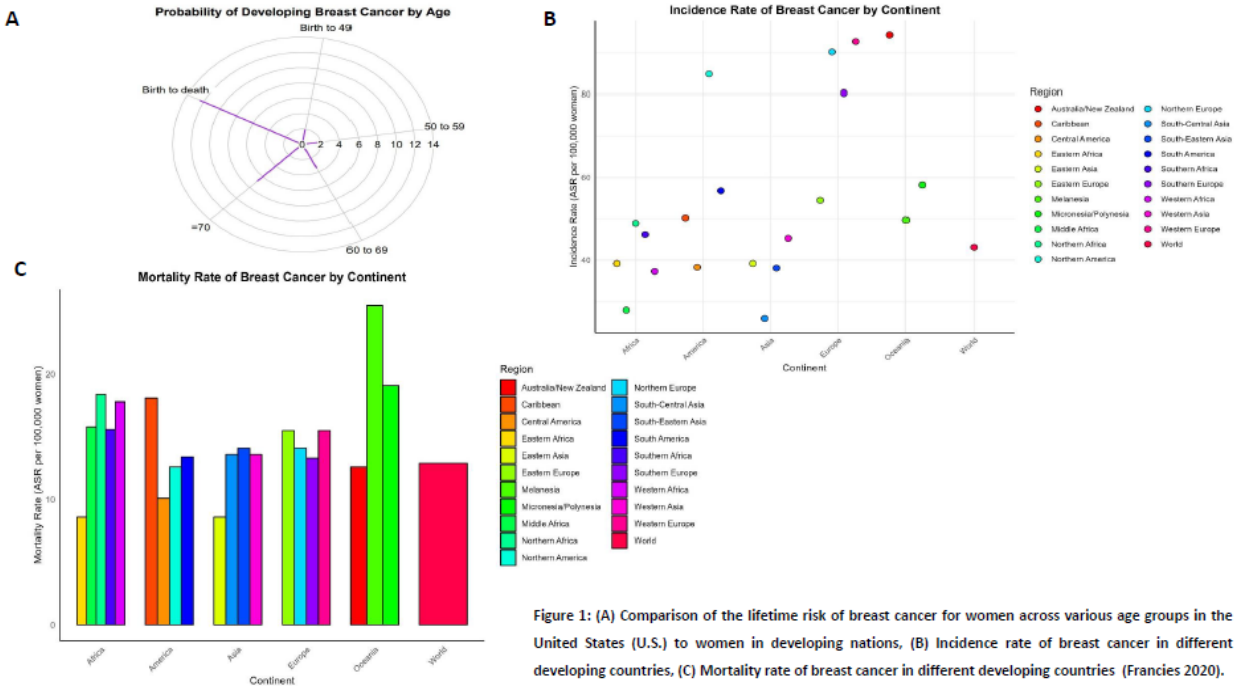

Figure 1: (A) Comparison of the lifetime risk of breast cancer for women across various age groups in the United States (U.S.) to women in developing nations, (B) Incidence rate of breast cancer in different developing countries, (C) Mortality rate of breast cancer in different developing countries (Francies 2020).

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