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THE RELATIONSHIP BETWEEN OBESITY AND BREAST CANCER AMONG WOMEN OF PUNJAB, PAKISTAN

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Abstract

The increasing trends of obesity and breast cancer in the Punjab province of Pakistan are therefore portend for the future health, health care reform and socioeconomic advancement of the province. This socioecological form of inflammation and adipokine imbalances as mediating factors of primary and metastatic growth is highly relevant for primary prevention, early diagnosis, and intervention approaches in the province. This perspective from Punjab can prove useful for understanding the lessons from precision cancer control efforts in other LMICs struggling to contain increasing breast cancer rates. Knowledge of these mechanistic connections and their environmental modifiers is therefore important in the development of rational interventions, especially in the province of Punjab, in Pakistan, where both breast cancer and obesity are raging epidemics. First of all, minimizing the hormonal and metabolic risk factors in the development of BC, as well as optimizing the use of hormone-related biomarkers in clinical practice, can significantly reduce the incidence of this cancer crisis among Punjabi women. In conclusion, the risk factors associated with obesity, such as hormonal imbalances, chronic inflammation, and insulin resistance, may contribute to the development and progression of breast cancer among women in Punjab.

INTRODUCTION

Today the world must address breast cancer and obesity as serious health concerns that trouble our population. These health problems create lasting problems for both individuals and society which shows why research and treatments for prevention must continue (Mohajan *et al.*, 2023).

Every year breast cancer affects 2 million women worldwide as the most frequent cancer type killing around 600,000 females annually. The disease affects breast tissue because of many different factors including genes and hormonal changes plus exposure to external influences that can damage normal cell behavior. Despite recent medical progress that has

helped people live longer breast cancer remains a main threat to women's survival rates (LeVee and Mortimer, 2023).

Recent worldwide increases in obesity levels have made weight excess a primary danger for developing breast cancer. More than 1.9 billion adults weigh too much with 650 million suffering from obesity worldwide. A person is termed obese if excessive fat tissue builds up in their body because their food intake exceeds the amount of energy they use. People commonly develop diseases such as diabetes type 2 alongside cardiovascular problems and several cancers when experiencing this need condition (Campbell *et al.*, 2023).

Several key factors explain how obesity relations to breast cancer develop. Women after menopause who carry extra weight produce more reproductive hormones that help feed hormone receptor-positive breast tumors. Fat tissue operates as an endocrine body part by producing inflammation-related chemicals that can impact the normal ways cells talk to each other. Research shows that high insulin levels and diabetes from obesity can increase breast cancer risk (Boubertakh *et al.*, 2022).

The presence of obesity creates worse breast cancer results throughout all stages of the disease progression. Being overweight puts women at higher risk for developing breast cancers that do not respond well to treatment. People experience shorter survival times than normal-weight individuals due to reduced treatment effectiveness and more surgical challenges which raise the likelihood of cancer recurring (Bandera *et al.*, 2021).

Reducing obesity levels will help fight breast cancer at the global level. A successful prevention approach must combine changes to individual habits with improvements in our social environment. We can help patients through healthy lifestyle education about proper nutrition and exercise plus better screening tools and official policies that support better food choices and community health (Manson and Achel, 2023).

The health risks of breast cancer and obesity exist as connected significant public threats. We need better knowledge about the link between breast cancer and obesity to create better ways to prevent it and find it early. When different medical specialists join forces to tackle these health obstacles, we can improve life quality and health for people around the world (Ugai *et al.*, 2022).

Breast cancer leads all cancers in women's diagnoses globally with 2 million new cases and 600,000 deaths each year. Breast cancer stems from multiple causes including genes, hormones and environmental elements that reduce normal cell growth patterns. While survival rates have improved considerably in recent decades due to advances in early detection and therapy, breast cancer remains a leading cause of cancer-related mortality among women (Adam *et al.*, 2023).

Excess weight represents a key breast cancer risk factor because obesity rates have skyrocketed worldwide. Our research finds that 1.9 billion adults carry excess weight while 650 million adults test as obese. Obesity appears when you gain too much fat tissue because you eat more than your body uses. This health condition tends to lead to type 2 diabetes, cardiovascular disease, and specific cancers (Manca *et al.*, 2022).

Many different biological processes link obesity to breast cancer persistence. The body weight of postmenopausal women affects their blood estrogen levels which can help hormone receptor-positive breast tumors develop. Adipose tissue produces inflammatory chemicals called cytokines and adipokines from its endocrine function which can affect regular cell communications. The combination of insulin resistance and high insulin levels from obesity plays a role in developing breast cancer formation (Omotoso *et al.*, 2023).

The effects of obesity damage breast cancer patients at every stage of disease progression. Women with obesity are more likely to develop breast cancer types that prove difficult to treat. Obese patients have lower chances of survival than people with normal weight because their treatments do not work as well and they often develop more surgical problems while also showing a higher risk of cancer returning (Mao *et al.*, 2022).

Breaking down obesity through effective prevention will help reduce breast cancer cases worldwide. To prevent more breast cancer cases, we must help individuals make better choices while modifying the conditions that affect their health. Our approach should combine support for nutritious foods and exercises with improved medical testing methods and

rules that build spaces where people can live healthier lives (Soldato *et al.*, 2023).

The public health community faces major challenges from breast cancer and obesity that interact with each other. Our research into both conditions working together will help us develop better methods to prevent and discover these diseases at their earliest stage. Concerted, multidisciplinary efforts to tackle these issues will be instrumental in improving health outcomes and quality of life for countless individuals worldwide (Daly *et al.*, 2021).

Beyond this high-level overview, it is important to delve deeper into the epidemiology, biology, and socioeconomic impacts of these conditions to fully appreciate their significance as global health priorities (Lv *et al.*, 2023).

Epidemiology

Breast cancer occurs at different levels of frequency and deaths across regional zones and specific population groups. Pay rightly have a higher rate of breast cancer than poor nations because they provide more advanced medical tests and screening while their people follow unhealthy habits more actively. The breast cancer fatality rate for Black women in the United States stands higher than that seen among other racial groups (Arzanova and Mayrovitz, 2022).

The obesity crisis has grown quickly in nations across all income levels. Low- and middle-income nations now face growing obesity rates as their cities expand and residents adopt new eating practices. Gender, age, and economic status strongly influence obesity risk rates and older women face heavier health risks worldwide (Pati *et al.*, 2023).

Cancer poses a major threat to public health across nations with Pakistan included. Breast cancer stands as the leading type of cancer affecting women throughout Pakistan. We need to study women's cancer patterns especially breast cancer to build effective care solutions. Pakistan's population of 220 million has seen a growing number of breast cancer cases since the past few decades. The National Cancer Registry Program shows breast cancer makes up 40% of all cancer diagnoses among women in Pakistan today. Many genes and hormones plus environmental factors contribute to the rising number of breast cancer cases (Amir *et al.*, 2021).

The recent rise of obesity among people in Pakistan makes women more prone to breast cancer. Research shows obese women after menopause have a stronger connection to developing breast cancer. In Pakistan, the prevalence of obesity among women has been on the rise, with a national prevalence of approximately 30%. This is a concerning trend, as excess body weight is known to increase the production of certain hormones, such as estrogen, which can promote the growth and development of breast tumors (Roheel *et al.*, 2023).

Past conditions in Pakistan make breast cancer risk higher because of obesity plus social class and lifestyle habits. Women from rural and poorer families in Pakistan face many barriers to getting proper medical care especially regular testing for breast cancer. When breast cancer goes undetected it leads to poor long-term survival rates and limits medical treatment choices. Traditional customs and social views in Pakistan guide Pakistani women's medical choices. Women in specific communities struggle to receive medical treatment because they cannot access transportation or meet healthcare costs while facing opposition from their culture about specific diseases. The social environment of Pakistan brings extra hardships to Pakistani women trying to deal with breast cancer (Zaib *et al.*, 2024).

We need to use multiple methods to fight the increasing rates of women's cancer in Pakistan. Our work should focus on educational efforts to spread health information about eating right for weight control and staying active through exercise. Taking these actions decreases the risk of getting breast cancer and other cancers that occur because of obesity. We must build thorough screening programs for cancer plus effective ways to detect it early. The state needs to set up widespread mammogram testing plus teach medical staff how to examine breasts for signs and how to direct patients toward proper follow-up exams. Detecting cancers early helps doctors treat them more effectively and patients live longer (Gohar *et al.*, 2024).

Building better medical facilities with fair access to top cancer care serves as a key step toward solving Pakistan's women's cancer problem. Our approach demands funding for cancer facilities alongside staff development and accessible medical treatments such as chemotherapy, radiation therapy, and surgery

(Mehmood *et al.*, 2022). Furthermore, collaborative research efforts between Pakistani institutions and international partners can contribute to a better understanding of the unique epidemiological patterns and risk factors associated with women's cancers in the country. Such research can inform the development of culturally appropriate and evidence-based prevention and treatment strategies (Figure 1).

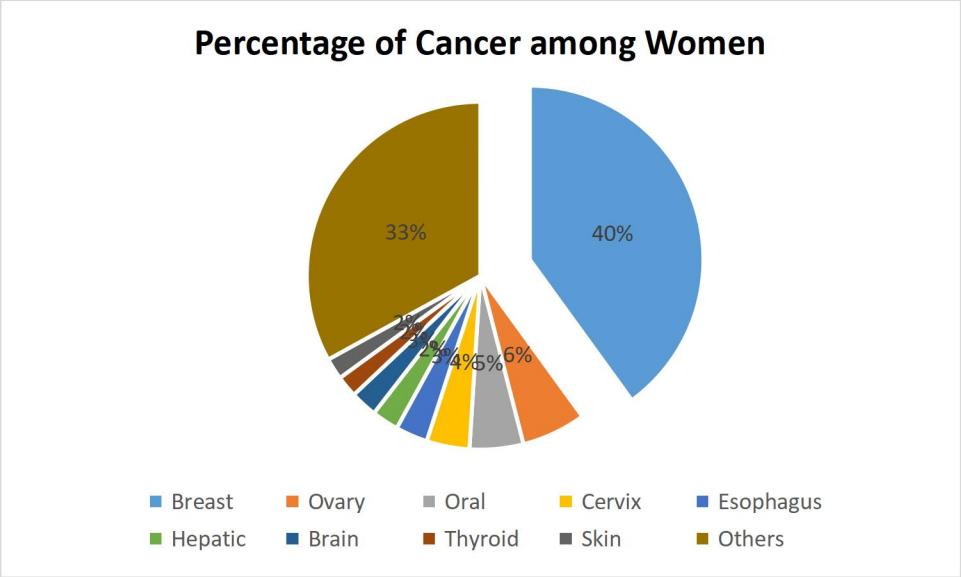

Figure 1: Percentage of cancer among Pakistani women

Biological Mechanisms Linking

The molecular chain of events that connects obesity to breast cancer development and growth uses many different pathways. Obesity activates persistent low-grade inflammation that raises inflammatory molecules such as IL-6 and TNF-α. These substances damage cells, affect cell communication, and reduce tumor immune defense. Problems with leptin and adiponectin hormone levels from fat tissue promote cancer development patterns (Larson *et al.*, 2023).

The body's condition of insulin resistance and high insulin levels that occur in obesity turns on cell growth signals that help tumors grow and survive. Beyond insulin resistance, harmful changes in the insulin-like growth factor system boost cancer development. Increased estrogen levels in postmenopausal women act as a main cause of breast cancer growth because estrogen drives the development of cancers that have hormone receptors (Judana *et al.*, 2021).

Socioeconomic Impacts

Our communities face major challenges because breast cancer and obesity increase medical costs, reduce workforce capacity, and diminish individual quality of life. Society bears enormous financial responsibility through medical expenses with breast cancer generating $1.16 trillion globally every year and obesity costing $200 billion annually in health care in the United States (Pageot *et al.*, 2022).

These diseases create more societal damage through interruptions in work and lost wages beyond the healthcare bills. Living with breast cancer and obesity makes people more likely to experience emotional troubles from anxiety and depression to social stigma and self-image problems. These issues deeply affect how people live at home, work and within their relationships (Azin *et al.*, 2023).

Low- and middle-income countries face significant health care system strain because breast cancer and obesity happen together at higher rates to people who cannot get proper preventive care or treatment. A balanced strategy in public health policies and programs should aim for equality to eliminate such health differences (Luo *et al.*, 2022).

Breast cancer and obesity have become serious worldwide health problems that need quick solutions from many different medical fields. We need more research about these health problems to learn how they start and discover new ways to prevent them and help patients recover fully. When we unite our actions in these key areas, we can achieve better

health and equality across global populations (Harborg *et al.*, 2023).

Punjab is Pakistan's most vital region because it hosts the country's biggest population and economic output with its 110 million inhabitants. The health data from Punjab shapes overall national health progress. Putting research content and treatment methods first for the Pakistani population will create more effective healthcare results. Epidemiologically, the prevalence of both breast cancer and obesity appears to be on the rise in Punjab. Breast cancer has become the most common cancer afflicting women in Pakistan, with incidence rates that are among the highest globally. Concurrently, obesity levels have skyrocketed, with over 30% of adults in Punjab classified as overweight or obese. This dual burden of non-communicable diseases places an immense strain on the region's healthcare system and economy (Nag *et al.*, 2023).

Breast cancer and obesity interact more strongly in the Punjabi population than many other regions. Research has found that poor and working-class Pakistani women experience health differences that worsen their chance of getting breast cancer while overweight. Punjab women typically give birth multiple times and start having children at an early age without exercising much - researchers identify these patterns as breast cancer risk factors (Tan and Habib, 2021).

The social environment of Punjab creates specific obstacles and possibilities that affect how we solve this public health problem. Gender roles, food customs, and healthcare accessibility shape our solutions for creating specific health programs. We need to work directly with local communities to create programs that match their cultural setting and achieve real results. Punjab offers researchers a valuable opportunity to study how breast cancer and obesity affect each other. Epidemiological research and lab tests in this region will help develop better solutions for fighting breast cancer around the world. Scientific breakthroughs in Punjab can help solve health problems affecting other nations with similar population health conditions (Mos *et al.*, 2021).

Researchers can learn important insights about breast cancer-obesity interactions by studying Punjab Pakistan. The opportunity to understand and tackle breast cancer and obesity in Punjab presents an important research opportunity because of its large disease impact and advanced socioeconomic structure within its distinct cultural environment. Testing prevention and treatment strategies in Punjab will create solutions that reduce breast cancer risks for women globally. The most important economic center and biggest province of Pakistan, Punjab contains a population of over 110 million people. Scientific research demonstrates the serious scale of obesity and breast cancer problems in this particular area (Sinha *et al.*, 2022).

The growing obesity problem in Punjab creates major risks to public health services. According to the latest Pakistan Demographic and Health Survey, over 30% of adults in the province are classified as either overweight or obese. This figure is significantly higher than the national average of 25%. The rate of obesity shows an obvious difference between men and women in Punjab. Women shoulder more of the obesity challenge since 40% of female population is overweight or obese while just 24% of male population shows similar weight conditions. Obesity rates reach more than 50% for lower socioeconomic women living in Punjab (Murtaza, 2023).

Multiple elements lead to Punjab's high obesity levels. The nutrition shift in the region is driven by fast urban development along with inactive daily routines and readily available processed foods. People follow cultural beliefs that reward larger body sizes which makes obesity worse for women in particular. Type 2 diabetes and cardiovascular disease, known health complications of obesity, occur frequently among Punjab residents. Scientific data indicates that 16% or more of the adult Punjab population deals with diabetes largely due to obesity levels. The growing number of heart and metabolic health disorders creates both health risks for the public and strains on medical resources (Singh and Lal, 2023).

Punjab leads Pakistan in both obesity rates and breast cancer incidence rates. The province has one of the highest breast cancer incidence rates worldwide and women face breast cancer at a rate above 50 cases per 100,000 people. Punjab's women face breast cancer as the top cancer killer despite having the most breast cancer cases (Maqbool and Khan, 2023).

Unique population groups and medical aspects raise breast cancer risk in these populations. The

combination of early menarche menopause among Pakistani women plus high birth rates and reduced breastfeeding times makes them more vulnerable to breast cancer. The high percentage of patients diagnosed with late-stage breast cancer results from delayed testing and limited access to good medical care. Fifty percent of patients reach the healthcare system at stages when treatment is less effective (Tufail and Wu, 2023).

Breast cancer rates in Punjab show large differences between people of different social classes. Women from poor rural backgrounds usually show higher breast cancer progression and poorer survival chances than women in better-off urban settings. The fact that poorer regions and ethnic groups suffer worse breast cancer outcomes shows we must take direct steps to help these populations. The coexistence of obesity and breast cancer epidemics in Punjab is not merely coincidental. Emerging evidence points to a complex, bidirectional relationship between these two conditions that has profound implications for women's health in the region (Khan *et al.,* 2024).

Obesity, particularly in postmenopausal women, is a well-established risk factor for the development of hormone receptor-positive breast cancers. The excess adipose tissue associated with obesity drives hormonal dysregulation, chronic inflammation, and insulin resistance - all of which can contribute to carcinogenesis. Conversely, breast cancer diagnosis and treatment also appear to heighten the risk of obesity. Cytotoxic chemotherapies, hormonal therapies, and physical inactivity during and after cancer care can lead to weight gain, metabolic disturbances, and reduced quality of life - further exacerbating the obesity burden (Khalid *et al.,* 2023).

The intersection of these epidemics is especially concerning in the Punjab context, where both conditions disproportionately affect women from disadvantaged socioeconomic backgrounds. Socioeconomic status is a key determinant of obesity risk, while also shaping access to timely breast cancer screening, diagnosis, and comprehensive care. This "double burden" compounds the health disparities experienced by vulnerable populations (Kashif *et al.,* 2024).

Implications and Opportunities for Intervention

The widespread growth of obesity and breast cancer in Punjab threatens both public health standards and regional economic progress. We require swift multi-directional efforts to overcome these connected public health threats. Non-communicable diseases spreading quickly across Punjab strain the inadequate healthcare system of the state. We need to build stronger prevention programs while improving cancer treatment facilities and adding obesity treatment to standard medical care (Ali *et al.,* 2022).

Community health programs must teach local families about healthy eating and exercise through campaigns focused on female members and girls. Going beyond treatment to teach people good health habits leads to better results against obesity and breast cancer. Our effort to reduce these disease rates should target the underlying issues first. The health conditions in Punjab are primarily affected by poor economic status, unfair treatment of women, and low levels of educational achievement. By implementing policies that boost economic wellbeing, fight gender discrimination, and make good healthcare available to everyone we can start to break these deeply rooted health problems (Siddique *et al.,* 2024).

The obesity and breast cancer epidemic in Punjab affects women's health strongly and requires urgent public health attention. The overlapping presence of these issues gives us new ways to develop better prevention methods for overall public health support. The people of Punjab can create positive change through sector wide collaboration by studying local conditions (Rehman *et al.,* 2024).

Trends in obesity prevalence among women in Punjab over time.

National surveys and provincial health data show that Punjab's obesity epidemic has grown worse as more women suffer from obesity than men. During the early 2000s research showed that 25% of adult female residents in Punjab met the criteria for being obese or overweight. The situation unfolds dangerously as obesity rates continue to increase in the recent two decades. The 2017-2018 Pakistan Demographic and Health Survey showed that 40% of women in Punjab met the criteria for obesity.

Punjabi women experienced a shocking doubling of their obesity rate across just 20 years (Chaudhry and Sharma, 2023).

Obesity affects a majority of poor women living in Punjab. A study shows that more than half of women from poor households in Punjab have obesity or overweight bodies. Women in economic extremes demonstrate significant disparities in obesity rates with 30% obesity prevalence in the richest households yet 50% obesity rates among the poorest families. Socioeconomic differences help explain why obesity rates in Punjab are becoming a major health issue. Urban growth, less physical activity, and unhealthy processed food choices affect poor communities much harder than others. The problem of obesity has grown stronger because social traditions favor women who are over-weight (Saharwardi *et al.,* 2022).

Rising obesity among Punjabi women threatens to destroy both their health and their local healthcare facilities. Obesity directly increases the risk of developing type 2 diabetes, heart problems, and particular cancers. The rise of obesity diseases is pushing Punjab's healthcare system too far beyond its limits. The obesity epidemic blocks women's ability to be healthy and become empowered in the province. Excess weight gain can lead to stigma, decreased physical mobility, and poor mental health outcomes - all of which undermine women's ability to actively participate in social, economic, and political spheres (Saif and Anwar, 2023).

In response to these alarming trends, stakeholders in Punjab must urgently prioritize multi-pronged strategies to address the growing obesity crisis, with a particular focus on women's health. This will require investing in prevention programs that promote healthy lifestyles, strengthening primary healthcare capacity to manage obesity and related conditions, and tackling the underlying social determinants that drive this epidemic. Failure to act decisively will have far-reaching consequences, not only for the health and wellbeing of women in Punjab, but also for the broader socioeconomic development of the province and the nation as a whole. By confronting the obesity epidemic head-on, Punjab can pave the way for a healthier, more equitable future for all its citizens (Qaisar and Karim, 2021).

Geographic and demographic variations in breast cancer incidence within Punjab

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Setting up cancer care facilities in districts with heavy disease burden will reduce barriers to treatment while helping detect tumors early. Access improvement projects must focus on helping both poor communities and people living in remote areas to ensure all can access affordable cancer treatment. Punjab communities require health education content that speaks their language while respecting their culture to motivate them toward prompt medical assistance. The efficiency of these programs grows when we partner with local organizations and use local delivery systems. Punjab must improve its cancer registry tracking system to accurately track future changes in disease patterns. The right information from specific data helps policymakers create better solutions to prevent breast cancer in Punjab (Shoukat and Shah, 2023).

Differences in breast cancer occurrence between Punjab's regions and population types make this public health challenge harder to address. Understanding these breast cancer trends gives us chances to design programs that help everyone get equal access to better healthcare against this disease. The local population's different needs provide stakeholders with guidance to create effective cancer care systems that serve all Punjab women (Aslam *et al.*, 2024).

Obesity Rates: Punjab vs Other Regions

Punjab now leads Pakistan's obesity crisis at a higher rate than any other province in the country. Research finds 30% of Punjab adults suffer from being overweight or obese - this rate surpasses the 25% national obesity and overweight percentage. The obesity problem in Punjab looks similar to other richer nations in the world instead of Pakistan's national obesity levels or poor countries. Punjab has similar obesity rates compared to Mexico and Britain at 33% and 28% respectively yet these numbers far surpass obesity levels seen in neighboring India and Bangladesh at 20% and 19% respectively (Bibi *et al.*, 2021).

The rate of obesity in Punjab shows a much greater impact on women than men. Data shows 40 percent of women in Punjab exceed healthy weight levels while only 24 percent of men do the same. The obesity problem hits women harder in poor economic groups as more than half of them become obese. The way obesity affects men and women in Punjab follows an unusual pattern compared to how it develops globally (Basit *et al.*, 2021).

Punjab leads the world in both overweight rates and breast cancer cases. The state ranks among nations with the highest incidence of these health issues. Punjab has a breast cancer incidence rate higher than many developed countries at 50 cases per 100,000 women - this exceeds the breast cancer rates in the United States (43 per 100,000 women) and the United Kingdom (35 per 100,000 women). Breast cancer now leads all types of cancers found in Pakistani women and Punjab carries most of this serious health problem throughout the nation. Breast cancer stands as a less common cancer type in South Asian countries India and Bangladesh than other types of cancer including gynecological and gastrointestinal cancers (Asif *et al.*, 2024).

Breast cancer cases in Punjab show significant variation between different types of patients. Rich women living in cities show more breast cancer cases than their poor rural counterparts. The breast cancer distribution among different socioeconomic classes in Punjab differs from what Western countries typically show with poorer neighborhoods having higher rates. Research shows both obesity rates and breast cancer cases continue to rise statewide in Punjab. This province has breast cancer rates that outpace national Pakistan numbers and extend beyond levels found in countries with a similar income status to reach those in high-income nations (Tanveer *et al.*, 2022).

Our results emphasize the need to solve these linked health problems in Punjab urgently. Not tackling this problem will affect Punjab residents' health plus harm Pakistan's social and economic growth (Ullah *et al.*, 2021). A combination of local healthcare programs will help Punjab control obesity and breast cancer based on the specific needs in the area. We need to build up primary healthcare systems while running focused health education programs and solving health-related life conditions to ensure everyone gets proper screening and treatment resources (Khan *et al.*, 2021).

Punjab should act on new research findings to create a better future for public health while helping other regions handle non-communicable diseases. The province needs to apply its local health information

to develop better solutions that can easily scale up across systems (Luqman *et al.*, 2021).

Genetic Predispositions to Breast Cancer in Punjab

Breast cancer forms because of genetic changes plus hormone activity and exposure to environmental elements. Hereditary gene mutations responsible for breast cancer occur in a smaller portion of cases at 5-10% but significantly raise disease risk for those affected. Researchers now believe that specific combinations of genes appear more often in Punjab populations which explains why breast cancer rates in the province are higher than expected. Global research shows BRCA1 and BRCA2 gene mutations occur more frequently in breast cancer patients from Punjab than in other worldwide populations (Sadia *et al.*, 2021).

Research at Lahore University revealed that 20% of breast cancer patients in Lahore had pathogenic BRCA1/2 mutations which exceeded the normal 5-10% occurrence found in Western societies. Younger-aged women with breast cancer in Punjab showed more BRCA1/2 mutations which help explain how hereditary breast cancer differs in this area (Bilal *et al.*, 2021 and 2024).

Scientists discovered new genetic changes that can increase breast cancer risk in the Punjab population. Scientists discovered that specific DNA repair mechanisms, cell cycle proteins, and hormonal pathways raise breast cancer risk in Punjab genes (Bilal *et al.*, 2024).

Familial Aggregation of Breast Cancer in Punjab

Research shows that breast cancer has high chances of occurring between family members who live in Punjab. Scientific studies prove women get a 200% to 300% greater risk of breast cancer when they have a relative by blood who developed breast cancer. Family members who live under similar conditions develop a higher risk of breast cancer because they share both genetic and environmental influences. Breast cancer risk spreads more easily among Punjab families because of their practice of marrying relatives and having multiple children (Bilal *et al.*, 2023).

Cancer cases due to a family's breast cancer history display specific traits in Punjab. Family-history breast cancer cases start at younger ages and result in more serious types of cancer that produce worse treatment outcomes. The data shows we must develop screening programs and early detection methods to protect people at high risk in Punjab province (Bilal *et al.*, 2022).

Implications for Precision Cancer Prevention and Control

Studies linking breast cancer genes and family traits in Punjab suggest changes are needed to better protect and test people in this region. Medical centers that add BRCA1/2 and panel tests to standard practice can better assess patients' genetic risks and find cancers sooner. Family history of breast cancer requires women to undergo more frequent medical checks accompanied by breast prevention measures plus medication (Shah *et al.*, 2022).

The roll out of genetic services in Punjab meets several operational and social barriers. The lack of medical facilities plus money problems and social beliefs about cancer genes may prevent many people from taking this test. Local communities must be active partners as we design solutions to make healthcare services more accessible to persons facing these barriers. Research about breast cancer genetics in Punjab leads scientists to design screening models tailored for the local population's needs. These risk models that use relevant health test results and medical history data can divide women into risk groups to help choose better breast cancer screening methods at lower cost (Bilal[a,b], 2021).

Breaking down the social barriers that influence familial breast cancer risk remains our essential strategy for Punjab. We should work on reducing wealth differences and empowering both genders while building a setting that supports better health outcomes to lower the disease's unequal distribution. We should develop cancer prevention methods that work directly with communities across the board. To fully understand breast cancer development in Punjab researchers must build stronger research programs and better data management systems throughout the region. We need researchers from different fields to study together how genes, actions, and community settings affect breast cancer development and treatment (Rubi *et al.*, 2022).

The study of breast cancer genetics and family history in Punjab reveals a unique pattern of disease occurrence that demands targeted public health strategies. The identified context details will help stakeholders create better plans to prevent breast cancer and spot it early while offering fair treatment options throughout the province. Policymakers and healthcare teams need to understand Punjab's breast cancer risk patterns to advance meaningful interventions that lower disease impact in the area. Success depends on combined sector collaborations that focus on genetic healthcare development alongside family risk assessment and equal access programs (Khan *et al.,* 2023).

By studying Punjab's breast cancer situation, we can develop better strategies to combat rising breast cancer rates in other lower- and middle-income areas. Research-based health solutions will create better health opportunities for all women across Punjab and worldwide. The weightiest region Punjab hosts more Pakistani residents and produces most economic output and faces high risks from obesity and breast Cancer. In Punjab half of all adult women have body weights classified as overweight or obese with breast cancer incidence reaching high levels worldwide. The lifestyle habits and biological effects of these diseases work together in a direct feedback loop (Bilal *et al.,* 2024).

Dietary Patterns and Nutrition Transition

The continuous shift in Punjabi nutrition toward processed, high-energy meals is one of the main lifestyle factors behind the obesity and breast cancer epidemics. Traditional, plant-based diets are giving way to ones heavy in saturated fats, processed carbs, and added sugars as a result of rapid urbanization, growing affluence, and globalization of food systems (Sajjad *et al.,* 2024).

The obesity epidemic, especially among Punjabi women, has been exacerbated by these dietary changes as well as rising intake of items high in calories but low in nutrients. Weight gain and excessive calorie intake are known risk factors for the emergence of some subtypes of breast cancer, particularly in the postmenopausal stage. Crucially, Punjab's lower socioeconomic classes have been disproportionately affected by the nutrition change, with over 50% of women suffering from obesity. This emphasizes the significance of wider societal (Jawad *et al.,* 2022).

Physical Inactivity and Sedentary Lifestyles

Declining physical activity levels have also been identified as a major factor in Punjab's obesity and breast cancer epidemics, coinciding with the nutrition change. Sedentary lives have become more common, particularly among women, as a result of urbanization, labor mechanization, and the expansion of sedentary leisure and transportation options (Khan *et al.,* 2021).

Absence of regular exercise raises the risk of obesity and weight gain, but it also raises the chance of breast cancer development on its own. Hormonal dysregulation, chronic inflammation, and metabolic disorders have all been connected to physical inactivity, and these conditions can exacerbate carcinogenic processes (Luqman *et al.,* 2021).

It's concerning that Punjabi gender norms and societal expectations frequently confine women to more sedentary, domestic responsibilities, which further discourages physical activity. Creating community-based, customized physical activity programs (Rubi *et al.,* 2022).

Reproductive and Hormonal Factors

Women's vulnerability to obesity and breast cancer is significantly influenced by Punjab's unique reproductive patterns and hormonal profiles. Increased lifelong exposure to endogenous hormones has been associated with factors like early menarche, high parity, and low breastfeeding rates—all of which are more prevalent in the Punjab environment. Obesity and weight gain may result from this elevated hormonal environment. These reproductive traits are also known risk factors for specific subtypes of breast cancer, especially those that are hormone receptor-positive (Iftikhar *et al.,* 2021).

A diversified strategy would be needed to address these ingrained hormonal and reproductive factors in Punjab. This could entail encouraging breastfeeding, expanding access to family planning services, and giving women the knowledge and ability to make decisions regarding their reproductive health (Iftikhar *et al.,* 2024).

Environmental Determinants of Obesogenic and Carcinogenic Exposures

The physical environment of Punjab helps determine how people develop obesity and breast cancer risk. Public health challenges have grown more severe due to rapid city expansion and industrial development plus unhealthy space design. The growth of cities in Punjab switched from walkable green neighborhoods to road-focused development which supports indoor living and limited physical activity. Poor urban residents endure extensive weight gain because of readily available high-calorie processed foods that marketers aggressively promote (Shahin *et al.*, 2024).

The health risks of breast cancer rise in Punjab due to toxic substances produced by industries throughout the region. Studies show that endocrine-disrupting chemicals and air pollutants work together with other cancer-causing agents to mess with hormones and cells which can trigger tumor growth. Most polluted zones in Punjab surround poor neighborhoods where industrial sites concentrate making these communities bear a larger burden of environmental exposure. Poor communities face double obstacles because environmental pollution worsens both the health problems and income gaps in breast cancer and obesity cases (Noor *et al.*, 2024).

The Obesity-Inflammation-Breast Cancer Axis

Obesity with its increased fat tissue builds up in our bodies and strongly increases the risk of various types of cancer like breast cancer. Recent findings demonstrate that the relationship has many contributing factors and ongoing low-level inflammation serves as its principal mechanism. Fat tissue grows excessively in obese people which makes the lower abdominal fat tissue stop functioning properly. The immune response activates immune cells in the problem area to trigger a chain reaction of pro-inflammatory substances called cytokines and chemokines. This inflammatory state helps cancer development through tissue growth and promotes new blood vessel formation and spread (LeVee and Mortimer, 2023).

Inflammation from obesity leads to more significant breast cancer dangers and disease effects during postmenopausal years. Hormonal changes during menopause combined with abnormal body fat distribution increase breast cancer growth through greater inflammation (Bandera *et al.*, 2021).

The Role of Adipokines in Breast Cancer Progression

Adipokines secreted by fat tissue form a network that connects obesity to inflammation which links to breast cancer development. These bioactive peptides help control the body's metabolic and inflammatory functions which determine how cancer advances and grows. Leptin functions as the essential energy-balancing molecule that white adipose tissue produces to control both energy storage and appetite. The increase of leptin levels due to obesity has proven to enhance breast cancer development and decrease treatment effectiveness (Bilal *et al.*, 2022).

Leptin supports tumor formation by using several distinct mechanisms. Leptin triggers breast cancer cell growth by turning on signaling networks like JAK/STAT and MAPK throughout the tumor development process. Leptin speeds up breast cancer growth through its effects on blood vessel formation while reducing immune system control and encouraging inflammation. The adipokine adiponectin offers breast cancer protection through its vital role in defense against the disease. The insulin-sensitizing hormone adiponectin has reduced levels in people who have obesity. Research links lower adiponectin levels in the body to higher breast cancer risks and poorer results because this hormone naturally blocks cell growth while fighting inflammation (Bilal and Ansari, 2021).

Estrogen and Breast Cancer Risk in Punjab

The primary sex hormone in women called estrogen regulates breast cancer growth and advancement. Elevated estrogen levels whether made by our bodies naturally or from external sources continue to show a connection to breast cancer development over time. Multiple distinctive hormonal and reproductive patterns in Punjab explain why this region experiences unusually high rates of breast cancer. The reproductive patterns of Punjab women show early first menstrual cycle and delayed end of menstruation compared to worldwide norms. The prolonged duration of female reproduction means a higher estrogen dose during life, boosting breast cancer risk (Hussain *et al.*, 2022).

Punjab's traditional customs and financial situation encourage women to give birth to more children while they breastfeed for shorter periods. Studies link reproduction factors to increased estrogen production in these women and show they face an elevated threat of estrogen-dependent breast cancer particularly hormone receptor positive tumors. Breast cancer susceptibility in Punjab shows additional effects from the province's characteristic metabolic health and obesity rates. The widespread presence of fat deposits in Punjab produces estrogen naturally through the conversion of androgen hormone materials. Repeated exposures to obesity and hormone shift continuously raise the risk of breast cancer in affected women (Khalid *et al.,* 2023).

Estrogen receptor activity and its related signaling sequences affect many aspects of breast cancer behavior and patient recovery in Punjab. Estrogen receptor-positive breast cancers behave differently and react differently to treatment than breast cancers without ER receptors. The large number of estrogen receptor positive breast cancer cases found in Punjab matches the distinctive hormonal environment of the province. ER+ tumors tend to be more responsive to endocrine therapies targeting estrogen signaling, such as selective estrogen receptor modulators (SERMs) and aromatase inhibitors. However, the effectiveness of these targeted treatments may be influenced by factors like age, menopausal status, and underlying metabolic health (Javed and Khalid *et al.,* 2022; Bilal *et al.,* 2024).

Concerningly, women in Punjab also tend to present with breast cancer at younger ages, often before the menopausal transition. This epidemiological pattern can result in a higher proportion of aggressive, hormone receptor-positive tumors that may exhibit more rapid progression and poorer outcomes, particularly in the absence of timely diagnosis and appropriate hormonal management (Sattar *et al.,* 2024).

Implications for Precision Public Health Approaches in Punjab

Prostate cancer risk and survival in Punjab point to the importance of developing personalized public health strategies that recognize local hormone patterns and reproduction factors. Prevention programs in Punjab might help decrease breast cancer prevalence by focusing on weight control, reproductive health teaching, and monitoring endocrine-disrupting chemicals. Our health programs will work best when we adapt them to fit Punjab's local traditions and understanding between men and women (Khalique ad Khan, 2021).

The use of estrogen receptor status and related hormone biomarkers in standard risk assessments and treatment decisions helps doctors provide better tailored care for Punjab women. We need to improve diagnostic equipment availability while training more healthcare professionals and facilitating teamwork for oncologists' endocrinologists and public health specialists to work together. Buildings better research facilities and data networks in Punjab will help scientists learn more about hormone-related breast cancer in the region. Through detailed studies of entire populations, we can learn how estrogen works together with obesity and reproductive variables plus contextual factors to develop effective public health programs (Saleem *et al.,* 2023).

Conclusion

The importance of estrogen and its signaling pathways in determining the risk and prognosis of breast cancer in Punjab, Pakistan, emphasizes the necessity of precision public health strategies that take into consideration the distinct hormonal and reproductive characteristics of the area. Stakeholders can develop more fair and successful initiatives for breast cancer prevention, early detection, and management across the province by utilizing these contextual insights.

The disproportionate burden of breast cancer among Punjabi women may be lessened by addressing the hormonal and metabolic causes of the disease and incorporating hormone-related biomarkers into therapeutic decision-making. In the end, the Punjab experience can be a useful case study to direct precision cancer control programs in other low- and middle-income areas where the incidence of breast cancer is on the rise.

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