Research Article

A Meta-Analysis of Induced Abortion, Alcohol Consumption, and Smoking Triggering Breast Cancer Risk among Women from Developed and Least Developed Countries

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Background. The most prominent form of cancer in women is breast cancer, and modifiable lifestyle risk factors, including smoking, alcohol consumption, and induced abortion, can all contribute significantly to this disease. Objectives. This study’s primary purpose was to assess the prevalence of breast cancer among women in developed and developing countries and the association between three modifiable hazard factors (induced abortion, smoking behavior, and alcohol use) and breast cancer. Methods. This study performed a systematic literature database review up to September 21, 2021. We employed meta-analytic tools such as the random effects model, forest plot, and subgroup analysis to conduct the research. Additionally, we conducted a sensitivity analysis to assess the influence of outliers. Results. According to the random effects model, smoker women have a higher risk of developing breast cancer from different countries (OR = 1.46; 95% CI: 1.08–1.97). In the case of induced abortion, the pooled estimate (OR = 1.25; 95% CI: 1.01–1.53) indicated a significant link between abortion and breast cancer. Subgroup analysis revealed that smoking substantially influences breast cancer in developing and developed countries. Breast cancer was more common among women who smoked in developed countries than in developing nations. Conclusion. The observed findings give sufficient support for the hypothesis that smoking and abortion have a significant influence on breast cancer in different nations. Health organizations should individually design comprehensive scientific plans to raise awareness about the risks of abortion and smoking in developed and developing countries.

1. Introduction

As the most commonly diagnosed neoplasm, breast cancer is a leading cause of cancer-related mortality among females in both developed and less developed nations [1, 2]. Cancer has spread to the majority of countries (154 out of 185) and is currently the primary cause of cancer-related deaths in more than 100 nations [3]. In conformity with the global cancer statistics for 2018, about 2.1 million recent cases, representing nearly one of every four women, were diagnosed with breast cancer. Approximately 626,679 women died due to breast cancer in 2018 [4]. The incidence (number of new cases occurring or rate per 100,000 persons per year) is highest in developing countries, which account for 60% of the deaths, yet it is growing at a faster pace in middle- and low-income countries [5, 6]. More specifically, most occurrence rates are detected in many European countries, notably Switzerland, Italy, and U.S. whites, whereas rates are low in South America, Asia, and Africa [7]. The incidence rate for women living in developed countries (except Japan) is four times higher than that of the least developed countries [8, 9]. A risk factor is defined as an element that increases the probability of inciting breast cancer [10]. In this way, the identification of modifiable breast cancer risk factors has crucial implications for preventing and reducing the incidence of breast cancer [11]. Physical activity, diet, weight,
use of oral contraceptives, alcohol, ingestion of smoke, anxiety, and stress are conventionally modifiable risk factors [12]. Alcohol consumption and smoking are modifiable influencing factors that are generally related to breast cancer to a few more extensive degrees [13, 14]. Besides, it is grounded that full-term pregnancy (without abortion or miscarriage) consummately recommends a defensive impact on the possibility of breast cancer. In contrast, the idea of incomplete pregnancies affecting the risk of breast cancer remains ambiguous [15]. Various articles have explored the association between alcohol consumption, smoking intake, induced abortion, and breast cancer [16–31]. Previous research suggested an association between alcohol consumption and breast cancer [16–18, 21–24]. Moreover, it is evident that multiple studies have found a possible link between smoking and breast cancer [25, 29, 32, 33]. Alcohol causes approximately 4% of breast cancer cases in developed nations [32]. Numerous research studies have suggested a beneficial relationship between breast cancer and induced abortion. Regardless of the alarmingly high frequency of breast malignancy and prompted abortion, the past forty years have delivered neither agreement of opinion into the clinical research nor a need to keep moving to show up at one. Nevertheless, several studies have shown an inverse, null, or weak association between breast cancer and these risk factors (alcohol consumption, smoking intake, and induced abortion), leading to inconsistent findings [15, 18–20, 26, 34–40]. It may be owing to the short sample size and methodological constraints [36]. Moreover, biases, especially those connected with the case-control studies and the insufficient alternative of the reference group, can produce conflicting results on induced abortion and breast cancer [41]. The literature review reveals that the association between three lifestyle-related variables (such as abortion, alcohol consumption, and smoking) and breast cancer varies between studies. The generalization of lifestyle-related indicators’ influence on breast cancer among women is pivotal in light of their clinical significance, although it is scarce in the literature. To overcome this gap, the primary aim of this study is to apply a meta-analysis based on a comprehensive review of observational studies published by 2021. This study elucidates the degree of association between these three attributes and breast cancer among women from least developed and developed countries.

2. Methods

2.1. Data Source and Search Strategy. The previous works of literature were individually searched in four English databases (PubMed, Wiley, Scopus, and ScienceDirect) and most commonly searched in Google Scholar. These searches are conducted manually. The searching strategy utilized different search keywords in each database: (1) “breast cancer,” “breast carcinoma,” “breast tumor,” “breast neoplasm,” “mammary cancer,” “mammary carcinoma,” “mammary neoplasm,” “smoking,” “alcohol consumption,” and “abortion.” (2) “Breast cancer,” “smoking,” “alcohol consumption,” and “abortion.” (3) “Risk,” “risk factors,” “influencing factors,” “susceptibility,” phrased with “breast cancer,” “smoking,” “alcohol consumption,” and “abortion.” (see supplementary file 1). Therefore, the search strategy required four stages for this potential study: (1) cross-sectional study, cohort study, prospective study, and case-control study. (2) Breast cancer, mammary carcinoma, breast neoplasm, breast carcinoma, mammary neoplasm, mammary cancer, and breast tumor. (3) Risk, risk factors, influencing factors, and susceptibility. (4) Name of the particular country.

We considered literature in the present investigation based on the following criteria: (a) bivariate data available for the breast cancer risk with alcohol consumption, smoking influence, and abortion cases; (b) article full-text availability; (c) information made available in the English language; and (d) peer-reviewed, accepted, or published articles. The authors evaluated the appropriateness of the studies after finding the full texts. In the case of multiple studies in one country, the data of individual variables were appropriately merged.

2.2. Study Selection and Data Extraction. The following criteria for including different studies were identified in accordance with the PICO’s acronym:

- Population: women with breast cancer.
- Intervention: consider three lifestyle-related indicators (e.g., abortion, alcohol consumption, and smoking) of developing breast cancer.
- Comparison: consider three lifestyle-related indicators (e.g., abortion, alcohol consumption, and smoking) of developing breast cancer.
- Outcomes: breast cancer, mammary neoplasm, breast neoplasm, breast tumor, mammary cancer, breast carcinoma, and mammary carcinoma.
- Study design: prospective study, cross-sectional study, cohort study, and case-control study.

Initially, 895 articles were appended after employing distinct search strategies and PICO’s schema for each database. In the final stage, the authors rechecked and rescanned the abstracts of the included papers to ensure their accuracy. Figure 1 depicts the overall eligibility requirements of the studies for the final assessment.

2.3. Statistical Analysis. We have applied the software R version 3.6.2 (Bell Laboratories, New Jersey, USA) and IBM SPSS version 27 (SPSS Inc., Chicago, USA) to convey the investigation. We utilized meta-analysis to examine studies from different countries. Computing values evaluated heterogeneity using the $p$ values and $I^2$ of the datasets [42, 43]. We performed the meta-analytical procedure by executing a random-effects model as this study found significant heterogeneity, which assessed DerSimonian and Laird’s pooled effect [44]. The Q statistic, a weighted squared deviation, is used to estimate $I^2$, and the value ranges from 0 to 100% [45] to display the 95% confidence interval, summary measure, and weight for each article for the most significant factors [46]. A leave-one-out sensitivity analysis was conducted to determine the effect of heterogeneity and outliers.
[47]. We utilized the odds ratio for the summary measures, and all outcomes were weighted to handle bias due to underselection and overselection [48]. For the dichotomous variable, the odds ratio (OR) as well as effect size were estimated with 95 percent confidence intervals (CI). A contour-enhanced funnel plot is adopted for the assessment of publication bias. We have observed the symmetry of the plot to determine whether there is a presence or absence of publication bias. In addition, Egger’s test was used to estimate the risk of publication bias, with \( p < 0.05 \) indicating the occurrence of publication bias [49].

2.4. Variables. In this meta-analysis, we well-thought-out breast cancer as the dependent variable. In addition, Egger’s test was used to estimate the risk of publication bias, with \( p < 0.05 \) indicating the occurrence of publication bias. We also considered the impacting factors of alcohol consumption, smoking, and abortion cases included as covariates to execute the exploration and find out the most impacting factors around the world.

3. Results

Table 1 represents the baseline characteristics of different selected studies focusing on smoking, alcohol consumption, and induced abortion triggering breast cancer among women of different countries.

Table 2 shows the output of the heterogeneity test for alcohol consumption. The estimated value of tau square is 0.25, which indicates the absolute estimated value of the between-study variation. From the value of \( I^2 \), we have come to know that 95.2% of the overall variation is due to true heterogeneity (which can be explained). Also, the observed weighted value of S.S. is 456.00 with df = 22 and \( p < 0.001 \), thus significant.

Table 2 shows that the pooled estimate is 0.9401 and the 95% confidence interval is [0.751; 1.176]. This outcome suggests that alcohol consumption has no significant impact on breast cancer in different studies in different countries.

Table 3 shows the output of the heterogeneity test for smoking influence. The estimated value of the tau square is 0.55, which indicates the absolute estimated value of the between-study variation. From the value of \( I^2 \), we have come to know that 98.8% of the overall variation is due to true heterogeneity (which can be explained). Also, the observed weighted value of S.S. is 1930.79 with df = 24 and \( p < 0.001 \), which is significant.

Table 3 shows that the pooled estimate is 1.454 and the 95% confidence interval is [1.08, 1.97]. This table suggests that smoking has an impact on breast cancer in different studies. The studies by Croghan et al., 2009; Ellingjord-Dale et al., 2017; Kaufman et al., 2008; and Liu et al., 2017, show the odds of breast cancer occurring due to smoking are the highest.

Figure 2 shows the vibrant sight of the random effects model for variable smoking. Inclusive concise information on data from individual studies is given there. We can perceive individual studies’ confidence intervals and estimated values with a rectangular shape and combined effects with a diamond shape. The combined effect for the fixed effects model is 1.27, and for the random effect, the model is 1.46. The overall visualization of the studies suggests that smoking significantly impacts breast cancer in different studies.

Table 4 shows the output of the heterogeneity test for abortion cases. The estimated value of tau square is 0.18. It indicates the absolute estimated value of the between-study variation. From the value of \( I^2 \), we have come to know that 84.7% of the overall variation is due to true heterogeneity (which can be explained). Also, the observed weighted value of S.S. is 117.96 with df = 18 and \( p < 0.001 \), which is also significant.

Table 4 shows that the pooled estimate is 1.25, and the 95% confidence interval is [1.01; 1.53]. This table suggests that abortion case has an impact on breast cancer in different studies. The studies by Ahmed et al., 2015, and Balekouzou et al., 2017, have the highest odds of breast cancer occurring due to abortion cases.

Figure 3 shows the vibrant sight of the random effects model for the variable abortion case. A comprehensive summary of the data from individual studies is given there. We can perceive individual studies’ confidence intervals and estimated values with rectangular and combined diamond-shaped effects. The combined effect for the fixed effects model is 1.13, and for the random effects model, it is 1.25. The overall visualization of studies suggests that abortion cases significantly impact breast cancer in different studies.

Table 5 represents that the cases of abortion and smoking have a substantial influence on breast cancer in developing and developed countries. Women who had abortions in developing countries were more likely to have breast cancer (OR: 1.39, \( p < 0.01 \), \( I^2 = 90% \)) compared to women in
Table 1: Baseline characteristics of different selected studies for alcohol consumption, induced abortion, and smoking.

| Study                  | Country                  | Country type   | Breast cancer among women in the alcohol, abortion, or smoking group | Total number of women with alcohol, abortion, or smoking | Breast cancer among women with no alcohol, abortion, or smoking | Total number of women with no alcohol, abortion, or smoking |
|------------------------|--------------------------|----------------|---------------------------------------------------------------------|--------------------------------------------------------|------------------------------------------------------------------|-------------------------------------------------------------|
| **Alcohol consumption**|                          |                |                                                                     |                                                        |                                                                  |                                                             |
| Ahles et al., 2014     | USA                      | Developed country | 136                                                                | 288                                                    | 18                                                              | 28                                                          |
| Ahmed et al., 2015     | Bangladesh               | Developing country | 28                                                                 | 60                                                     | 52                                                              | 100                                                         |
| Berrandou et al., 2019 | France                   | Developed country | 924                                                                | 1899                                                   | 201                                                             | 398                                                         |
| Bidstrup et al., 2013  | Denmark                  | Developed country | 429                                                                | 22660                                                  | 19                                                               | 1168                                                        |
| Brown et al., 2010     | USA                      | Developed country | 357                                                                | 942                                                    | 234                                                             | 609                                                         |
| Butler et al., 2016    | USA                      | Developed country | 1242                                                               | 2299                                                   | 565                                                             | 1071                                                        |
| Chen et al., 2014      | China                    | Developing country | 32                                                                 | 52                                                     | 637                                                             | 1299                                                        |
| Croghan et al., 2009   | USA                      | Developed country | 576                                                                | 1235                                                   | 3165                                                            | 4072                                                        |
| Ellingjord-Dale et al., 2017 | Norway             | Developed country | 3677                                                               | 23586                                                  | 725                                                             | 5306                                                        |
| Galukande et al., 2016 | Uganda                   | Developing country | 31                                                                 | 135                                                    | 77                                                               | 208                                                         |
| Gibson et al., 2010    | Philippines              | Developing country | 8                                                                  | 91                                                     | 115                                                             | 993                                                         |
| Hu et al., 2013        | China                    | Developing country | 18                                                                 | 34                                                     | 178                                                             | 373                                                         |
| Kawai et al., 2014     | USA                      | Developed country | 733                                                                | 1439                                                   | 220                                                             | 447                                                         |
| Kufman et al., 2008    | USA                      | Developed country | 61                                                                  | 196                                                    | 11                                                               | 79                                                          |
| Li et al., 2020        | 21 centers in western countries | Developing countries | 2175                                                               | 6197                                                   | 631                                                             | 1786                                                        |
| Liu et al., 2017       | China                    | Developing country | 15                                                                  | 27                                                     | 1466                                                            | 2937                                                        |
| Nishino et al., 2014   | Japan                    | Developing country | 322                                                                | 1093                                                   | 815                                                             | 3103                                                        |
| Pakzad et al., 2020    | Iran                     | Developing country | 892                                                                | 1863                                                   | 40                                                               | 69                                                          |
| Pirie et al., 2008     | UK                       | Developed country | 1082                                                               | 1316                                                   | 667                                                             | 814                                                         |
| Sandsveden et al., 2017 | Sweden              | Developed country | 1122                                                               | 2193                                                   | 64                                                              | 161                                                         |
| Tong et al., 2014      | China                    | Developing country | 64                                                                  | 177                                                    | 248                                                             | 447                                                         |
| Xu et al., 2012        | China                    | Developing country | 37                                                                  | 135                                                    | 379                                                             | 1437                                                        |
| Yu et al., 2021        | China                    | Developing country | 123                                                                | 224                                                    | 910                                                             | 1845                                                        |
| **Induced abortion**   |                          |                |                                                                     |                                                        |                                                                  |                                                             |
| Ahmed et al., 2015     | Bangladesh               | Developing country | 30                                                                  | 39                                                     | 50                                                              | 121                                                         |
| Balekouzou et al., 2017 | Central African Republic | Developing country | 114                                                                | 213                                                    | 60                                                              | 309                                                         |
| Becher et al., 2003    | Germany                  | Developed country | 103                                                                | 259                                                    | 482                                                             | 1465                                                        |
| Daling et al., 1994    | USA                      | Developed country | 193                                                                | 422                                                    | 652                                                             | 1384                                                        |
| Daling et al., 1996    | USA                      | Developed country | 314                                                                | 585                                                    | 779                                                             | 1506                                                        |
| Giangreco et al., 2003 | USA                      | Developed country | 74                                                                  | 168                                                    | 670                                                             | 1320                                                        |
| Gilani et al., 2004    | Pakistan                 | Developing country | 105                                                                | 327                                                    | 194                                                             | 899                                                         |
| Hosseinzadeh et al., 2014 | Iran              | Developing country | 64                                                                  | 157                                                    | 76                                                              | 263                                                         |
| Jiang et al., 2012     | China                    | Developing country | 76                                                                  | 140                                                    | 284                                                             | 610                                                         |
| Karim et al., 2015     | Saudi Arabia             | Developing country | 47                                                                  | 104                                                    | 45                                                              | 88                                                          |
| Lipworth et al., 1995  | Greece                   | Developed country | 502                                                                | 1341                                                   | 318                                                             | 1027                                                        |
| Parazzini et al., 1991 | Italy                    | Developed country | 423                                                                | 789                                                    | 1682                                                            | 3230                                                        |
| Rao et al., 1994       | India                    | Developing country | 71                                                                  | 168                                                    | 593                                                             | 1195                                                        |
| Robertson et al., 2001 | Slovenia                 | Developed country | 247                                                                | 490                                                    | 377                                                             | 758                                                         |
| Study            | Country          | Country type     | Breast cancer among women in the alcohol, abortion, or smoking group | Total number of women with alcohol, abortion, or smoking | Breast cancer among women with no alcohol, abortion, or smoking | Total number of women with no alcohol, abortion, or smoking |
|------------------|------------------|------------------|--------------------------------------------------------------------|---------------------------------------------------------|----------------------------------------------------------------|---------------------------------------------------------|
| Rookus et al., 1996 | Netherlands      | Developed country | 56                                                                  | 92                                                      | 862                                                            | 1744                                                    |
| Wang et al., 2011  | China            | Developing country| 125                                                                | 273                                                     | 275                                                            | 527                                                     |
| Xu et al., 2012    | China            | Developing country| 233                                                                | 878                                                     | 183                                                            | 694                                                     |
| Ye et al., 2002    | China            | Developing country| 344                                                                | 135462                                                  | 358                                                            | 131574                                                  |
| Yunan et al., 2019 | China            | Developing country| 355                                                                | 694                                                     | 93                                                             | 217                                                     |
| **Smoking**        |                  |                  |                                                                     |                                                         |                                                                |                                                         |
| Ahles et al., 2014 | USA              | Developed countries | 74                                                                  | 100                                                     | 49                                                             | 66                                                      |
| Berrandou et al., 2019 | France         | Developed countries | 437                                                                | 901                                                     | 688                                                            | 1396                                                    |
| Bissonauth et al., 2009 | Canada         | Developed countries | 178                                                                | 358                                                     | 102                                                            | 232                                                     |
| Bidstrup et al., 2013 | Denmark       | Developed countries | 124                                                                | 5883                                                    | 334                                                            | 17544                                                   |
| Brown et al., 2010 | USA              | Developed countries | 162                                                                | 400                                                     | 429                                                            | 1151                                                    |
| Butler et al., 2016 | Carolina, USA  | Developed countries | 866                                                                | 1590                                                    | 942                                                            | 1782                                                    |
| Chen et al., 2014  | China            | Developing countries | 16                                                                  | 21                                                      | 653                                                            | 1330                                                    |
| Croghan et al., 2009 | USA            | Developed countries | 1278                                                                | 1545                                                    | 958                                                            | 6552                                                    |
| Ellingjord-Dale et al., 2017 | Norway  | Developed countries | 1098                                                                | 6924                                                    | 1748                                                           | 11748                                                   |
| Gibson et al., 2010 | Philippines | Developing countries | 13                                                                  | 100                                                     | 110                                                            | 988                                                     |
| Ginsburg et al., 2009 | USA            | Developed countries | 995                                                                | 1975                                                    | 1543                                                           | 3101                                                    |
| Hu et al., 2013    | China            | Developing countries | 10                                                                  | 19                                                      | 186                                                            | 388                                                     |
| Ilic et al., 2014  | Serbia           | Developing countries | 61                                                                  | 128                                                     | 130                                                            | 254                                                     |
| Kawai et al., 2014 | USA              | Developed countries | 354                                                                | 653                                                     | 606                                                            | 1245                                                    |
| Kufman et al., 2008 | USA            | Developed countries | 79                                                                  | 173                                                     | 13                                                             | 190                                                     |
| Li et al., 2020    | 21 centers in western countries | Developing countries | 1330                                                                | 3738                                                    | 1476                                                           | 4245                                                    |
| Liu et al., 2017   | China            | Developing countries | 30                                                                  | 44                                                      | 1455                                                           | 2922                                                    |
| Luo et al., 2011   | USA              | Developed countries | 1692                                                                | 41022                                                   | 3520                                                           | 79990                                                   |
| Mckenzie et al., 2013 | New Zealand  | Developed countries | 942                                                                | 2294                                                    | 856                                                            | 2037                                                    |
| Nishino et al., 2014 | Japan       | Developed countries | 242                                                                | 650                                                     | 918                                                            | 3547                                                    |
| Prescott et al., 2007 | USA            | Developed countries | 737                                                                | 917                                                     | 991                                                            | 1252                                                    |
| Sandsveden et al., 2017 | Sweden       | Developed countries | 680                                                                | 1325                                                    | 488                                                            | 1011                                                    |
| Shore et al., 2008 | USA              | Developed countries | 265                                                                | 543                                                     | 253                                                            | 506                                                     |
| Xu et al., 2012    | China            | Developing countries | 9                                                                   | 41                                                      | 407                                                            | 1531                                                    |
| Yu et al., 2021    | China            | Developing countries | 35                                                                  | 55                                                      | 1000                                                           | 2016                                                    |
Table 2: Summary of the random effects and fixed effects models for alcohol consumption.

| Author               | Country          | OR   | 95% CI          | Fixed effects model (%) | Random effects model (%) |
|----------------------|------------------|------|-----------------|--------------------------|--------------------------|
| Ahles et al., 2014   | USA              | 0.50 | [0.22; 1.11]    | 0.4                      | 3.1                      |
| Ahmed et al., 2015   | Bangladesh       | 0.81 | [0.43; 1.53]    | 0.5                      | 3.6                      |
| Berrandou et al., 2019 | France         | 0.93 | [0.75; 1.15]    | 4                        | 4.9                      |
| Bidstrup et al., 2013 | Denmark        | 1.17 | [0.73; 1.86]    | 0.8                      | 4.2                      |
| Brown et al., 2010   | USA              | 0.98 | [0.79; 1.21]    | 4.2                      | 4.9                      |
| Butler et al., 2016  | USA              | 1.05 | [0.91; 1.22]    | 8.4                      | 5.1                      |
| Chen et al., 2014    | China            | 1.66 | [0.94; 2.94]    | 0.4                      | 3.9                      |
| Croghan et al., 2009 | USA              | 0.25 | [0.22; 0.29]    | 18.3                     | 5.1                      |
| Ellingjord-Dale et al., 2017 | Norway    | 1.17 | [1.07; 1.27]    | 23.6                     | 5.1                      |
| Galukande et al., 2016 | Uganda        | 0.51 | [0.31; 0.83]    | 1.1                      | 4.1                      |
| Gibson et al., 2010  | Philippines      | 0.74 | [0.35; 1.56]    | 0.4                      | 3.3                      |
| Hu et al., 2013      | China            | 1.23 | [0.61; 2.49]    | 0.3                      | 3.4                      |
| Kawai et al., 2014   | USA              | 1.07 | [0.87; 1.33]    | 3.9                      | 4.9                      |
| Kufman et al., 2008  | USA              | 2.79 | [1.38; 5.65]    | 0.3                      | 3.4                      |
| Li et al., 2020      | 21 centers in western countries | 0.99 | [0.89; 1.11]    | 15                       | 5.1                      |
| Liu et al., 2017     | China            | 1.25 | [0.59; 2.69]    | 0.3                      | 3.2                      |
| Nishino et al., 2014 | Japan            | 1.17 | [1.01; 1.37]    | 7.1                      | 5                        |
| Pakzad et al., 2020  | Iran             | 0.67 | [0.41; 1.08]    | 0.9                      | 4.2                      |
| Pirie et al., 2008   | UK               | 1.02 | [0.81; 1.28]    | 3.5                      | 4.9                      |
| Sandsveden et al., 2017 | Sweden        | 1.59 | [1.15; 2.20]    | 1.4                      | 4.7                      |
| Tong et al., 2014    | China            | 0.45 | [0.32; 0.65]    | 2.1                      | 4.6                      |
| Xu et al., 2012      | China            | 1.05 | [0.71; 1.57]    | 1.1                      | 4.4                      |
| Yu et al., 2021      | China            | 1.25 | [0.95; 1.65]    | 2.1                      | 4.8                      |
| Pooled (random)      |                  | 0.94 | [0.75; 1.18]    | 100%                     | 100%                     |

Q = 456.00
df = 22
P-value = <0.0001
I² = 95.2%
τ² = 0.25

OR odds ratio; CI confidence interval.

Table 3: Summary of the random effects and fixed effects models for smoking.

| Author               | Country          | OR   | 95% CI          | Fixed effects model (%) | Random effects model (%) |
|----------------------|------------------|------|-----------------|--------------------------|--------------------------|
| Ahles et al., 2014   | USA              | 0.99 | [0.49; 2.01]    | 0.2                      | 3.5                      |
| Berrandou et al., 2019 | France        | 0.97 | [0.82; 1.15]    | 3.7                      | 4.3                      |
| Bissonauth et al., 2009 | Canada      | 1.26 | [0.90; 1.76]    | 0.8                      | 4.1                      |
| Bidstrup et al., 2013 | Denmark       | 1.11 | [0.90; 1.37]    | 2.2                      | 4.3                      |
| Brown et al., 2010   | USA             | 1.15 | [0.91; 1.45]    | 1.7                      | 4.2                      |
| Butler et al., 2016  | Carolina, USA   | 1.07 | [0.93; 1.22]    | 5.3                      | 4.3                      |
| Chen et al., 2014    | China           | 3.32 | [1.21; 9.11]    | 0.1                      | 2.9                      |
| Croghan et al., 2009 | USA             | 27.95|[24.09; 32.43]   | 0.8                      | 4.3                      |
| Ellingjord-Dale et al., 2017 | Norway    | 1.08 | [0.99; 1.17]    | 14.4                     | 4.3                      |
| Gibson et al., 2010  | Philippines     | 1.19 | [0.64; 2.21]    | 0.2                      | 3.7                      |
| Ginsburg et al., 2009 | USA           | 1.03 | [0.92; 1.15]    | 7.9                      | 4.3                      |
| Hu et al., 2013      | China           | 1.21 | [0.48; 3.04]    | 0.1                      | 3.1                      |
| Ilic et al., 2014    | Serbia          | 0.87 | [0.57; 1.33]    | 0.6                      | 4                        |
| Kawai et al., 2014   | USA             | 1.25 | [1.03; 1.51]    | 2.5                      | 4.3                      |
| Kufman et al., 2008  | USA             | 11.44|[6.05; 21.65]    | 0.1                      | 3.6                      |
| Li et al., 2020      | 21 centers at western countries | 1.04 | [0.95; 1.14]    | 11.7                     | 4.3                      |
| Liu et al., 2017     | China           | 2.16 | [1.14; 4.09]    | 0.2                      | 3.6                      |
| Luo et al., 2011     | USA             | 0.94 | [0.88; 0.99]    | 30.2                     | 4.3                      |
| Mckenzie et al., 2013 | New Zealand  | 0.96 | [0.85; 1.09]    | 7                        | 4.3                      |
| Nishino et al., 2014 | Japan           | 1.70 | [1.43; 2.03]    | 2.4                      | 4.3                      |
| Prescott et al., 2007 | USA          | 1.08 | [0.87; 1.33]    | 2.2                      | 4.2                      |
| Sandsveden et al., 2017 | Sweden      | 1.13 | [0.96; 1.33]    | 3.6                      | 4.3                      |
| Shore et al., 2008   | USA             | 0.95 | [0.75; 1.22]    | 1.8                      | 4.2                      |
| Author              | Country | OR    | 95% CI          | Fixed effects model (%) | Random effects model (%) |
|---------------------|---------|-------|-----------------|-------------------------|-------------------------|
| Xu et al., 2012     | China   | 0.78  | [0.37; 1.64]    | 0.2                     | 3.4                     |
| Yu et al., 2021     | China   | 1.78  | [1.019; 3.10]   | 0.3                     | 3.8                     |
| Pooled (random)     |         | 1.46  | [1.08; 1.97]    | 100%                    | 100%                    |
|                     |         |       |                 |                         |                         |

\[ Q = 1930.79 \]
\[ df = 24 \]
\[ P - value = 0.000 \]
\[ I^2 = 98.8\% \]
\[ \tau^2 = 0.55 \]

OR odds ratio; CI confidence interval.

| Study               | OR    | Odds Ratio | 95%-CI (random) | Weight |
|---------------------|-------|------------|-----------------|--------|
| Ahles et al., 2014  | 0.99  | [0.49; 2.01] | 3.5%            |
| Berrandou et al., 2019 | 0.97  | [0.82; 1.15] | 4.3%            |
| Bidstrup et al., 2013 | 1.26  | [0.90; 1.76] | 4.1%            |
| Brown et al., 2010  | 1.11  | [0.90; 1.37] | 4.3%            |
| Butler et al., 2016 | 1.15  | [0.91; 1.45] | 4.2%            |
| Chen et al., 2014   | 1.07  | [0.93; 1.22] | 4.3%            |
| Croghan et al., 2009 | 3.32  | [1.21; 9.11] | 2.9%            |
| Ellingjord-Dale et al., 2017 | 27.95 | [24.09, 32.43] | 4.3% |
| Galukande et al., 2016 | 1.08  | [0.99; 1.17] | 4.3%            |
| Gibson et al., 2010 | 1.19  | [0.64; 2.21] | 3.7%            |
| Ginsburg et al., 2009 | 1.03  | [0.92; 1.15] | 4.3%            |
| Hu et al., 2013     | 1.21  | [0.48; 3.03] | 3.1%            |
| Illic et al., 2014  | 0.87  | [0.57; 1.33] | 4.0%            |
| Kawai et al., 2014  | 1.25  | [1.03; 1.51] | 4.3%            |
| Kufman et al., 2008 | 11.44 | [6.05; 21.65] | 3.6% |
| Li et al., 2020     | 1.04  | [0.95; 1.14] | 4.3%            |
| Liu et al., 2017    | 2.16  | [1.14; 4.09] | 3.6%            |
| Luo et al., 2011    | 0.93  | [0.88; 0.99] | 4.3%            |
| Mckenzie et al., 2013 | 0.96  | [0.85; 1.09] | 4.3%            |
| Nishino et al., 2014 | 1.70  | [1.42; 2.03] | 4.3%            |
| Pirie et al., 2008  | 1.08  | [0.87; 1.33] | 4.2%            |
| Sandsveden et al., 2017 | 1.13  | [0.96; 1.33] | 4.3%            |
| Shore et al., 2008  | 0.95  | [0.75; 1.21] | 4.2%            |
| Xu et al., 2012     | 0.78  | [0.37; 1.64] | 3.4%            |
| Yu et al., 2021     | 1.78  | [1.02; 3.10] | 3.8%            |
| Fixed effect model  | 1.27  | [1.23; 1.31] | --              |
| Random effects model| 1.45  | [1.08; 1.97] | 100.0%          |

Heterogeneity: \( I^2 = 99\% \), \( \chi^2 = 1930.79 \) (\( p = 0 \))

**Figure 2:** Forest plot showing the smoking influence on breast cancer.
developed countries (Figure 4). Besides, the odds of having breast cancer were higher among smoker women residing in developed countries (OR: 3.66, \( p < 0.01, I^2 = 87\% \)) than in women who smoked in developing countries (Figure 5).

At the 5% level of significance, Egger's test for a regression intercept produced nonsignificant \( p \) values of 0.3694 (smoking) and 0.0884 (abortion). It implies that there is no asymmetry in the funnel plot, which is compatible with the absence of publication bias. Therefore, the funnel plots depicted in Figures 6 and 7 show no evidence of publication bias.

### 4. Discussion

The purpose of this study is to systematically identify the degree of association between three lifestyle-related indicators (e.g., abortion, smoking, and alcohol consumption) and breast cancer risk in women in developed and least developed countries. Based on a systematic review of observational studies published in 2020 in PubMed, Wiley, and ScienceDirect, the study was analyzed. According to the author’s best knowledge, this is one of the first studies to execute a meta-analysis of tracking breast cancer risk using three lifestyle-related indicators. The random effects model in the meta-analysis found that exposure to smoking and abortion was significantly related to the chance of developing breast cancer.

Women who smoked had a 45 percent greater likelihood of having breast cancer than women who did not smoke. Smoking appears to raise the chance of developing breast cancer in both developed and developing countries. The positive relationship between smoking and breast cancer that was discovered in the present studies was consistent with previous research [50–53]. The increased risk of breast cancer associated with smoking could be responsible for the impaired metabolic and immune systems compared to nonsmokers. For instance, a previous study mentioned that tobacco smoke had a substantial adverse influence on endocrine function [50]. This might have also contributed to having worse steroid-responsive tissues and a decreased rate of endometrial neoplasia, accounting for smoking as a human carcinogen.

Individuals with a history of abortion were also found to have an increased chance of developing breast cancer. A meta-analysis reached a similar conclusion, indicating that abortion increases women’s risk of breast cancer [54]. Earlier studies that support this assertion have also found a statistically significant relationship between abortion and breast cancer risk [55, 56]. Contrary to this finding, two recent studies showed that women who do abortions have no influence on developing breast cancer [57–59]. The conflict could be due to variations in the environment, information, methodology, and so on. The precise data for abortion is arduous to gather as it is a very private incident for every individual. Therefore, it is argued that the combined effects of several articles increased the validity and accuracy of the present study findings.

In keeping with the findings of past systematic reviews, this investigation found no statistically significant relationship between alcohol use and breast cancer risk [60, 61]. The underreporting or absence of alcohol consumption in religious countries is one of the key factors

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**Table 4: Summary of the random effects and fixed effects models for induced abortion.**

| Author            | Country                  | OR    | 95% CI         | Fixed effect (%) | Random effect (%) |
|-------------------|--------------------------|-------|----------------|------------------|-------------------|
| Ahmed et al., 2015| Bangladesh               | 4.73  | [2.07;10.83]   | 0.3              | 3.1               |
| Balekouzou et al., 2017 | Central African Republic | 4.78  | [3.24;7.06]    | 1.0              | 5.0               |
| Becher et al., 2003 | Germany                 | 1.35  | [1.03;1.77]    | 3.9              | 5.5               |
| Daling et al., 1994 | USA                     | 0.95  | [0.76;1.18]    | 7.4              | 5.7               |
| Daling et al., 1996 | USA                     | 1.08  | [0.89;1.31]    | 9.1              | 5.8               |
| Giangreco et al., 2003 | USA               | 0.76  | [0.55;1.06]    | 3.8              | 5.3               |
| Gilani et al., 2004  | Pakistan               | 1.72  | [1.30;2.28]    | 3.2              | 5.5               |
| Hosseinizadeh et al., 2014 | Iran            | 1.69  | [1.12;2.56]    | 1.5              | 4.9               |
| Jiang et al., 2012  | China                   | 1.36  | [0.94;1.97]    | 2.2              | 5.1               |
| Karim et al., 2015  | Saudi Arabia            | 0.79  | [0.45;1.39]    | 1.2              | 4.2               |
| Lipworth et al., 1995 | Greece                | 1.33  | [1.12;1.59]    | 10.1             | 5.9               |
| Parazzini et al., 1991 | Italy             | 1.06  | [0.91;1.24]    | 13.8             | 5.9               |
| Rao et al., 1994   | India                   | 0.74  | [0.54;1.03]    | 3.8              | 5.3               |
| Robertson et al., 2001 | Slovenia         | 1.03  | [0.82;1.29]    | 6.6              | 5.7               |
| Rookus et al., 1996 | Netherlands            | 1.59  | [1.04;2.44]    | 1.5              | 4.8               |
| Wang et al., 2011  | China                   | 0.77  | [0.58;1.04]    | 4.6              | 5.4               |
| Xu et al., 2012    | China                   | 1.01  | [0.80;1.26]    | 6.7              | 5.7               |
| Ye et al., 2002    | China                   | 0.93  | [0.80;1.08]    | 16.3             | 5.9               |
| Yunan et al., 2019 | China                   | 1.40  | [1.03;1.90]    | 3.1              | 5.4               |
| Pooled (random)    |                         | 1.25  | [1.01;1.53]    | 100%             | 100%              |

\[ Q = 117.96 \]
\[ df = 18 \]
\[ P - value < 0.0001 \]
\[ I^2 = 84.7\% \]
\[ τ^2 = 0.18 \]
explaining the absence of a relationship between alcohol consumption and breast cancer risk. In the literature, however, there were inconsistent findings about the relationship between alcohol use and breast cancer risk [62, 63]. Arguably, the inconsistency may be explained by the prevalence, dose, and type of alcohol consumption due to its non-normative patterns [61, 64]. Thus, because the present study used the most recently published articles, the influence of diverse alcohol consumption incidents varied from country to country. However, some biological factors are correspondingly impactful in this regard. Therefore, further research is required on a large scale to identify the effects of different types of alcohol consumption and treatments on breast cancer risk.

This current study also includes a subgroup analysis to demonstrate the effects of abortion and smoking on breast cancer in developing and developed countries. The risk of breast cancer is greater across developing territories because of abortion than in developed countries, consistent with an earlier study [65]. The nonutilization and unavailability of
contraceptives among women in developing countries are observed, which increases the abortion rate [66]. Therefore, this discrepancy occurs due to birth control awareness restrictions in developing and developed settings. Besides, smoking is a sensitive factor in breast cancer in developed countries compared to developing countries. A study conducted with data from 187 countries similarly reveals that smoking influences breast cancer [67]. The possible reason might be that antismoking laws like MPOWER measures are not strictly followed in developed countries, provoking the increased possibility of smoking [68].

Smoking and abortion are two risk factors for breast cancer among women in developed and least developed countries, as shown in the present study. Strengthening the implementation of MPOWER policies might help create awareness among women about the hazards of smoking. In addition, multifaceted interventions like government, nongovernment, and NGO’s health programs based on sexuality education, unintended pregnancy awareness, and effective contraception and emergency contraception are needed to reduce abortion in society, thus controlling the risk of breast cancer. Besides, comprehensive science-based strategies for developed and developing countries might be designed individually to create awareness about the risks of abortion and smoking.

Thus, smoking and induced abortion are connected with breast cancer in different nations, which has clinical significance. Its explication will aid health organizations and

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| Study            | OR  | Odds Ratio        | Weight |
|------------------|-----|-------------------|--------|
| Ahmed et al., 2015 | 4.73| [2.07; 10.83]     | 3.1%   |
| Balekouzou et al., 2017 | 4.78| [3.24; 7.06]     | 5.0%   |
| Gilani et al., 2004 | 1.72| [1.30; 2.28]     | 5.5%   |
| Hosseinzadeh et al., 2014 | 1.69| [1.12; 2.56]     | 4.9%   |
| Jiang et al., 2012 | 1.36| [0.94; 1.97]     | 5.1%   |
| Karim et al., 2015 | 0.79| [0.45; 1.39]     | 4.2%   |
| Rao et al., 1994 | 0.74| [0.54; 1.03]     | 5.3%   |
| Wang et al., 2011 | 0.77| [0.58; 1.04]     | 5.4%   |
| Xu et al., 2012 | 1.01| [0.80; 1.26]     | 5.7%   |
| Ye et al., 2002 | 0.93| [0.80; 1.08]     | 5.9%   |
| Yunan et al., 2019 | 1.40| [1.03; 1.90]     | 5.4%   |
| Common effect model | 1.16| [1.06; 1.26] | -- |
| Random effects model | 1.39| [0.96; 2.00] | 55.4% |

Heterogeneity: $I^2 = 90\%$, $\chi^2 = 100.55$ ($p < 0.01$)

**Developed Country**

| Study            | OR  | Odds Ratio        | Weight |
|------------------|-----|-------------------|--------|
| Becher et al., 2003 | 1.35| [1.03; 1.77]     | 5.5%   |
| Daling et al., 1994 | 0.95| [0.76; 1.18]     | 5.7%   |
| Daling et al., 1996 | 1.08| [0.89; 1.31]     | 5.8%   |
| Giangreco et al., 2003 | 0.76| [0.55; 1.06]     | 5.3%   |
| Lipworth et al., 1995 | 1.33| [1.12; 1.59]     | 5.9%   |
| Parazzini et al., 1991 | 1.06| [0.91; 1.24]     | 5.9%   |
| Robertson et al., 2001 | 1.03| [0.82; 1.29]     | 5.7%   |
| Rookus et al., 1996 | 1.59| [1.04; 2.44]     | 4.8%   |
| Common effect model | 1.11| [1.03; 1.20] | -- |
| Random effects model | 1.11| [0.98; 1.25] | 44.6% |

Heterogeneity: $I^2 = 59\%$, $\chi^2 = 17.02$ ($p < 0.02$)

Common effect model | 1.13| [1.07; 1.20] | -- |
| Random effects model | 1.25| [1.01; 1.53] | 100.0% |

Test for subgroup differences (fixes effects): $\chi^2 = 0.05$, $df = 2$ ($p = 0.47$)

Test for subgroup differences (random effects): $\chi^2 = 1.33$, $df = 1$ ($p = 0.25$)

**Figure 4:** Forest plot showing subgroup analysis expressing the influence of induced abortion case by country status (developing or developed) on breast cancer.
stakeholders in establishing comprehensive scientific plans to promote awareness about the risks of abortion and smoking in women. This agreement is supported by the extant literature [69, 70]. A study on breast cancer patients determined that awareness of the benefits of quitting smoking is related to a reduction in breast cancer severity [69].

5. Strength and Limitation

There are numerous unique strengths in the present study. Firstly, the methodology is the main advantage, as the systematic reviews combine findings from several published studies and draw a pooled conclusion from them. Secondly, this study considered three exposures to identify their

| Study                        | OR  | Odds Ratio | Weight |
|------------------------------|-----|------------|--------|
| Developed Countries          |     |            |        |
| Ahles et al., 2014           | 0.99| [0.49; 2.01]| 3.5%   |
| Berrandou et al., 2019       | 0.97| [0.82; 1.15]| 4.3%   |
| Bidstrup et al., 2013         | 1.26| [0.90; 1.76]| 4.1%   |
| Brown et al., 2010           | 1.11| [0.90; 1.37]| 4.3%   |
| Butler et al., 2016          | 1.15| [0.91; 1.45]| 4.2%   |
| Chen et al., 2014             | 1.07| [0.93; 1.22]| 4.3%   |
| Ellingjord-Date et al., 2017 | 27.95| [24.09; 32.43]| 4.3%   |
| Galukande et al., 2016        | 1.08| [0.99; 1.17]| 4.3%   |
| Ginsburg et al., 2009         | 1.03| [0.92; 1.15]| 4.3%   |
| Kawai et al., 2014            | 1.25| [1.03; 1.51]| 4.3%   |
| Kufman et al., 2008           | 11.44| [6.05; 21.65]| 3.6%   |
| Luo et al., 2011              | 0.93| [0.88; 0.99]| 4.3%   |
| Mckenzie et al., 2013         | 0.96| [0.85; 1.09]| 4.3%   |
| Nishino et al., 2014          | 1.70| [1.42; 2.03]| 4.3%   |
| Pirie et al., 2008            | 1.08| [0.87; 1.33]| 4.2%   |
| Sandsveden et al., 2017       | 1.13| [0.96; 1.33]| 4.3%   |
| Shore et al., 2008            | 0.95| [0.75; 1.21]| 4.2%   |
| Fixed effect model            | 1.30| [1.26; 1.34]| --     |
| Random effects model          | 1.51| [1.02; 2.22]| 71.2%  |

Heterogeneity: $I^2 = 99\%$, $\chi^2 = 1907.51 \ (p = 0)$

Developed Countries

| Study                        | OR  | Odds Ratio | Weight |
|------------------------------|-----|------------|--------|
| Croghan et al., 2009         | 3.32| [1.21; 9.11]| 2.9%   |
| Gibson et al., 2010           | 1.19| [0.64; 2.21]| 3.7%   |
| Hu et al., 2013               | 1.21| [0.48; 3.03]| 3.1%   |
| Ilic et al., 2014             | 0.87| [0.57; 1.33]| 4.0%   |
| Li et al., 2020               | 1.04| [0.95; 1.14]| 4.3%   |
| LiU et al., 2017              | 2.16| [1.14; 4.09]| 3.6%   |
| Xu et al., 2012               | 0.78| [0.37; 1.64]| 3.4%   |
| Yu et al., 2021               | 1.78| [1.02; 3.10]| 3.8%   |
| Fixed effect model            | 1.07| [0.98; 1.16]| --     |
| Random effects model          | 1.25| [0.96; 1.62]| 28.8%  |

Heterogeneity: $I^2 = 53\%$, $\chi^2 = 14.95 \ (p = 0.04)$

Fixed effect model

| OR  | Odds Ratio | Weight |
|-----|------------|--------|
| 1.27| [1.23; 1.31]| --     |
| 1.45| [1.08; 1.97]| 100.0% |

Heterogeneity: $I^2 = 99\%$, $\chi^2 = 1930.79 \ (p = 0)$

**Figure 5:** Forest plot showing subgroup analysis expressing the influence of smoking by country status (developing or developed) on breast cancer.
relationship with breast cancer risk. Thirdly, subgroup analysis appends an additional advanced dimension to the current study.

The current study is not without limitations. Firstly, the methodology follows observational trials that restrict the nature of the generalizability of the study findings [45]. Secondly, the unavailability of factors such as genetic factors or family factors was not appended, which might contribute to the risk of breast cancer. Additionally, underreporting or the absence of alcohol consumption in religious countries could introduce bias into the study.

6. Conclusion

Initially, the risk of breast cancer was not associated with smoking-related cancer. Over time, however, sufficient evidence has accumulated to suggest that smoking is correlated with an increased risk of breast cancer. Although this study found no correlation between drinking and breast cancer, it did find a substantial association between induced abortion and breast cancer. This study reveals that the risk of breast cancer linked to smoking is higher in developed nations than in developing countries. So, the authority should consider...
these influences and make their strategies to raise awareness accordingly among people to reduce the smoking habit for a better healthcare situation in their respective countries.

**Data Availability**

The data supporting the findings of this study are available from the corresponding author upon request.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

**Authors’ Contributions**

Akhtarul Islam conceptualized the study. Akhtarul Islam was in charge of duration. Nusrat Jahan Sathi, Hossain Mohammad Abdullah, and Tarana Tabassum was in charge of formal analysis. Akhtarul Islam and Nusrat Jahan Sathi was in charge of investigation. Akhtarul Islam, Nusrat Jahan Sathi, Hossain Mohammad Abdullah, and Tarana Tabassum was in charge of methodology. Akhtarul Islam and Nusrat Jahan Sathi handled resources. Akhtarul Islam were in charge of software. Akhtarul Islam and Nusrat Jahan Sathi supervised the study. Akhtarul Islam was in charge of writing original draft. Akhtarul Islam, Nusrat Jahan Sathi, Hossain Mohammad Abdullah, and Tarana Tabassum were in charge of writing review and editing.

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**Supplementary Materials**

S1: a comprehensive search strategy for each database. (Supplementary Materials)

**References**

[1] M. Ellingjord-Dale, L. Vos, K. V. Hjerkind et al., “Alcohol, physical activity, smoking, and breast cancer subtypes in a large, nested case–control study from the Norwegian breast cancer screening program,” Cancer Epidemiology, Biomarkers & Prevention, vol. 26, no. 12, pp. 1736–1744, 2017.

[2] J. Ferlay, H. R. Shin, F. Bray, D. Forman, C. Mathers, and D. M. Parkin, “Estimates of worldwide burden of cancer in 2008: GLOBOCAN 2008,” International Journal of Cancer, vol. 127, no. 12, pp. 2893–2917, 2010.

[3] R. Babita, N. Kumar, R. Karwasa, M. Singh, J. Malik, and A. Kaur, “Reproductive risk factors associated with breast carcinoma in a tertiary care hospital of north India: a case-control study,” Indian Journal of Cancer, vol. 51, no. 3, p. 251, 2014.

[4] F. Bray, J. Ferlay, I. Soerjomataram, R. L. Siegel, L. A. Torre, and A. Jemal, “Global cancer statistics 2018: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries,” CA: A Cancer Journal for Clinicians, vol. 68, no. 6, pp. 394–424, 2018.

[5] E. Panieri, “Breast cancer screening in developing countries,” Best Practice & Research Clinical Obstetrics & Gynaecology, vol. 26, no. 2, pp. 283–290, 2012.

[6] R. A. da Costa Vieira, G. Bilger, G. Uemura, C. A. Ruiz, and M. P. Curado, “Breast cancer screening in developing countries,” Clinics, vol. 72, no. 4, pp. 244–253, 2017.

[7] A. Jemal, M. M. Center, C. DeSantis, and E. M. Ward, “Global patterns of cancer incidence and mortality rates and trends,” Cancer Epidemiology, Biomarkers & Prevention, vol. 19, no. 8, pp. 1893–1907, 2010.

[8] R. Ghasavand, H.-O. Adami, I. Harirchi, R. Akrami, and K. Zendehebel, “Higher incidence of premenopausal breast cancer in less developed countries; myth or truth?” BMC Cancer, vol. 14, no. 1, pp. 343–348, 2014.

[9] F. Kamangar, G. M. Dores, and W. F. Anderson, “Patterns of cancer incidence, mortality, and prevalence across five continents: defining priorities to reduce cancer disparities in different geographic regions of the world,” Journal of Clinical Oncology, vol. 24, no. 14, pp. 2137–2150, 2006.

[10] A. Balekouzou, P. Yin, C. M. Pamatika et al., “Reproductive risk factors associated with breast cancer in women in Bangui: a case–control study,” BMC Women’s Health, vol. 17, no. 1, pp. 14–19, 2017.

[11] R. M. Tamimi, D. Spiegelman, S. A. Smith-Warner et al., “Population attributable risk of modifiable and nonmodifiable breast cancer risk factors in postmenopausal breast cancer,” American Journal of Epidemiology, vol. 184, no. 12, pp. 884–893, 2016.

[12] Breastcancer.org. Breast Cancer Risk Factors 2016, https://www.breastcancer.org/symptoms/understand_bc/risk/factors.

[13] M. S. Rice, A. H. Eliassen, S. E. Hankinson, E. B. Lenart, W. C. Willett, and R. M. Tamimi, “Breast cancer research in the nurses’ health studies: exposures across the life course,” American Journal of Public Health, vol. 106, no. 9, pp. 1592–1598, 2016.

[14] J. Kerr, C. Anderson, and S. M. Lippman, “Physical activity, sedentary behaviour, diet, and cancer: an update and emerging new evidence,” The Lancet Oncology, vol. 18, no. 8, pp. e457–e471, 2017.

[15] G. K. Reeves, S. W. Kan, T. Key et al., “Breast cancer risk in relation to abortion: results from the EPIC study,” International Journal of Cancer, vol. 119, no. 7, pp. 1741–1745, 2006.

[16] M. Gago-Dominguez, J. E. Castela, F. Gude et al., “Alcohol and breast cancer tumor subtypes in a Spanish Cohort,” Springerplus, vol. 5, no. 1, pp. 39–9, 2016.

[17] L. Strumylaite, S. J. Sharp, R. Kregzdyte, L. Poskiene, A. Bogusevicius, and D. Pranys, “The association of low-to-moderate alcohol consumption with breast cancer subtypes defined by hormone receptor status,” PLoS One, vol. 10, no. 12, Article ID e0144680, 2015.

[18] G. Fagherazzi, A. Vilier, M.-C. Boutron-Ruault, S. Mesrine, and F. Clavel-Chapelon, “Alcohol consumption and breast cancer risk subtypes in the E3N-EPIC cohort,” European Journal of Cancer Prevention, vol. 24, no. 3, pp. 209–214, 2015.

[19] R. T. Falk, P. Maas, C. Schairer et al., “Alcohol and risk of breast cancer in postmenopausal women: an analysis of etiological heterogeneity by multiple tumor characteristics,” American Journal of Epidemiology, vol. 180, no. 7, pp. 705–717, 2014.

[20] G. C. Kabat, M. Kim, A. I. Phipps et al., “Smoking and alcohol consumption in relation to risk of triple-negative breast cancer in postmenopausal women in the nurses’ health studies: exposures across the life course,” American Journal of Epidemiology, vol. 180, no. 7, pp. 705–717, 2014.
cancer in a cohort of postmenopausal women,” *Cancer Causes & Control*, vol. 22, no. 5, pp. 775–783, 2011.

[21] S. Jung, M. Wang, K. Anderson et al., “Alcohol consumption and breast cancer risk by estrogen receptor status: in a pooled analysis of 20 studies,” *International Journal of Epidemiology*, vol. 45, no. 3, pp. 916–928, 2016.

[22] K. A. Hirko, W. Y. Chen, W. C. Willett et al., “Alcohol consumption and risk of breast cancer by molecular subtype: prospective analysis of the nurses’ health study after 26 years of follow-up,” *International Journal of Cancer*, vol. 138, no. 5, pp. 1094–1101, 2016.

[23] A. Tjonneland, J. Christensen, B. L. Thomsen et al., “Lifetime alcohol consumption and postmenopausal breast cancer rate in Denmark: a prospective cohort study,” *Journal of Nutrition*, vol. 134, no. 1, pp. 173–178, 2004.

[24] R. Suzuki, N. Orsini, L. Mignone, S. Saji, and A. Wolk, “Alcohol intake and risk of breast cancer defined by estrogen and progesterone receptor status—a meta-analysis of epidemiological studies,” *International Journal of Cancer*, vol. 122, no. 8, pp. 1832–1841, 2007.

[25] M. Kawai, K. E. Malone, M. T. C. Tang, and C. I. Li, “Active smoking and the risk of estrogen receptor-positive and triple-negative breast cancer among women ages 20 to 44 years,” *Cancer*, vol. 120, no. 7, pp. 1026–1034, 2014.

[26] Y. Nishino, Y. Minami, M. Kawai et al., “Cigarette smoking and breast cancer risk in relation to joint estrogen and progesterone receptor status: a case-control study in Japan,” *Springerplus*, vol. 3, no. 1, pp. 65–15, 2014.

[27] E. N. Butler, C.-K. Tse, M. E. Bell, K. Conway, A. F. Olshan, and M. A. Troester, “Active smoking and risk of luminal and basal-like breast cancer subtypes in the Carolina breast cancer study,” *Cancer Causes & Control*, vol. 27, no. 6, pp. 775–786, 2016.

[28] A. Morabia, M. Bernstein, J. Ruiz, S. Héritier, S. Diebold Berger, and B. Borisch, “Relation of smoking to breast cancer by estrogen receptor status,” *International Journal of Cancer*, vol. 75, no. 3, pp. 339–342, 1998.

[29] L. Dossus, M. C. Boutron-Ruault, R. Kaaks et al., “Active and passive cigarette smoking and breast cancer risk: results from the EPIC cohort,” *International Journal of Cancer*, vol. 134, no. 8, pp. 1871–1888, 2014.

[30] J. Brind, S. I. Condly, A. Lanfranchi, and B. Rooney, “Induced abortion as an independent risk factor for breast cancer: a systematic review and meta-analysis of studies on south Asian women,” *Issues in Law & Medicine*, vol. 33, no. 1, pp. 32–54, 2018.

[31] X. Yuan, F. Yi, C. Hou, H. Lee, X. Zhong, and P. Tao, “Induced abortion, birth control methods, and breast cancer risk: a case-control study in China,” *Journal of Epidemiology*, vol. 29, no. 5, pp. 173–179, 2018.

[32] P. D. Terry and T. E. Rohan, “Cigarette smoking and the risk of breast cancer in women: a review of the literature,” *Cancer Epidemiology, Biomarkers & Prevention: A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, vol. 11, no. 10 Pt 1, pp. 953–971, 2002.

[33] S. S. Hecht, “Tobacco smoke carcinogens and breast, *Environmental and Molecular Mutagenesis*, vol. 39, no. 2-3, pp. 119–126, 2002.

[34] Collaborative Group on Hormonal Factors in Breast Cancer, “Alcohol, tobacco and breast cancer–collaborative reanalysis of individual data from 53 epidemiological studies, including 58 515 women with breast cancer and 95 067 women without the disease,” *British Journal of Cancer*, vol. 87, no. 11, pp. 1234–1245, 2002.

[35] P. D. Terry and M. Goodman, “Is the association between cigarette smoking and breast cancer modified by genotype? a review of epidemiologic studies and meta-analysis,” *Cancer Epidemiology, Biomarkers & Prevention*, vol. 15, no. 4, pp. 602–611, 2006.

[36] H. Li, M. B. Terry, A. C. Antoniou et al., “Alcohol consumption, cigarette smoking, and risk of breast cancer for BRCA1 and BRCA2 mutation carriers: results from the BRCA1 and BRCA2 cohort consortium,” *Cancer Epidemiology, Biomarkers & Prevention: A Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, vol. 29, no. 2, pp. 368–378, 2020.

[37] A. Morabia, “Smoking (active and passive) and breast cancer: epidemiologic evidence up to June 2001,” *Environmental and Molecular Mutagenesis*, vol. 39, no. 2-3, pp. 89–95, 2002.

[38] M. Melbye, J. Wohlfahrt, J. H. Olsen et al., “Induced abortion and the risk of breast cancer,” *New England Journal of Medicine*, vol. 336, no. 2, pp. 81–85, 1997.

[39] D. H. Brewster, D. L. Stockton, R. Dobbie, D. Bull, and V. Beral, “Risk of breast cancer after miscarriage or induced abortion: a Scottish record linkage case-control study,” *Journal of Epidemiology & Community Health*, vol. 59, no. 4, pp. 283–287, 2005.

[40] C. M. Braüner, K. Overvad, A. Tjonneland, and J. Attemann, “Induced abortion and breast cancer among parous women: a Danish cohort study,” *Acta Obstetricia et Gynecologica Scandinavica*, vol. 92, no. 6, pp. 700–705, 2013.

[41] Y. Huang, X. Zhang, W. Li et al., “A meta-analysis of the association between induced abortion and breast cancer risk among Chinese females,” *Cancer Causes & Control*, vol. 25, no. 2, pp. 227–236, 2014.

[42] J. P. T. Higgins, S. G. Thompson, J. J. Deeks, and D. G. Altman, “Measuring inconsistency in meta-analyses,” *BMJ*, vol. 327, no. 7414, pp. 557–560, 2003.

[43] R. DerSimonian and N. Laird, “Meta-analysis in clinical trials,” *Controlled Clinical Trials*, vol. 7, no. 3, pp. 177–188, 1986.

[44] M. Borenstein, L. V. Hedges, J. P. Higgins, and H. R. Rothstein, “A basic introduction to fixed-effect and random-effects models for meta-analysis,” *Research Synthesis Methods*, vol. 1, no. 2, pp. 97–111, 2010.

[45] M. Borenstein, L. V. Hedges, J. P. Higgins, and H. R. Rothstein, *Introduction to Meta-Analysis*, John Wiley & Sons, New York, NY, USA, 2021.

[46] A. P. Verhagen and M. L. Ferreira, “Forest plots,” *Journal of Physiotherapy*, vol. 60, no. 3, pp. 170–173, 2014.

[47] N. A. Patsopoulos, E. Evangelou, and J. P. Ioannidis, “Sensitivity of between-study heterogeneity in meta-analysis: proposed metrics and empirical evaluation,” *International Journal of Epidemiology*, vol. 37, no. 5, pp. 1148–1157, 2008.

[48] M. Szumilas, “Explaining odds ratios,” *Journal of the Canadian Academy of Child and Adolescent psychiatry*, vol. 19, no. 3, pp. 227–229, 2010.

[49] M. Egger, G. D. Smith, M. Schneider, and C. Minder, “Bias in meta-analysis detected by a simple, graphical test,” *BMJ*, vol. 315, no. 7019, pp. 629–634, 1997.

[50] K. M. Egan, M. J. Stampfer, D. Hunter et al., “Active and passive smoking in breast cancer: prospective results from the nurses’ health study,” *Epidemiology*, vol. 13, no. 2, pp. 138–145, 2002.
[51] M. M. Gaudet, S. M. Gapstur, J. Sun, W. R. Diver, L. M. Hannan, and M. J. Thun, “Active smoking and breast cancer risk: original cohort data and meta-analysis,” *Journal of the National Cancer Institute: Journal of the National Cancer Institute*, vol. 105, no. 8, pp. 515–525, 2013.

[52] C. Catsburg, A. B. Miller, and T. E. Rohan, “Active cigarette smoking and risk of breast cancer,” *International Journal of Cancer*, vol. 136, no. 9, pp. 2204–2209, 2015.

[53] P. Reynolds, S. Hurley, D. E. Goldberg et al., “Active smoking, household passive smoking, and breast cancer: evidence from the California teachers study,” *JNCI Journal of the National Cancer Institute*, vol. 96, no. 1, pp. 29–37, 2004.

[54] J. Brind, V. M. Chinchilli, W. B. Severs, and J. Summy-Long, “Induced abortion as an independent risk factor for breast cancer: a comprehensive review and meta-analysis,” *Journal of Epidemiology & Community Health*, vol. 50, no. 5, pp. 481–496, 1996.

[55] M. C. Pike, B. E. Henderson, J. T. Casagrande, I. Rosario, and G. E. Gray, “Oral contraceptive use and early abortion as risk factors for breast cancer in young women,” *British Journal of Cancer*, vol. 43, no. 1, pp. 72–76, 1981.

[56] H. L. Howe, R. T. Senie, H. Bzduch, and P. Herzfeld, “Early abortion and breast cancer risk among women under age 40,” *International Journal of Epidemiology*, vol. 18, no. 2, pp. 300–304, 1989.

[57] M. Mahue-Giangreco, G. Ursin, J. Sullivan-Halley, and L. Bernstein, “Induced abortion, miscarriage, and breast cancer risk of young women,” *Cancer Epidemiology, Biomarkers & Prevention: a Publication of the American Association for Cancer Research, Cosponsored by the American Society of Preventive Oncology*, vol. 12, no. 3, pp. 209–214, 2003.

[58] M. Sanderson, X. O. Shu, F. Jin et al., “Abortion history and breast cancer risk: results from the Shanghai breast cancer study,” *International Journal of Cancer*, vol. 92, no. 6, pp. 899–905, 2001.

[59] L. Lipworth, K. Katsouyanni, A. Ekbom, K. B. Michels, and D. Trichopoulos, “Induced abortion and the risk of breast cancer: a case-control study in Greece,” *International Journal of Cancer*, vol. 61, no. 2, pp. 181–184, 1995.

[60] C. Nagata, T. Mizoue, K. Tanaka et al., “Alcohol drinking and breast cancer risk: an evaluation based on a systematic review of epidemiologic evidence among the Japanese population,” *Japanese Journal of Clinical Oncology*, vol. 37, no. 8, pp. 568–574, 2007.

[61] Y. Gao, Y.-B. Huang, X.-O. Liu et al., “Tea consumption, alcohol drinking and physical activity associations with breast cancer risk among Chinese females: a systematic review and meta-analysis,” *Asian Pacific Journal of Cancer Prevention*, vol. 14, no. 12, pp. 7543–7550, 2013.

[62] S. M. Zhang, I.-M. Lee, J. E. Manson, N. R. Cook, W. C. Willett, and J. E. Buring, *Alcohol Consumption and Breast Cancer Risk in the Women’s Health Study*, AACR, Philadelphia, PA, USA, 2006.

[63] P. J. Brooks and S. Zakhari, “Moderate alcohol consumption and breast cancer in women: from epidemiology to mechanisms and interventions,” *Alcoholism: Clinical and Experimental Research*, vol. 37, no. 1, pp. 23–30, 2013.

[64] K. D. Shield, I. Soerjomataram, and J. Rehm, “Alcohol use and breast cancer: a critical review,” *Alcoholism: Clinical and Experimental Research*, vol. 40, no. 6, pp. 1166–1181, 2016.

[65] I. H. Shah and E. Ahman, “Unsafe abortion differentials in 2008 by age and developing country region: high burden among young women,” *Reproductive Health Matters*, vol. 20, no. 39, pp. 169–173, 2012.

[66] M. T. Mbizvo and S. J. Phillips, “Family planning: choices and challenges for developing countries,” *Best Practice & Research Clinical Obstetrics & Gynaecology*, vol. 28, no. 6, pp. 931–943, 2014.

[67] M. Ng, M. K. Freeman, T. D. Fleming et al., “Smoking prevalence and cigarette consumption in 187 countries, 1980–2012,” *JAMA*, vol. 311, no. 2, pp. 183–192, 2014.

[68] GBD 2015 Tobacco Collaborators, N. Fullman, M. Ng, J. S. Salama, A. Abajobir, and K. H. Abate, “Smoking prevalence and attributable disease burden in 195 countries and territories, 1990–2015: a systematic analysis from the global burden of disease study 2015,” *Lancet (London, England)*, vol. 389, no. 10082, pp. 1885–1906, 2017.

[69] A. Singareeka Raghavendra, G. Kypriotakis, M. Karam-Hage et al., “The impact of treatment for smoking on breast cancer patients’ survival,” *Cancers*, vol. 14, no. 6, p. 1464, 2022.

[70] P. Jasen, “Breast cancer and the politics of abortion in the United States,” *Medical History*, vol. 49, no. 4, pp. 423–444, 2005.