

The Breast Cancer Screening Gap in Muslim-Majority Countries: Beyond Human Development Index

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Research Article

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Abstract

Countries with a greater Human Development Index (HDI) have greater breast cancer incidence rates compared to those with lower developmental statuses, but Muslim-majority countries do not follow this pattern, raising concerns about why Muslim countries have overall lower incidence rates regardless of HDI. The goal of this study was to examine the relationship between HDI, Muslim population percentage, and breast cancer incidence rates across countries to address a gap in breast cancer incidence and provide reasoning as to why a gap might be present. Breast cancer data from the GLOBOCAN database of the age-adjusted incidence of breast cancer were taken for 46 Muslim-majority countries (> 50% Muslim population) and 14 non-Muslim territories for a total of $n = 60$ countries, and countries were grouped into high and low HDI. Welch's t-tests compared average ASR between high- and low-HDI Muslim-majority countries, and between high-HDI Muslim-majority and high-HDI non-Muslim countries, and Linear regression assessed the relationship between percent Muslim population and breast cancer incidence. Among Muslim-majority countries, high-HDI countries had significantly greater average incidence rates than low-HDI countries ($p = 0.0047$). However, when comparing only high-HDI countries, Muslim-majority countries had significantly lower incidence rates than non-Muslim countries ($p = 2.48e-11$). Linear regression showed a statistically significant negative correlation between percent Muslim population and breast cancer incidence rates ($R^2 = 0.144$, $p = 0.0085$). Muslim-majority countries do not follow the global trends between HDI and breast cancer incidence, since even high HDI countries have lower breast cancer incidence rates, suggesting that there is a significant screening gap in Muslim countries. These findings emphasize the need for culturally tailored breast cancer screening and awareness programs across Muslim-majority countries, regardless of development status.

Background

Breast cancer is the most frequently diagnosed cancer worldwide and accounts for 11.7% of new cancer cases in 2020 [1]. In previous studies, it has been shown that countries with a greater Human Development Index (HDI) have a greater incidence rate of breast cancer, while those with a lower HDI have a lower incidence rate comparatively [1]. This is due to many factors, such as lifestyle, cultural beliefs and norms, and access to screening and early detection methods [2]. Studies have also shown that there is a disparity in breast cancer incidence among different racial and ethnic groups due to socioeconomic factors, diet differences, and environmental exposures [1]. Studying these disparities and differences in data is important to address breast cancer risk reduction, prevention, and treatments in different countries and how each country's specific factors change the approach that can be adopted to reduce breast cancer incidence and increase breast cancer patient survivorship.

A prominent area of study for breast cancer incidence has been in Muslim countries because of an observed increase in cases in those countries [2]. The incidence of breast cancer in Muslim countries varies with the HDI of these countries, ranging from high to low [3]. It is important to keep this factor in mind since countries that are lower on the HDI have fewer incidences due to less access to screening and diagnostic resources, and countries that are higher on the HDI, such as the United States, have

higher incidences and sometimes overdiagnosis due to increased access to mammographies and other types of screening [4]. The objective of this study is to understand the effects of HDI on breast cancer incidence across Muslim countries, see if there is an association between the percent of Muslims in a country's population and the country's female breast cancer incidence rate, and to explore reasons and risk reduction strategies for the patterns present across countries. We hypothesize that there will be no significant difference in the breast cancer incidence rates when comparing Muslim countries with high HDI and low HDI, suggesting that HDI is not a major factor in the low incidence rates seen in Muslim majority countries.

Theoretical/Conceptual Framework

Epidemiology of Breast Cancer Across Muslim Countries

Figure 1 displays the data for the incidence of breast cancer for various Muslim countries from the 2022 GLOBOCAN database [5]. Countries were determined as Muslim by considering whether or not the percentage of Muslims in a country was 50% or greater using data from Pew Research Center [6]. Muslim countries are shown to have a lower incidence rate compared to other non-Muslim countries, which can be due to many factors, such as the Human Development Index as well as political and environmental factors. Countries on the lower end of the HDI, such as Sierra Leone, Burkina Faso, and Afghanistan [3], have corresponding age-adjusted incidence rates (ASRs) of 7.00, 21.4, and 29.4, respectively, which all fall in the lower quartile of ASRs for this data set. Countries on the higher end of the HDI, such as Algeria, Jordan, and Turkey [3], have corresponding ASRs of 61.9, 60.0, and 46.8, which all fall in the upper quartile of this data set. This suggests that countries with greater socioeconomic statuses have greater incidence rates than countries with a lower economic status. Previous studies show that countries with a high or increasing HDI often have a greater ASR; this is due to increased longevity, improved data collection and increased screening rates, and greater cancer awareness [7]. Countries with a lower HDI have a lower ASR but an increased mortality rate, which suggests that there is a gap in breast cancer screening and prevention in countries with a low ASR [7]. Although an increased ASR can seem alarming, it allows for greater breast cancer awareness and an increased response for breast cancer prevention and risk reduction strategies to be put in place.

The majority of Muslim countries fall in the intermediate/medium range of HDI [8], meaning that it is important to address the rising incidences of breast cancer in these countries and for these countries to adopt the appropriate preventative measures to decrease breast cancer mortalities. Part of this study explores the correlation between the percentage of Muslims in a country and the breast cancer incidence rate of that country, which can shed light on the measures Muslim countries could take to increase breast cancer awareness and risk reduction.

Methods

Data Collection

Breast cancer data from the GLOBOCAN database of the age-adjusted incidence of breast cancer were taken for 46 Muslim-majority countries (> 50% Muslim population) and 14 non-Muslim majority countries (< 50% Muslim population) for a total of $n = 60$ countries. The breast cancer data collected pertains only to women, meaning it is a given that each case is a woman [5].

Measures and Analysis

When comparing Muslim countries with high HDI and Low HDI, as well as between non-Muslim countries and Muslim countries both with high HDI, the HDI for each country was obtained from the Human Development Reports database [12]. Countries were grouped into high HDI if they had an index score greater than 0.50, and countries were grouped into low HDI if they had an index score less than 0.50. The average ASR of each group was taken with data from the GLOBOCAN database [5], and Welch's t-test was performed using RStudio to test for a significant difference between each group's averages. The groups compared were high HDI Muslim majority countries to low HDI Muslim majority countries, and high HDI non-Muslim majority countries with high HDI Muslim majority countries.

To check for correlation between the percentage of Muslims in a country's population and the percent of breast cancer incidences, the ASR of each country for breast cancer was changed to a percentage and the percent of Muslims per country was derived from the Pew Research Center [6]. Linear regression analysis was performed using RStudio to evaluate if there was a significant correlation between the percentage of the population identifying as Muslim and the age-standardized incidence rate of female breast cancer.

The statistical assumptions made were that breast cancer incidence and percent of Muslims in any given country are independent from one another, and that ASR is used to calculate the percent of women with breast cancer. ASR is often better than raw case counts because it adjusts for differences in age structure between countries.

Results

In Fig. 2, when comparing Muslim-majority countries with a high HDI ($n = 38$) and Muslim-majority countries with a low HDI ($n = 8$), there is a statistically significant difference in the average ASR of breast cancer in Muslim countries with a high HDI compared to Muslim countries with a low HDI, with a t-test p-value of 0.0047. Muslim countries with a greater HDI have significantly greater average ASR for breast cancer compared to Muslim countries with a low HDI, which aligns with current global trends [4].

In Fig. 3, when comparing Muslim majority countries with a high HDI ($n = 38$) and non-Muslim majority countries with a high HDI ($n = 25$), there is a significantly greater difference in the average ASR of breast cancer in non-Muslim countries with a high HDI compared to Muslim countries with a high HDI, with a t-

test p-value of 2.48×10^{-11} . Muslim majority countries with a high HDI have a significantly lower average ASR for breast cancer compared to non-Muslim majority countries.

In Fig. 4, the linear regression between the percent of Muslims in a given country and the corresponding breast cancer incidence yielded an R^2 of 0.144 and a p-value of 0.008512 (less than 0.05), indicating a statistically significant negative correlation between Muslim population percentage and breast cancer ASR.

Discussion

Figure 2 shows that within Muslim majority countries, ASRs follow suit with global trends when considering the HDI of each country. Muslim countries with a higher HDI have significantly greater recorded breast cancer incidences compared to countries with a lower HDI, mostly due to an increased number of screenings and preventative measures present in countries with more development [4]. However, Fig. 3 shows that when comparing between Muslim countries and non-Muslim majority countries which both have a high HDI, Muslim countries in this category have a significantly smaller ASR compared to non-Muslim countries. This suggests that although many Muslim countries are greatly developed, there is a significant gap in the number of recorded breast cancer incidences and screenings taking place compared to non-Muslim countries. To close this gap, it is important to consider reasons why this difference in breast cancer incidence rates may exist and ways to address this issue.

According to Fig. 4, an increased percentage of Muslims in a population corresponds to a decreased ASR, which can be used to understand the lower ASR in Muslim-majority countries. As previously mentioned, lower ASR rates are usually due to decreased access to screening and mammograms, which correspond to lower breast cancer awareness in these countries [7]. Although it is projected that Muslim countries will have an increase in breast cancer incidence [1], it is important to understand that these incidences are found through breast cancer screenings; this correlates to the ASR because it means it is an important statistic to measure what screening resources are needed to further prevent breast cancer risk. As previously mentioned, lower ASR means that there is usually a higher mortality rate since cancers are usually detected at a later stage [13]. In many Arab countries, most women present with metastatic breast cancer or large tumor sizes, indicating a decreased availability or willingness to undergo screening [14]. Getting an accurate incidence count of breast cancer in Muslim countries is important to be able to allocate the appropriate resources for breast cancer prevention and risk reduction.

Accuracy of breast cancer incidence can be assured by promoting breast cancer screening to Muslim women in the countries mentioned. As of now, there are many reasons why Muslim women may hesitate to get screenings, resulting in the lower ASRs above; reasons for this within the Muslim community are lack of awareness about breast cancer screening and mammographies, religious coping, breast cancer stigma, unfavorable political climates, perceived religious discrimination in healthcare settings, and language barriers [9]. In Muslim countries with lower socioeconomic groups, poor education is a

significant barrier that can prevent women from seeking the appropriate medical aid they need, causing a delay in diagnosis [1]. In many clinical settings, there is also a lack of cultural accommodation when it comes to mammograms and breast cancer screenings, causing a greater decrease in the number of Muslim women who can get proper diagnoses [10]. According to a previous survey study, the majority of breast cancer diagnoses made in Muslim countries arose from women presenting with symptoms rather than through a screening [11]. Women who were cared for in specialist settings were well informed about their diagnosis and condition, while women who were cared for in local hospitals that were not specialized were often lied to and were provided with incorrect advice, causing an increase in mistrust [11]. Negative societal reactions as well as limited family support for these women in Muslim-majority countries further decreased their willingness to appropriately address their breast cancer or to go for breast cancer screenings [11]. Although in Islam it is recommended to seek preventative medicine and to take care of one's body [1], cultural and socioeconomic pressures often prevent women in Muslim-dominant countries from seeking the medical aid they need.

In order to solve these education and care disparities, preventative measures could be adopted by Muslim countries. For example, increasing screening campaigns to create motivation to get a mammography outside physician care and governmental involvement in funding campaigns could increase the number of women who get mammograms [14]. In countries with a higher development index where decreased ASR is an issue, resources could be allocated to women's awareness programs as well as widespread screening programs. Using Islamic perspectives on upkeeping one's health as a motivator and creating accommodations for Muslim women at screening centers has also been shown to be an effective way to bring more women into mammography centers [15]. Informing Muslim populations about the importance of preventative health can also be a way to reverse cultural stigmas around screenings [15].

Previous studies suggest that other factors, besides lack of education and cultural accommodations, can reduce incidence rates of breast cancer in low HDI Muslim countries. As shown in Fig. 2, Muslim countries with a low HDI have a significantly lower ASR for breast cancer incidence rates. It has been previously observed that countries with a lower HDI have greater nutrient deficiencies [16]. These nutritional deficiencies in low HDI countries lead to a decrease in children's growth, including a delayed menarche [17]. Increased rates of young women who have a delayed menarche cause lower rates of breast cancer in low HDI countries, since previous studies indicate that the early onset of menstrual cycles before the age of 12 increases the risk of developing breast cancer in the future [2].

Another factor which could also point to lower breast cancer ASRs in Muslim countries is the age at which women have their first full-term pregnancy. Muslim countries with a lower HDI follow the previously observed pattern of other low HDI countries, which is that women in countries with a low HDI are younger for their first pregnancy compared to countries with a higher HDI [18]. It has been previously proven that women who give birth at a younger age have a decreased risk of developing breast cancer, which could contribute to the lower rates of breast cancer in low HDI Muslim countries [2].

Conclusion

This study highlights the need for increased breast cancer screening and awareness in both developed and underdeveloped Muslim countries. Some limitations of this study are that it is not certain that the reduced ASR for each country was only due to social and cultural beliefs and that there could be another unknown factor. Another limitation was that the sample sizes of certain data groups were smaller than those of others, which could have skewed the results. These results can be used in the future to understand which Muslim countries require the most intervention from breast cancer awareness programs by looking at the HDI and percent Muslim population of a country, as well as by understanding the social and cultural beliefs of each country.

Declarations

Author Contribution

Conceptualization: S.A , M.H; Methodology, Figures 1-4, and formal analysis: S.A ; Writing – original draft: S.A ; Writing – review and editing: S.A, M.H; Supervision: M.H.

Data Availability

All data analyzed in this study are publicly available from the Global Cancer Observatory (GLOBOCAN, <https://gco.iarc.who.int/today>), the Pew Research Center (<https://www.pewresearch.org>), and the United Nations Development Programme Human Development Reports (<https://hdr.undp.org/data-center>).

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Figures

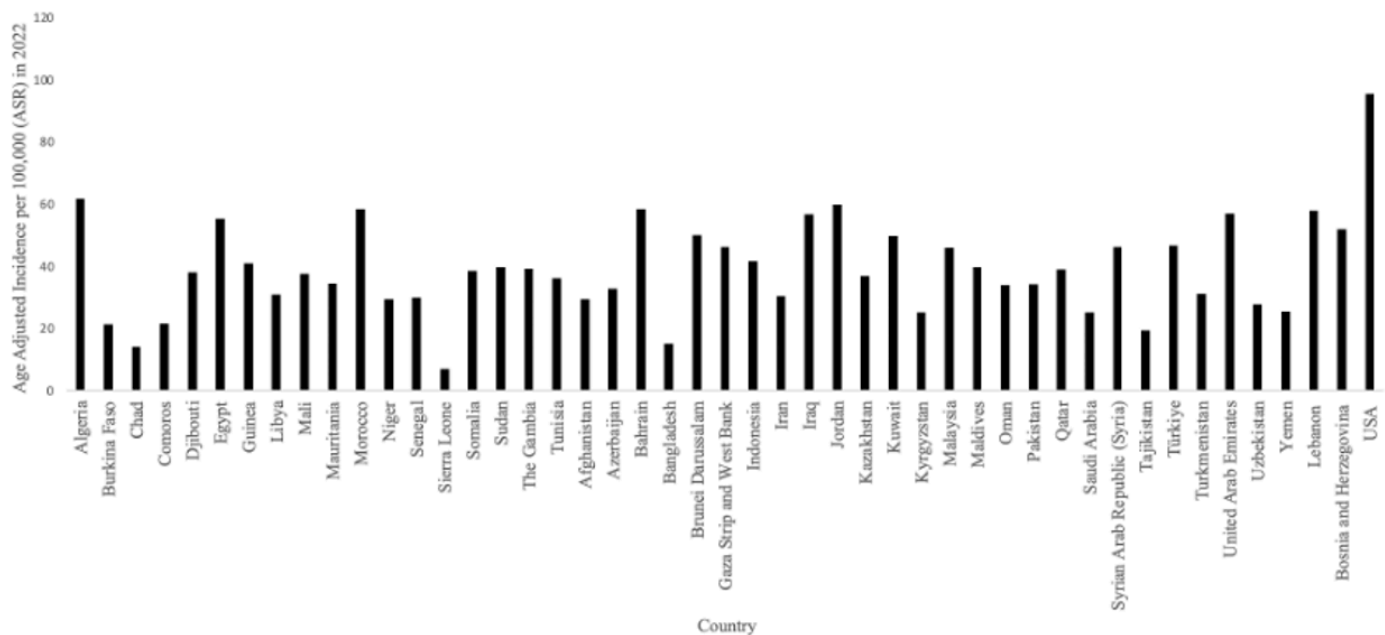


Figure 1

Age-adjusted incidence rate (ASR) of breast cancer as of 2022 in various Muslim countries, derived from the GLOBOCAN database

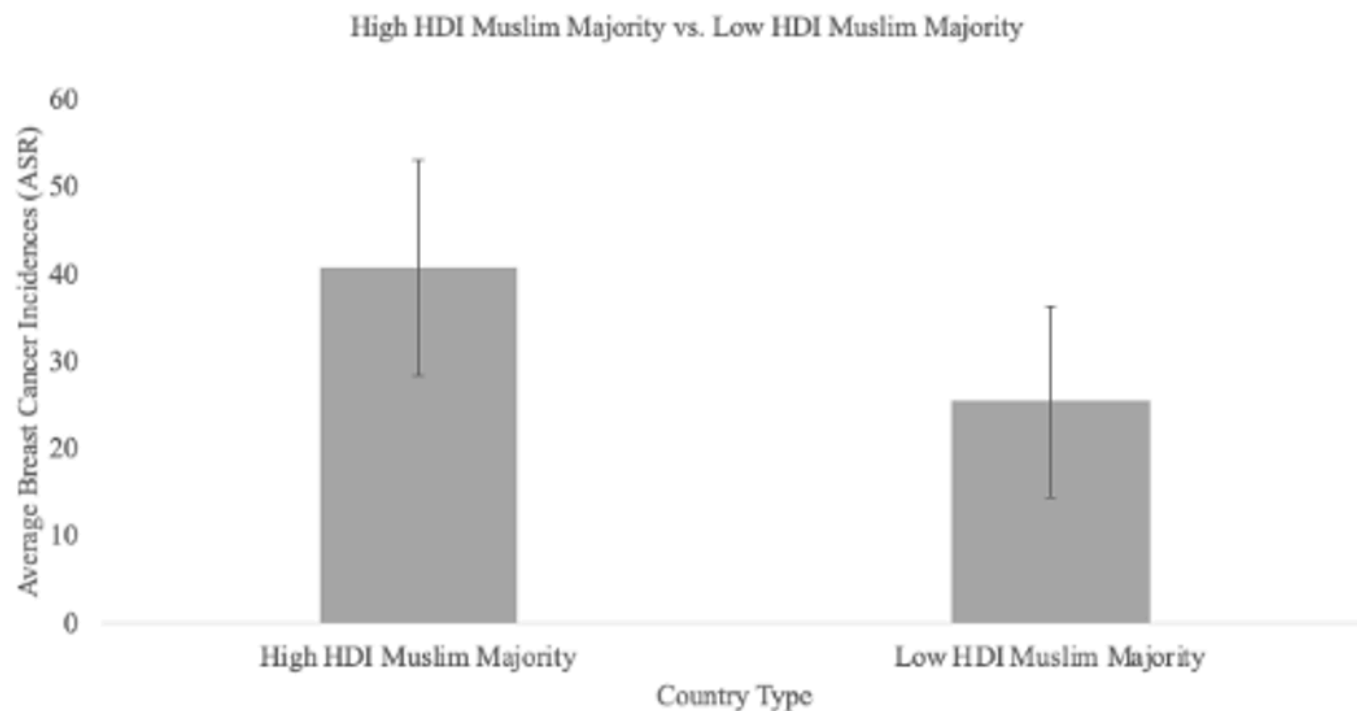


Figure 2

Comparison of the average age-adjusted incidence rate (ASR) of breast cancer between high-HDI and low-HDI Muslim-majority countries; data from the GLOBOCAN database (2022) and the Human Development Reports database ($p = 0.0047$)

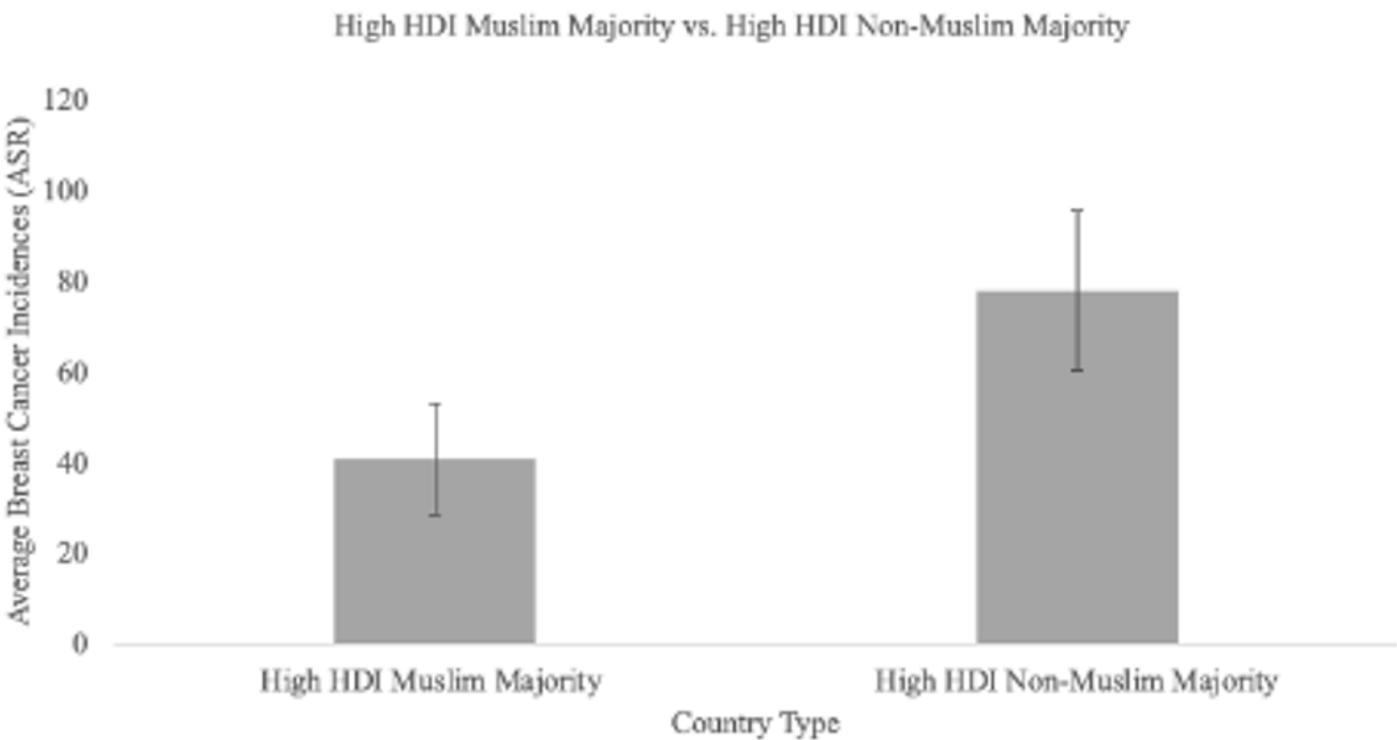


Figure 3

Comparison of the average ASR of breast cancer between high-HDI Muslim-majority and high-HDI non-Muslim-majority countries; data from the GLOBOCAN database (2022) and the Human Development Reports database ($p = 2.48 \times 10^{-11}$)

Linear Regression: Muslim % vs. Breast Cancer Incidence

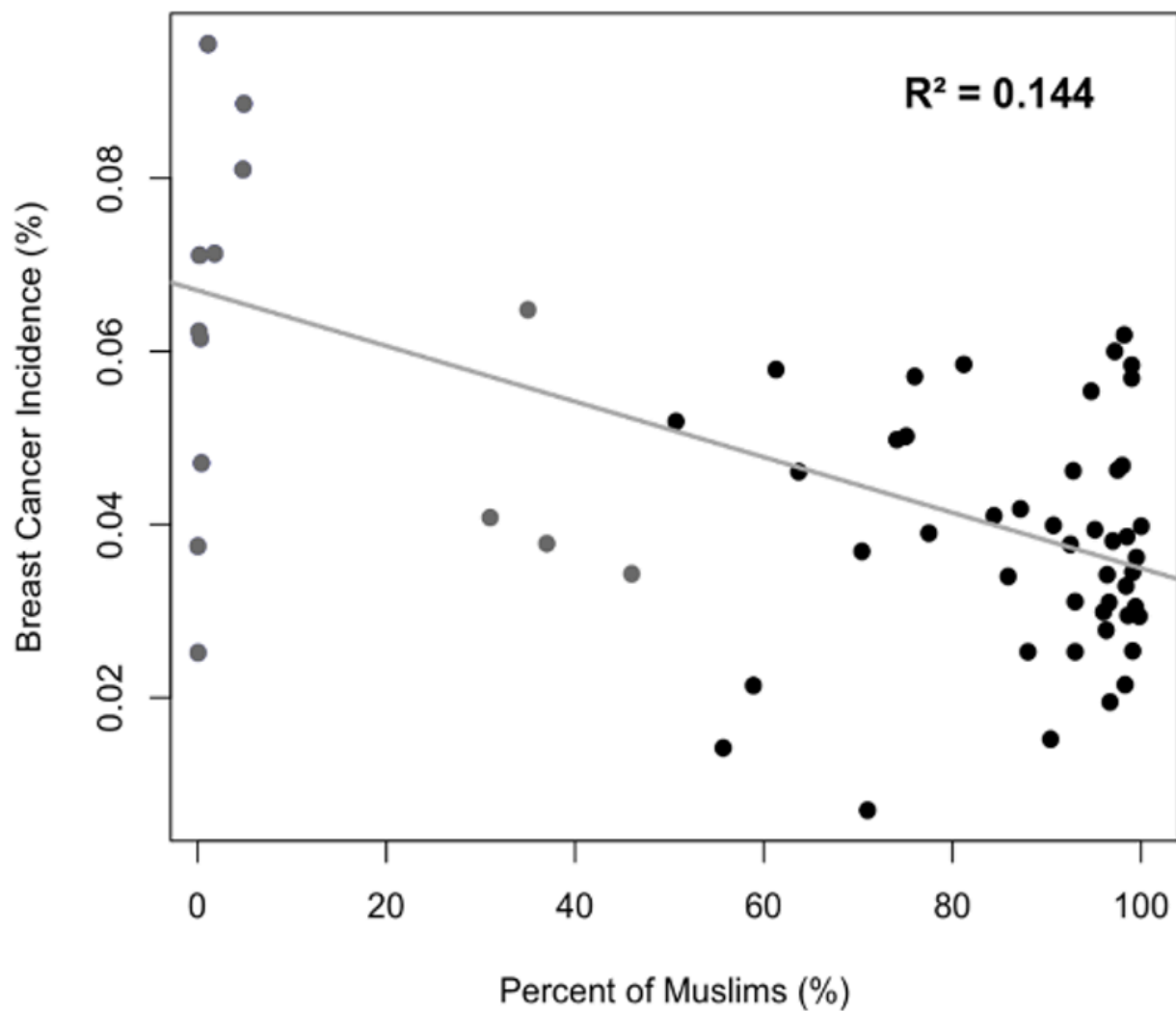


Figure 4

Linear regression of the percentage of Muslims in a country versus breast cancer incidence; each point represents one country ($n = 60$), showing a statistically significant negative correlation ($p = 0.008512$)