Wealth, Health Expenditure, and Cancer: A National Perspective

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Abstract

Background: The US health care system is characterized by high health expenditures with penultimate outcomes. This ecological study evaluates the associations between wealth, health expenditure, and cancer outcomes at the state level. Methods: We extracted gross domestic product (GDP) and health expenditure per capita from the 2009 Bureau of Economic Analysis and the Centers for Medicare & Medicaid Services, respectively. Using data from the NCI, we retrieved colorectal cancer (CRC), breast cancer, and all-cancer age-adjusted rates and computed mortality/incidence (M/I) ratios. We used the Spearman’s rank correlation to determine the association between the financial indicators and cancer outcomes, and we constructed geographic distribution maps to describe these associations. Results: GDP per capita significantly correlated with lower M/I ratios for all cancers, breast cancer, and CRC. As for health expenditure per capita, preliminary analysis highlighted a rift between the Northeastern and Southern states, which translated into worse breast and all-cancer outcomes in Southern states. Further analysis showed that higher health expenditure significantly correlated with decreased breast cancer M/I ratio. However, CRC outcomes were not significantly affected by health expenditure, nor were all-cancer outcomes. Conclusions: All cancers, breast cancer, and CRC outcomes significantly correlated with wealth, whereas only breast cancer correlated with higher health expenditure. Future research is needed to evaluate the potential role of policies in optimizing resource allocation in the states’ efforts against CRC and minimizing disparities in interstate cancer outcomes.


Background

The health care system in the United States is characterized by an unsustainable increase in spending with penultimate outcomes. In 2013, the United States spent a total of $2.9 trillion on health, which is approximately $9,255 per capita and 17.4% of the national gross domestic product (GDP), ranking first among the world’s leading economies. In contrast, of the 34 member countries in the Organisation for Economic Co-operation and Development (OECD), the United States ranked 27 in life expectancy. In fact, for almost all health outcome measures, the US ranking compared with the remaining 33 countries witnessed a decline between 1990 and 2010. This considerable weakness in the American health care system is exacerbated by an unequal resource allocations and severe socioeconomic disparities across the country.

As described in the social ecological model, health outcomes depend on various factors at the personal (patient), organizational (provider), and system (policy) levels (Figure 1). In this context, socioeconomic status (SES) has been established as a strong determinant of health at the individual level. More specifically, lower personal SES is associated with worse disease outcomes and mortality rates. Investigating this relationship at the system level could potentially address the existing imbalance between the system inputs and outputs that is at the center of national and local health policies.

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Wealth, Expenditure, and Cancer

In terms of the health conditions that are most costly in the United States, cancer has the highest expenditure, with a 2010 estimate of $125 billion and a projected increase to approximately $158 billion in 2020.\textsuperscript{17,18} Cancer is also one of the top contributors to the overall burden of disease in the country. According to recent data, among the top 20 diseases contributing to premature death in the United States, colorectal cancer (CRC) and breast cancer ranked 10th and 13th, with costs of care approximately $14 and $17 billion, respectively.\textsuperscript{18,19}

Previous research has documented that the relationship between economic development and health transcends the individual and interpersonal levels to guide policies ensuring outcome improvement and equity.\textsuperscript{20,21} However, whether these associations persist at the state level in the United States is unclear. Despite being one federal entity, each of its 50 states holds some independence in terms of certain legislations, namely health policy. Therefore, health expenditure and outcomes are not uniform across all states.\textsuperscript{7,16,22} This divide is apparent from a regional standpoint where most states in the Northeast and Midwest tend to spend more on health care compared with states in the South and West regions.\textsuperscript{23–25} Moreover, cancer incidence and mortality are also variable across states. For incidence, the distinct profile of each state is dictated by several demographic, socioeconomic, and environmental factors. However, both cancer incidence and mortality may be greatly affected by the amount of money spent on prevention and treatment.\textsuperscript{26,27}

Our study investigates the associations between wealth, health expenditure, and cancer outcomes across states. This is particularly important in the United States given the historical efforts of state and local governments to curb the rapidly growing health expenditure and efficiently allocating available funds.\textsuperscript{28–30} Our analysis focuses on (1) overall cancer outcomes, (2) breast cancer outcomes, and (3) CRC outcomes. The choice of these 2 cancer sites was based on their high prevalence and burden on the US health care system, and the existence of widely available screening and early detection methods.\textsuperscript{31–34}

Methods

Data

We extracted the most recently available public data at the time (December 2014) to measure the 3 sets of indicators: wealth, health expenditure, and cancer outcomes. We collected information on the 50 states, and excluded the District of Columbia for being an outlier in wealth and health expenditure. For wealth, we used state per capita real GDP from the Bureau of Economic Analysis. The data were in chained 2009 dollars and reflected all-industry total including private and government sources.\textsuperscript{35} To assess state spending, we used per capita health expenditure by state of residence from the Centers for Medicare & Medicaid Services. We specifically chose the 2009 total personal health care measure, a widely recommended metric consisting of a range of expenditures including, but not limited to, hospital care, physician services, and pharmaceuticals.\textsuperscript{22,36} Lastly, we measured cancer outcomes using data from the US Cancer Statistics, CDC, and the NCI.\textsuperscript{37} We collected 2010 state-level cancer incidence and mortality rates that were age-adjusted to the 2000 US standard population. We also computed the mortality/incidence (M/I) ratios as proxy measures for outcomes (Table 1).

Analysis

We first conducted a descriptive analysis of the different indicators across the 4 census regions: Northeast, Midwest, South, and West.\textsuperscript{38} We computed the median for each indicator, and then compared the states in relation to that median (see supplemental eAppendix 1, available with this article at JNCCN.org). As for visualizing the regional distributions, we constructed maps of the 48 contiguous states displaying GDP per capita, health expenditure per capita, and M/I ratios of CRC and breast cancer using ArcMap 10.1 (Environmental Systems Research Institute, Redlands, CA).
Results

Our descriptive analysis highlighted a rift in health expenditure between the Northeastern and Southern states (Table 2). Hence, all the Northeastern states (n=9) spend above the median on health care, and most of them tend to have lower M/I ratios for all cancers (89%) and breast cancer (78%). In contrast, approximately 70% of Southern states (n=11) spend less than the median on health care and tend to have higher M/I ratios for all cancers (80%) and breast cancer (87%). This descriptive classification based on the median shows that, in general, states that spend more on health per capita tend to have a lower M/I ratio. This is particularly true for breast cancer and states located in the Southern region of the United States. Furthermore, the geographic mapping provides a detailed description of the distribution of GDP per capita, health expenditure per capita, and CRC and breast cancer M/I ratios by state. This highlights the regional clustering of states with correlations between low GDP and worse CRC and breast cancer outcomes. It also underlines specific states with high health expenditure per capita associated with worse cancer outcomes (Figure 2). This warranted a closer look to determine whether these associations are statistically significant.

We identified a statistically significant, positive correlation between GDP per capita and health expenditure per capita (rho = +0.4346; P = .0016); wealthier states tend to spend more on health care. As for the associations between the financial indicators and cancer, in general, it appeared that GDP per capita is more strongly associated with cancer outcomes than is health expenditure. Hence, higher GDP per capita was significantly correlated with lower M/I ratios for all cancers (rho = –0.4406; P = .0017), breast cancer (rho = –0.3605; P = .0118) and CRC (rho = –0.3612; P = .0117), whereas health expenditure was only correlated with breast cancer M/I ratio (rho = –0.4237; P = .0027) (Table 3, Figures 3 and 4).

By further investigating the associations between the financial indicators and cancer, we determined a significant correlation between health expenditure and all-cancer incidence (rho = +0.4752; P = .0006), and between GDP per capita and lower all-cancer mortality (rho = –0.4044; P = .0036). In contrast, the M/I ratio of all cancers had a significant, negative, and moderate association with GDP per capita (rho = –0.4406; P = .0017), but not with health expenditure (Table 3).

To better understand these associations we ran the analysis on breast cancer and CRC separately.

In terms of breast cancer, both GDP and health expenditure were significantly correlated with incidence (rho = +0.4116; P = .0037, and rho = +0.4002; P = .0048, respectively), but they did not translate into significant correlations with lower breast cancer mortality (rho = –0.1601; P = .2669, and rho = –0.2358; P = .0993, respectively). In contrast, CRC incidence had no significant association with GDP or health expenditure (rho = 0.0447; P = .7630, and rho = 0.2500; P = .0865, respectively); however, mortality from CRC was significantly correlated with wealth (rho = –0.2935; P = .0386) (Table 3).

Discussion

Our findings provide additional and updated evidence on the documented association between financial factors and cancer outcomes in the United States. Further research is needed to explore the mechanisms behind these associations and to identify strategies for improving cancer outcomes in states with lower financial resources.
Furthermore, the results reinforce the international view on the inefficiencies of the US health care system where, except for breast cancer, higher spending did not correlate with corresponding improvement in outcomes. \(^1\)\(^{-}\)\(^7\) In terms of the association between wealth and health expenditure, we found that wealthier states tend to spend more on health care. This is in accordance with the findings of Woodward and Wang\(^4\)\(^2\) who describe the unchanging “GDP-health expenditure” relationship in the United States since 1929. This highlights a need to better manage and allocate health funds in the United States, especially in states with a lower GDP per capita.

Some studies reported that an increase in GDP and health expenditure usually implies better cancer screening and quality of care, which in turn leads to increased early detection of cancer and, ultimately, improved outcomes. \(^3\)\(^9\)\(^,\)\(^4\(^0\) This is particularly true for breast cancer and CRC, which have

<table>
<thead>
<tr>
<th>Region</th>
<th>Health Expenditure per capita</th>
<th>Mortality/Incidence Ratio (All Cancers)(^a)</th>
<th>Mortality/Incidence Ratio (Breast Cancer)(^a)</th>
<th>Mortality/Incidence Ratio (Colorectal Cancer)(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; median(^b) % (n)</td>
<td>&gt; median(^b) % (n)</td>
<td>&lt; median(^b) % (n)</td>
<td>&gt; median(^b) % (n)</td>
</tr>
<tr>
<td>Northeast</td>
<td>0 (9)</td>
<td>100 (9)</td>
<td>89 (8)</td>
<td>11 (1)</td>
</tr>
<tr>
<td>Midwest</td>
<td>33 (4)</td>
<td>67 (8)</td>
<td>55 (6)</td>
<td>45 (5)</td>
</tr>
<tr>
<td>South</td>
<td>69 (11)</td>
<td>31 (5)</td>
<td>20 (2)</td>
<td>80 (12)</td>
</tr>
<tr>
<td>West</td>
<td>77 (10)</td>
<td>23 (3)</td>
<td>54 (7)</td>
<td>46 (6)</td>
</tr>
</tbody>
</table>

\(^{a}\): Missing data on cancer outcomes: Minnesota (Midwest) and Arkansas (South).

\(^{b}\): The median was computed for each indicator: median health expenditure per capita = $6,795.263; median mortality/incidence ratio (all cancers) = 0.387; median mortality/incidence ratio (breast cancer) = 0.185; median mortality/incidence ratio (colorectal cancer) = 0.389.

\(^{c}\): The District of Columbia was excluded from the analysis for being an outlier in gross domestic product and health expenditure per capita.

Figure 2. Mapping of state-level data. * (A) Gross domestic product (GDP) per capita. (B) Health expenditure per capita. (C) Ratio of colorectal cancer (CRC) mortality/incidence. (D) Ratio of breast cancer mortality/incidence.

*The maps were drawn for the 48 contiguous states only; data on Alaska and Hawaii are as follows: Alaska: GDP per capita: $71,476; health expenditure per capita: $9,127.634; CRC mortality/incidence: 0.34; (D) breast cancer mortality/incidence: 0.173. Hawaii: GDP per capita: $48,328; health expenditure per capita: $6,856.164; CRC mortality/incidence: 0.282; (D) breast cancer mortality/incidence: 0.113.
established screening programs at the state level. Our findings showed a contrast between these 2 cancer types, which could be attributed to a number of factors, including disparities in access to care and variability in resource allocation.\(^{38,43}\) This discrepancy appears to reinforce the potential effect of breast cancer screening, wherein early detection increases incidence and decreases mortality.\(^{44,45}\) Accordingly, we detected a significant correlation between breast cancer incidence and both financial indicators. This potentially indicates the effectiveness of screening mechanisms, navigator programs, and advocacy organizations, among other initiatives at the state level. Overall, despite established geographic and demographic disparities, the efforts in allocating resources for breast cancer seem to be correlating with improved outcomes.\(^{31,33,41}\) On the other hand, the incidence of CRC does not correlate with better financial indicators. This could be due to multiple barriers limiting disease detection, including, but not limited to, low use of and compliance with screening.\(^{43,46}\) Moreover, health expenditure was not associated with CRC M/I ratio, indicating that spending more might not be the right approach. Thus, it is important for states and federal agencies to conduct system-wide efforts against barriers to CRC screening programs by limiting disparities, increasing access, and improving compliance.

Our study is the first to examine the correlations between state-level wealth, health expenditure, and cancer outcomes in the United States. Internationally, a similar analysis was conducted by Ades et al,\(^{47}\) focusing on 27 European countries. Similar to our findings, the authors identified a positive correlation between wealth and health expenditure, with a marked regional discrepancy between Eastern and Western European countries. As for the correlations between financial indicators and cancer outcomes, we reached comparable conclusions, specifically for breast cancer. The findings were consistent, showing that GDP and health expenditure are significantly correlated with higher breast cancer incidence and mortality.

### Table 3. Correlation Between Wealth, Health Expenditure, and Cancer Outcomes

<table>
<thead>
<tr>
<th></th>
<th>Incidence(^a)</th>
<th>Mortality(^a)</th>
<th>Ratio M/I(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Rho(^b)</td>
<td>P Value</td>
<td>Rho(^b)</td>
</tr>
<tr>
<td>All cancers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.0286</td>
<td>.8472</td>
<td>-0.4044</td>
</tr>
<tr>
<td>Health expenditure per capita</td>
<td>0.4752</td>
<td>.0006(^c)</td>
<td>0.0484</td>
</tr>
<tr>
<td>Breast cancer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.4116</td>
<td>.0037(^c)</td>
<td>-0.1601</td>
</tr>
<tr>
<td>Health expenditure per capita</td>
<td>0.4002</td>
<td>.0048(^c)</td>
<td>0.0235</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.0447</td>
<td>.7630</td>
<td>-0.2935</td>
</tr>
<tr>
<td>Health expenditure per capita</td>
<td>0.2500</td>
<td>.0865</td>
<td>0.0522</td>
</tr>
</tbody>
</table>

This analysis was conducted on all the states, except for the District of Columbia, which was excluded for being an outlier in gross domestic product (GDP) and health expenditure per capita.

\(^{a}\)State-level cancer data consisted of incidence and mortality rates from 2010 that were age-adjusted to the 2000 US standard population. The mortality/incidence (M/I) ratios were computed from these data.

\(^{b}\)Correlation strength: “weak” rho ≤ 0.30; “moderate” 0.31 ≤ rho ≥ 0.6; “strong” rho ≥ 0.61.

\(^{c}\)Statistically significant for α=0.05.

![Figure 3. Scatter plots showing GDP per capita and M/I (y axis) for (A) all cancers, (B) breast cancer, and (C) colorectal cancer; the x axis is the state-level per capita GDP in real US dollars. Each point on the graph represents a US state identified by the labeled abbreviated name.](image_url)

Abbreviations: GDP, gross domestic product; M/I, ratio of mortality over incidence; rho\(_s\), Spearman’s rank correlation coefficient.
Wealth, Expenditure, and Cancer

Wealth, Expenditure, and Cancer

We followed an ecological study design, analyzing data at the aggregate state level with no individual data. This may have introduced ecological fallacies in drawing conclusions from our findings. However, we argue that it is important to match observations to the level of decision-making. As such, assessing these associations at the higher system level of the allocative model is warranted to guide health policies but could not justify individual-level inferences. Another limitation in our method was the use of overall health expenditure data, not specifically targeted toward cancer. This may have led to bias in interpreting the “health expenditure–cancer outcomes” associations. Nevertheless, the data we used were comprehensive in depicting the state-level health spending needed to answer our study objectives. Finally, our study is limited to one point in time, subsequent to the US financial downturn of 2008 and before the introduction of the Affordable Care Act in 2010. As such, we are unable to generalize the findings to historical or future trends on wealth, health expenditure, and cancer outcomes. This highlights the need to conduct studies incorporating the time factor and accounting for major changes in US health policies.

Conclusions

In the United States, wealth is more strongly correlated with cancer outcomes than is health expenditure at the state level. Our findings represent evidence of regional disparities in terms of financial and cancer outcomes, indicating a potential inefficient allocation of resources in the efforts against cancer. This imbalance was more prominent for CRC compared with breast cancer, for which states’ efforts seem to correlate with improved outcomes. Future research is needed to monitor the evolution of the highlighted interstate disparities in wealth, health expenditure, and cancer outcomes in light of the passage of the Patient Protection and Affordable Care Act in 2010. Furthermore, efficient policies are needed to bend the health expenditure curve through emphasizing prevention and screening and minimizing disparities in interstate cancer outcomes.

References


