The relationship between dermatologist density in specific urban zip codes and population socioeconomic factors in a cross-sectional analysis.

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Author Contributions:
Anne Lynn Chang had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

Study concept and design: All authors.
Acquisition of data: Pyles and Nkansah.
Analysis and interpretation of data: Nkansah and Pyles.
Drafting of the manuscript: All authors.
Critical revision of the manuscript for important intellectual content: All authors.
Study supervision: Resneck and Chang.

Abstract:
There is limited data regarding health disparities for access to health care. The majority of prior studies have focused on the primary care workforce and underserved patient populations with respect to lower socio-economic status, race and insurance status. Few studies assess these issues in dermatology. At the state level, increased numbers of both family physicians and specialists per capita are associated with higher quality of care. Even though increased numbers of physicians leads to better health outcomes, if these physicians are poorly distributed then there are subsets within the population that do not have ready access to care.

Methods: New York (185 zip codes), Boston (24 zip codes), Chicago (66 zip codes), and Philadelphia (47 zip codes) were selected for the analysis based on their large, dense and ethnically diverse populations. Data for dermatologists’ practice locations were gathered from the American Academy of Dermatology and correlated with demographic data from the United States census bureau 2010 by zip code. A 2-tailed Pearson correlation was performed to analyze the significance of the results.
Results:

Only New York City showed a correlation between higher dermatologist density and higher median family income by zip code (p=0.001). In New York city, there was also an association between higher dermatologist density and higher Caucasian population in zip code (p=0.001). No other significant associations were identified for New York City nor the other studied cities.

Conclusions: Much of the research regarding the geographic distribution of physicians have compared urban and rural populations. However there has not been an analysis of the micropopulations within densely populated cities. With the exception of New York City, in which dermatology density was associated with higher median family income, the three other cities did not demonstrate a link between dermatology density and socioeconomic factors such as median family income, race, education or insurance status indicating more complex factors may be driving the distribution of dermatologists.

Introduction

Access to health care is a critical area of health disparity research. In 1974, Aday and Anderson described a framework for the study of access to medical care. This framework highlighted multiple variables, which play a part in determining the extent of access among a population. These interconnected variables include: health policy, characteristics of the health delivery system, characteristics of the population at risk, utilization of health services, and consumer satisfaction. Years later, the Institute of Medicine (IOM) published Access to Health Care in America, which defined access as ‘the timely use of personal health services to achieve the best possible health outcomes’. It acknowledged the multifactorial approach to measuring health care access and sought to establish an inclusive definition. Healthy People 2020 specifies three essential steps to ensuring health service access: 1. Gaining entry into the health care system, 2. Accessing a health care location where needed services are provided, and 3. Finding a health care provider with whom the patient can communicate and trust. The 1993 IOM report highlights the importance of investigating the above factors for equity among population groups.

Subsequent to the publication of the above reports, extensive epidemiologic studies have explored the relationship between physician practice distribution in communities and access to care. The majority of these studies have focused on the primary care workforce and specialties that traditionally serve a high proportion of underserved patient populations (e.g., racial/ethnic minorities, underinsured, lower socio-economic status). Unfortunately, few studies were identified that studied similar trends in dermatology. One earlier study showed a disproportionate number of dermatologists located in areas known for their high median income demographic group, such as Boston, Palo Alto, Manhattan. The Dartmouth Atlas, a well-known epidemiologic database maintained by Dartmouth Institute for Health Policy and Clinical Practice, uses the American Medical Association Masterfile to provide nationwide data on the distribution of physicians. It provides a report of the density of dermatologists by various geographic indicators, however, the tool does not address how dermatologist density might relate to common socioeconomic variables. The objective of this study is to explore the relationship of dermatologist density with socioeconomic variables typically associated with health care disparities.
Methods

Data sources: Zip code level demographic and population data was exported from Social Explorer, a website which maintains data from the United States Census Bureau conducted American Community Survey 2008-2012. Dermatologist distribution data was based on the American Academy of Dermatologists (AAD) database.

Location selection: Census data was used to sort cities based on population density, population size, and distribution of self-reporting Hispanic and/or African-Americans within the population. Cities with a population of greater than 500,000 in size and at least 15% of the population self-reporting as Hispanic and/or African-American were selected for inclusion in the analysis. The a priori minimum of 15% population proportion of Hispanic and/or African-American was made to ensure an adequate representation of populations typically associated with low health access.

Dermatologist density/demographic comparisons: The United States Postal Service zip code search function was used to identify zip codes for each city meeting inclusion criteria. Dermatologist density was calculated for each of these zip codes using 100,000 as the denominator and comparisons were made by the following socioeconomic predictor variables: median family income, ethnic/racial categorization, educational status, insurance status. The Census bureau categorizes ethnicity based on Hispanic/Latino or Not Hispanic/Latino; within this subset, proportions are specified for each racial group. For the purposes of this study, ethnic/racial categorization analyses were performed by evaluating the relative proportion of individuals within each for the following Census discrete categorizations: Not Hispanic/Latino White, Not Hispanic/Latino Black or African American, Not Hispanic/Latino Asian, and Hispanic (including any racial group). These groups were chosen to represent the largest racial groups within the United States. Education status was analyzed based on proportion of the population with a Bachelor’s degree and proportion of population with a professional degree. Insurance status was analyzed based on proportion of population with private health insurance and proportion of population with no health insurance.

Data Analysis: Data for each city were descriptively analyzed. In addition, heat maps were created to visually plot dermatologist density for each socioeconomic variable specified above. IBM SPSS Statistics for Windows, version 22.0 was used to perform multivariate linear regression analyses on socioeconomic covariates. A correlation test was run on the predictor variables to test for multicollinearity. A covariate was considered to have high correlation with another covariate if the correlation coefficient was greater than 0.8. The model was adjusted for multicollinearity by using a step-wise approach to independently remove each implicated variable from the regression model.

Results

Location--Based on the selection criteria specified, the following locations were identified for the purposes of this study: Boston, Massachusetts (24 zip codes); Chicago, Illinois (66 zip codes); New York, New York (185 zip codes); Philadelphia, PA (47 zip codes). See Table 1 for national and city-level demographic data.

Population characteristics—Each of the cities, with the exception of Philadelphia, had a majority white population; the majority racial/ethnic group in Philadelphia was African-American. Educational attainment in each of the cities was well distributed with Boston having the largest proportion of the population attaining a bachelors degree or higher. Median family income was
highest in Boston. Boston also had the smallest proportion of uninsured population (ie. 5.2%) compared to greater than 14% in the other cities and nation as a whole.

**Factors predicting access**--There was no significant association between dermatologist density and socioeconomic variables for Boston, Chicago, nor Philadelphia. In New York City (NYC), there was no association between dermatologist density and race/ethnicity. However, there was a statistically significant positive association between dermatologist density and the proportion of individuals with professional degrees (p=0.013). The NYC model demonstrated multicollinearity (r>0.8) between median family income and 3 covariates (i.e., proportion of population with a bachelors degree, proportion of population with a professional degree, proportion of population with private health insurance). When the professional degree covariate was removed from the model, NYC dermatologist density was positively associated with median family income (p=0.015), proportion of population with a bachelor's degree (p=0.003), and negatively associated with the proportion of population with no health insurance (p=0.035).

Percentage wise, dermatologists practicing in New York City were more likely to practice in higher income areas (64%), as compared to dermatologists in Philadelphia (7%). Dermatologists in Boston had the most equitable distributions as far as income in each area. (Figure 1).

**Discussion**

This study showed that a significant relationship exists between dermatologist density and median family income, education, and lack of insurance in NYC, but not in other studied metropolitan cities. To date studies have not assessed the distribution of dermatologists within racially/ethnically diverse metropolitan areas. Studies have shown a maldistribution of dermatologists between rural and urban areas. Other medical specialties (eg, cardiology, urology) show a similar maldistribution of dermatologists between rural and urban areas. This study is unique in that it assesses the distribution of dermatologists at the zip code level within specific metropolitan cities. Although the locations of many of the dermatologist practices are accessible by public transportation, the generalized maldistribution of dermatologists to areas of affluence or higher education, may indirectly impact patient mix and appointment availability. Studies have estimated the average wait time for a dermatologist appointment at 3 - 4 weeks, however, another study showed the average wait time for a cosmetic procedure, which is typically carved out from insurance and paid out of pocket, at 6-8 days. The same study showed a lower acceptance rate of Medicaid (32%) compared with Medicare (85%) and private insurance (87%); and higher wait times for Medicaid patients (50 days) compared to Medicare and private insurance (both at 37 days). In metropolitan areas where such a maldistribution exists, there is the possibility of reduced access to dermatologic care due to a shortage of appointment slots for poorly reimbursed non-cosmetic dermatology concerns. The possibility of this occurring is higher when a dermatologist's practice is located in a highly affluent area where patients may be able to afford the out of pocket cost of cosmetic procedures.

Another potential contributing factor to dermatologist maldistribution is the observed tendency of dermatology residency graduates to stay within 100 miles of their training location, with greater than 70% of NYC residents staying in the state. The data from this study did not evaluate whether these residents stayed within the metropolitan NYC area or the types of practices they decided to join. A shift has been observed in the practice styles of early career physicians to prefer employment with existing practices as opposed to establishing a new practice site. This might
further contribute to maldistribution in some areas due to residency graduates joining practices in areas with a high density of established dermatology or multispecialty practices instead of seeking to establish a new practice in another less saturated location.

One limitation of this study is the assumption made that if a dermatologist’s practice location was listed in the AAD practice database, then that location potentially provided a patient access to dermatology services. There were many dermatologists who practiced in multiple locations and as such it was unclear the extent to which each location was open and had available appointment slots. Another limitation was the observation of a relatively high number of dermatologists affiliated with academic institutions. A subgroup analysis was performed by excluding academic dermatologists from the NYC analysis; this did not impact the results. It is possible that a relatively low sample size of zip codes for Boston, Chicago, and Philadelphia (ie. 24, 66, and 47 respectively) compared to NYC (ie. 185) could have impacted the ability to detect a relationship between socioeconomic variables and dermatologist density in these cities. In addition, the contributing factors to maldistribution could differ by each city’s unique zoning requirements, regulatory determinations, and patient and provider demographic. Last, it was outside of the scope of this study to ascertain reasons for the maldistribution in metropolitan areas. This could be multifactorial and further research should investigate such reasons.

**Conclusion**

There are variations in the geographic distribution of dermatologists in the four cities evaluated. Although the zip code level analysis, did not yield a statistically significant association with multiple socioeconomic covariates, the heat map and scatter plot depictions of data visually show differences in distribution. Complex factors may contribute to the distribution of dermatologists in metropolitan areas. Additional research is needed to further identify these factors and understand the extent to which maldistribution of dermatologists in metropolitan areas may affect access to dermatologic care.

Table 1: Demographic characteristics of studied cities compared with national averages
### Table 2: Relationship between dermatologist density and socioeconomic variables in New York City (without adjusting for multicollinearity)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>β</th>
<th>( p )-value</th>
<th>95% CI</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Family Income (2012)</td>
<td>8e-07</td>
<td>0.881</td>
<td>-9.97e-06</td>
<td>1.16e-05</td>
</tr>
<tr>
<td>% White</td>
<td>-0.016</td>
<td>0.895</td>
<td>-.250</td>
<td>.219</td>
</tr>
<tr>
<td>% African-American</td>
<td>-0.013</td>
<td>0.916</td>
<td>-.250</td>
<td>.225</td>
</tr>
<tr>
<td>% Asian</td>
<td>-0.005</td>
<td>0.968</td>
<td>-.245</td>
<td>.236</td>
</tr>
<tr>
<td>Predictor Variable</td>
<td>Med Fam Income</td>
<td>White</td>
<td>Black</td>
<td>Asian</td>
</tr>
<tr>
<td>----------------------------</td>
<td>----------------</td>
<td>--------</td>
<td>--------</td>
<td>--------</td>
</tr>
<tr>
<td>% Hispanic</td>
<td>-0.008</td>
<td>0.950</td>
<td>-0.246</td>
<td>0.231</td>
</tr>
<tr>
<td>% Bachelor Degree</td>
<td>0.029</td>
<td>0.209</td>
<td>-0.017</td>
<td>0.075</td>
</tr>
<tr>
<td>% Professional</td>
<td>0.162</td>
<td>0.013*</td>
<td>0.0347</td>
<td>0.2884</td>
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<tr>
<td>% No Health Insurance</td>
<td>-0.047</td>
<td>0.249</td>
<td>-0.129</td>
<td>0.034</td>
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<tr>
<td>% Private Health Insurance</td>
<td>-0.007</td>
<td>0.699</td>
<td>-0.044</td>
<td>0.030</td>
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<tr>
<td>Constant</td>
<td>2.617</td>
<td>-21.5</td>
<td>26.7</td>
<td></td>
</tr>
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</table>

*p ≤ .05; R² = 0.61

Table 3: Correlations Between Predictor Variables—Test for multicollinearity
Table 4: Relationship between dermatologist density and socioeconomic variables in New York City (adjusting for multicollinearity)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>$\beta$</th>
<th>$p$-value</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median Family Income (2012)</td>
<td>1e-5</td>
<td>0.015*</td>
<td>-2.05e-6 1.83e-5</td>
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<tr>
<td>% White</td>
<td>-0.03</td>
<td>0.791</td>
<td>-0.274   0.210</td>
</tr>
<tr>
<td>% African-American</td>
<td>-0.03</td>
<td>0.819</td>
<td>-0.274   0.217</td>
</tr>
<tr>
<td>% Asian</td>
<td>-0.02</td>
<td>0.880</td>
<td>-0.268   0.230</td>
</tr>
<tr>
<td>% Hispanic</td>
<td>-0.02</td>
<td>0.879</td>
<td>-0.266   0.228</td>
</tr>
<tr>
<td>% Bachelor Degree</td>
<td>0.06</td>
<td>0.003*</td>
<td>0.022    0.100</td>
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<tr>
<td>% No Health Insurance</td>
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<td>0.039*</td>
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<tr>
<td>% Private Health Insurance</td>
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<td>0.249</td>
<td>-0.058   0.015</td>
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<td>_Constant</td>
<td>4.55</td>
<td>0.249</td>
<td>-20.3    29.42</td>
</tr>
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</table>

*p ≤ 0.05; R²=0.58

Figure 1. Proportion of dermatologists in each income quintile by city.
References


