Disaggregating Data on Asian American and Pacific Islander Women to Provide New Insights on Potential Exposures to Hazardous Air Pollutants in California

Thu Quach1,2, Ruiling Liu1, David O. Nelson1,2, Susan Hurley1, Julie Von Behren1, Andrew Hertz1, and Peggy Reynolds1,2

Abstract

Background: The Asian American and Pacific Islander (AAPI) population is heterogeneous and rapidly growing in the United States, with a high proportion concentrated in California. Although traditionally assumed to have lower rates of breast cancer than non-Hispanic white women, recent studies have suggested considerable variation in incidence by AAPI ethnic group, with rates in some exceeding those in non-Hispanic whites. The potential role of environmental toxicants has not been well explored and may provide insights into these patterns.

Methods: We created an exposure potential index (EPI) score for 24 hazardous air pollutants modeled by the U.S. Environmental Protection Agency National-Scale Air Toxics Assessment considered to be mammary gland carcinogens, and compared values at the census tract level for “geographically concentrated” AAPI groups throughout the State. “Geographically concentrated” populations were defined as census tracts with at least 100 individuals from a specified racial/ethnic population as enumerated by the 2000 Census.

Results: Although EPI scores differed little between census tracts with aggregated AAPI (mean EPI = 0.53) and non-Hispanic white women (mean EPI = 0.63), there was substantial variation between tracts for disaggregated AAPI groups, with notably higher EPI scores for tracts enumerated for Korean or Japanese women (mean EPI of 0.78 and 0.77, respectively) compared with other AAPI groups.

Conclusions: Our findings underscore the importance of disaggregating data for the heterogeneous AAPI population to identify differences in potential environmental exposures across groups.

Impact: Future cancer etiology studies should examine environmental exposure differences within and across groups for the diverse AAPI population.

See all the articles in this CEBP Focus section, “Cancer in Asian and Pacific Islander Populations.”

Introduction

The Asian American and Pacific Islander (AAPI) population is heterogeneous and has undergone significant growth in recent decades. According to the U.S. Census, this population grew faster than any other racial/ethnic population in the United States between 2000 and 2010 (1), with California having the largest AAPI population in the nation (2). Although typically aggregated into one broad “AAPI” category for statistical compilations by governmental agencies, this population is composed of more than a dozen distinct ethnic groups. A major concern is that the aggregated data may mask important differences and health disparities within and between groups, and thus perpetuate the “model minority” myth for the AAPI population as a whole (3).

A classic example of the “model minority” myth is that AAPI women are generally considered to have a relatively low risk of breast cancer compared with other women living in the United States. This fallacy, however, has largely been driven by national cancer surveillance data that historically has reported lower breast cancer incidence rates among the aggregated AAPI female population, compared with most other racial/ethnic groups (4–6). Provocative findings from a number of more recent studies based on disaggregated AAPI data have demonstrated substantial differences in breast cancer incidence rates, as well as differences in the rate of increase in those rates, between ethnic groups within the AAPI population (7–12). Furthermore, some studies have reported breast cancer incidence rates for certain AAPI groups that exceed those of non–Hispanic white women (7, 13, 14). The most recent of these, which were limited to younger U.S.-born...
women, further highlight the complexity in characterizing breast cancer risk within the AAPI population and underscore the importance of migration history.

Foreign-born AAPI women have lower breast cancer rates than U.S.-born AAPI women (13, 15–17). Furthermore, it has long been noted that AAPI women who move to the United States gradually acquire the higher breast cancer rates of their adoptive country, increasing with time since migration and with generational status (15, 17–20). Although research to date suggests that changing risk factor profiles (e.g., parity, age at first birth, diet, and other lifestyle factors) associated with acculturation may play a role in the changes in breast cancer incidence observed with migration, they do not fully account for observed geographic and racial/ethnic disparities in breast cancer (10, 12, 21–24). This has led to speculation that other factors, including environmental exposures, may play an etiologic role in breast cancer risk (25, 26).

A recent comprehensive review of the toxicologic literature aimed at elucidating priority environmental compounds of concern for breast cancer etiology identified 35 air contaminants that have been shown to cause mammary tumors in animals (27). At the same time, there has been increasing evidence that minority and low-income populations have a disproportionate burden of exposures owing to residential proximity to areas with higher levels of pollutants, including air pollution (28–32). These observations suggest a need to examine environmental exposures, particularly air pollution, for the AAPI population, taking into consideration heterogeneity in ethnic and other sociodemographic factors.

The purpose of this article is to explore whether estimated ambient concentrations to hazardous air pollutants (HAP) implicated in breast cancer risk differ for specific ethnic groups within the AAPI population in California. As the first such exploration targeting these potential exposures, it provides important preliminary data to inform future studies of environmental exposures and breast cancer as well as other cancers and health outcomes in this heterogeneous population.

Materials and Methods

Census tract information and description

We obtained female population counts at the census tract level by racial/ethnic groups (excluding multiple races/ethnicity) from U.S. 2000 Census files for California (33). Racial/ethnic detail is available only for groups with at least 100 individuals in a census tract. We used a composite measure for socioeconomic status (SES) based on education, blue-collar occupations, unemployment, median household income, poverty level, median rent, and median house values (34). We also obtained the percentage of the population who were an AAPI language speaker and spoke English not well or not at all (linguistically isolated AAPI speaker; ref. 35).

Exposure estimation

Amendments made to the U.S. Clean Air Act in 1990 identified 189 HAPs known to cause cancer or other adverse health effects in laboratory animals or in occupational health studies (36). The U.S. Environmental Protection Agency (U.S. EPA) regularly monitors HAPs in 27 sites across the United States and has developed the National-Scale Air Toxics Assessment (NATA) to help guide efforts to cut toxic air pollution. NATA has modeled annual average ambient concentrations of HAPs at the census tract level using dispersion models triennially since 1996, based on a national inventory of air toxics emissions from various outdoor source (including point and non-point sources, on-road and non-road mobile sources, area sources and background levels).

Building on an ongoing study of HAPs and breast cancer, we focused on HAPs compounds that are mammary gland carcinogens (MGC; ref. 27) and included them based on three criteria: (i) they were identified in the 2002 U.S. EPA NATA database; (ii) they were identified as MGCs by our literature review, which was based heavily on the work of Rudel and colleagues (27); and (iii) there was sufficient variability in estimated potential exposures across California’s 7,049 census tracts (at least 25% of the values were neither missing nor the same). On the basis of these criteria, we identified 24 MGCs: acrylamide, acrylonitrile, benzene, benzidine, 1,3-butadiene, carbon tetrachloride, chloroprene, 1,4-dioxane, ethyl carbamate, ethylene dibromide, 1,2-dichloroethane, ethylene oxide, 1,1-dichloroethane, hydrazine, dichloromethane, 4,4’-methylenebis (2-chloroaniline), nitrobenzene, 1,2-dichloropropane, propylene oxide, styrene, 2,4-toluene diisocyanate, o-toluidine, vinyl chloride, and 1,1-dichloroethylene.

We obtained data on the concentrations of these 24 MGCs in each of California’s 7,049 census tracts from the U.S. EPA NATA website (37). We calculated a tract-level summary exposure potential index (EPI) score for the MGCs by (i) calculating a rank score for each of the 24 MGCs based on ranks across the 7,049 census tracts (where ties were replaced by the minimum rank), and then shifting and scaling the rank scores so that the rank scores for each MGC ranged from 0 to 1; and then (ii) creating a summary EPI score for each census tract by summing across the 24 rank scores, and then shifting and scaling the resulting scores across the census tracts so that the EPI scores ranged from 0 to 1.

Statistical analysis

To determine whether the size of the within-group variation was different across various groups, we tested for heterogeneity of EPI score variances between (i) non-Hispanic whites and AAPI, and (ii) various AAPI groups, using statistical tests that compared an Ordinary Least Squares fit with unrestricted means to a Weighted Least Squares (WLS) fit that allowed for a different variance for each group. We tested whether or not any given group had a different mean than that of non-Hispanic whites by fitting a WLS model to the two groups and testing the
statistical significance of the coefficient of the difference in fitted coefficients. We tested for any difference in mean EPI scores between Asian groups, while allowing for a different variance for each group, by using a likelihood ratio test on two WLS models: one that restricted all means to be the same, and one that allowed different means. We calculated estimates, adjusted \( t \) statistics, and simultaneous \( P \) values for all pairwise differences between the EPI means of different Asian groups by using the robust methods described in Herberich and colleagues (38) and implemented in the R package (39) “multcomp,” using robust variance estimates as described in the R package “sandwich.” To assess which AAPI groups were different from each other, we performed agglomerative hierarchical clustering of Asian groups (40) using a dissimilarity matrix created from the absolute value of adjusted \( t \) statistics for pairwise differences between EPI scores. The clustering method used was “complete linkage,” in which the dissimilarity between two exposure groups A and B is defined to be the maximum absolute value of the set of \( t \) statistics comparing any member of A to any member of B.

In addition, we calculated the proportion of census tracts in each EPI score quintile by a summary SES index (34) and by quintiles of the percentage of linguistically isolated AAPI speaker for each disaggregated AAPI group. We used SAS 9.3 (41) and R 3.0.2 (39) for all statistical analysis. We also used ArcGIS (42) to create maps that illustrate the geographic distribution of quintiles of potential exposure to the MGCs and other sociodemographic factors by census tract.

**Results**

Table 1 shows U.S. 2000 census data distributions of California females in the non–Hispanic white population, the aggregated AAPI population, and the disaggregated groups within the AAPI population. Shown are total statewide counts and percentages for each group, as well as counts restricted to enumerated tracts. The vast majority of the AAPI populations (approximately 80%) were enumerated in fewer than 40% of California’s tracts, reflecting the fact that the AAPI population was more concentrated in certain geographic areas. As expected, the number of census tracts with sufficient numbers of individuals to be enumerated for the disaggregated AAPI ethnic groups was much smaller than the number enumerated for the aggregate AAPI group. A comparison of the percentages of tracts and of the female population in enumerated tracts for each of the disaggregated AAPI groups suggest that some groups may be more geographically concentrated than others. For example, 47.2% of Filipino females in the state lived in only 546 enumerated tracts (7.7% of all census tracts in California), suggesting this group may be especially concentrated in some geographic areas. In comparison, only 10.3% of the Japanese population and less than 4% of Pacific Islanders were enumerated in fewer than 40% of California’s tracts.

<table>
<thead>
<tr>
<th>Race/ethnicity</th>
<th>Female population</th>
<th>Census tracts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of females in enumerated tracts</td>
<td>Statewide total (%)</td>
</tr>
<tr>
<td>Major group</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>7,907,068</td>
<td>99.0</td>
</tr>
<tr>
<td>AAPI</td>
<td>1,569,924</td>
<td>79.5</td>
</tr>
<tr>
<td>AAPI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any Asian</td>
<td>1,567,736</td>
<td>81.8</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>2,188</td>
<td>3.8</td>
</tr>
<tr>
<td>Any Asian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asian Indian</td>
<td>33,159</td>
<td>23.1</td>
</tr>
<tr>
<td>Cambodian</td>
<td>12,469</td>
<td>33.6</td>
</tr>
<tr>
<td>Chinese</td>
<td>320,171</td>
<td>62.8</td>
</tr>
<tr>
<td>Filipino</td>
<td>232,681</td>
<td>47.2</td>
</tr>
<tr>
<td>Hmong</td>
<td>15,287</td>
<td>45.1</td>
</tr>
<tr>
<td>Japanese</td>
<td>16,437</td>
<td>10.3</td>
</tr>
<tr>
<td>Korean</td>
<td>61,800</td>
<td>33.6</td>
</tr>
<tr>
<td>Laotian</td>
<td>3,481</td>
<td>12.4</td>
</tr>
<tr>
<td>Vietnamese</td>
<td>108,707</td>
<td>48.6</td>
</tr>
</tbody>
</table>

**Table 1.** Distribution of females by racial/ethnic group in the state of California in those census tracts for which those totals have been enumerated in the 2000 census (“enumerated tracts”)

NOTE: Also shown are the number and proportion (out of 7,049) of enumerated census tracts for each racial/ethnic group.  
\( ^a \)Does not include individuals of mixed race/ethnicity.  
\( ^b \)A census tract is enumerated if a race/ethnic group had at least 100 individuals in that tract.  
\( ^c \)Census tracts that contain any Asian and Pacific Islanders are not mutually exclusive.
represented in enumerated census tracts (<1.0% of total tracts), suggesting less geographic concentration and greater dispersion of these ethnic groups across all census tracts in the general population. In addition, the total population of Japanese and Pacific Islanders in California is much smaller than the most populous AAPI groups, Filipino and Chinese; therefore, fewer census tracts reach the 100 count population threshold for enumeration for these groups.

Table 2 summarizes the distribution of EPI score statistics for MGCs by racial/ethnic group, and Fig. 1 provides more detail on the distributions across the different groups (in Fig. 1, the Asian groups are ordered from top to bottom by increasing mean EPI score). The mean and median EPI scores for the AAPI population (mean, 0.53; median, 0.44) were only slightly higher than that for the non–Hispanic white population (mean, 0.43; median, 0.35). Although statistically significant \((P < 0.001)\), this was no doubt due to the large sample sizes. Indeed, the means of all of the disaggregated AAPI groups, except for Pacific Islanders, were statistically significantly different \((P < 0.01)\) from the mean of the non–Hispanic white population. Most notably, the Japanese and Korean groups had mean EPI scores that were over 2-fold higher than that of the non–Hispanic white population, and the Cambodian group had a mean EPI score that was approximately 1.5 times higher than the non–Hispanic white population.

Although there was a considerable overlap in the distributions of the EPI scores for the disaggregated AAPI groups, there were also notable differences between them. For example, the Hmong and Asian Indian groups had mean EPI scores of 0.29 and 0.34, respectively, whereas Japanese and Korean groups had mean EPI scores of 0.78 and 0.77, respectively. A test to detect whether the mean EPI score was not the same for all Asian groups was statistically significant with \(P < 0.001\).

Figure 2 shows the results of an analysis of all 36 pairwise comparisons between the means of the nine Asian groups, designed to identify mutually exclusive “exposure groups.” The figure shows what exposure groups would be formed, as a function of the maximum allowable absolute \(t\) statistic (i.e., minimum allowable \(P\) value) when comparing any two members of the same exposure group. The resulting decision tree shows that even for an extremely wide range of \(P\) value cutoffs, ranging from quite modest \((P = 0.18)\) to quite stringent \((P < 0.0001)\), AAPI groups tend to cluster into the four exposure groups. Despite some similarities in exposure potential for a few groups, there are substantial differences between each of the clusters.

Figure 3 is a map with the distribution of MGC EPI scores by deciles across the census tracts in California. The map shows that tracts with higher MGC EPI scores tend to be in the more urban parts of the state, such as the Los Angeles, San Francisco, and San Diego areas. It also shows that census tracts with the highest MGC EPI scores tend to be located in the greater Los Angeles area. Figure 4 shows the population distribution of disaggregated AAPI groups and quintiles of MGC EPI scores in the greater

Table 2. Distribution of EPI scores by racial/ethnic group

<table>
<thead>
<tr>
<th>Race/ethnicitya</th>
<th>25th percentile</th>
<th>Median</th>
<th>Mean</th>
<th>75th percentile</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>0.24</td>
<td>0.35</td>
<td>0.43</td>
<td>0.63</td>
<td>0.25</td>
</tr>
<tr>
<td>AAPI</td>
<td>0.30</td>
<td>0.44</td>
<td>0.53</td>
<td>0.79</td>
<td>0.25</td>
</tr>
<tr>
<td>AAPI</td>
<td>0.30</td>
<td>0.44</td>
<td>0.53</td>
<td>0.79</td>
<td>0.25</td>
</tr>
<tr>
<td>Pacific Islanderb</td>
<td>0.29</td>
<td>0.34</td>
<td>0.45</td>
<td>0.39</td>
<td>0.25</td>
</tr>
<tr>
<td>Any Asianc</td>
<td>0.29</td>
<td>0.34</td>
<td>0.45</td>
<td>0.39</td>
<td>0.25</td>
</tr>
<tr>
<td>Asian Indian</td>
<td>0.25</td>
<td>0.30</td>
<td>0.34</td>
<td>0.37</td>
<td>0.19</td>
</tr>
<tr>
<td>Cambodian</td>
<td>0.29</td>
<td>0.39</td>
<td>0.49</td>
<td>0.75</td>
<td>0.25</td>
</tr>
<tr>
<td>Chinese</td>
<td>0.28</td>
<td>0.30</td>
<td>0.34</td>
<td>0.37</td>
<td>0.19</td>
</tr>
<tr>
<td>Filipino</td>
<td>0.28</td>
<td>0.30</td>
<td>0.34</td>
<td>0.37</td>
<td>0.19</td>
</tr>
<tr>
<td>Hmong</td>
<td>0.25</td>
<td>0.32</td>
<td>0.29</td>
<td>0.35</td>
<td>0.11</td>
</tr>
<tr>
<td>Japanese</td>
<td>0.80</td>
<td>0.85</td>
<td>0.78</td>
<td>0.90</td>
<td>0.21</td>
</tr>
<tr>
<td>Korean</td>
<td>0.69</td>
<td>0.83</td>
<td>0.77</td>
<td>0.88</td>
<td>0.16</td>
</tr>
<tr>
<td>Laotian</td>
<td>0.32</td>
<td>0.38</td>
<td>0.36</td>
<td>0.41</td>
<td>0.08</td>
</tr>
<tr>
<td>Vietnamese</td>
<td>0.33</td>
<td>0.55</td>
<td>0.58</td>
<td>0.84</td>
<td>0.26</td>
</tr>
</tbody>
</table>

aDoes not include individuals of mixed race/ethnicity.
bA census tract is enumerated if a race/ethnic group had at least 100 individuals in that tract.
cCensus tracts that contain any Asian and Pacific Islanders are not mutually exclusive.
Los Angeles area. This map shows strong geographic aggregation for some specific AAPI groups with many categorized in the two highest MGC quintiles. For example, 96% of the enumerated tracts for Korean, 91% for Japanese, and approximately 50% for Cambodian and Vietnamese were in this area, whereas none of the enumerated tracts for Hmong or Laotian (both groups with lower mean EPI scores) were in this area.

We also examined the EPI score by quintiles of census-based SES and percentage of linguistically isolated AAPI speakers for the aggregated AAPI population as well as for the different groups. As might be expected, neighborhood SES was inversely associated with tract-level MGC EPI scores for the aggregated AAPI population (38.8% of the tracts with the lowest SES quintile compared with 7.6% of the tracts with the highest SES quintile were in the highest MGC EPI quintile). Linguistic isolation was similarly skewed: 79.7% of the 2,736 AAPI enumerated tracts were in the highest two quintiles for percentage of AAPI language speakers with poor English proficiency, with 27.7% of these tracts with poor English proficiency compared with 9.9% of tracts with better English proficiency in the highest MGC EPI quintile. Analysis of the disaggregated groups showed that all enumerated tracts for Cambodian were in the highest quintile for percent of linguistically isolated AAPI speakers, and all enumerated tracts for Japanese, Korean (except one), Hmong, Laotian, and Vietnamese were in the two highest quintiles for percentage of linguistically isolated AAPI speakers. Of note, 74.5% of these enumerated tracts for Japanese and 58.7% for Korean were in the highest MGC EPI quintile. Because of small cell counts, these data are not shown.

Discussion

California has the largest and fastest growing AAPI population in the nation (2), with many AAPI ethnic groups geographically concentrated in select parts of the state. Although those census tracts with sufficient population to be enumerated for the aggregate AAPI...
population captures nearly 80% of the total AAPI population in the state, this proportion of the population occupies only 40% of the state’s census tracts, highlighting the geographic concentration of this aggregate population. There is also considerable variability in the geographic concentration between the AAPI groups with some more likely to be spatially concentrated (e.g., Chinese, Filipino, and Vietnamese) and others more dispersed (e.g., Japanese and Pacific Islanders). These results further underscore the heterogeneity within the AAPI
population, and highlight interest in those communities with a high population count of specific ethnic groups.

Our results suggest less difference between tracts with aggregated AAPI and non–Hispanic white women than seen with the considerable heterogeneity in exposure potential to MGCs across the disaggregated AAPI groups. Some groups living in enumerated tracts appear to have a much higher tract-level EPI average (e.g., Koreans and Japanese) while others have similar or slightly lower average EPI scores (e.g., Asian Indian Laotian, and Hmong). The groups with highest tract-level mean EPI scores, including Koreans, Japanese and Cambodians, were notably higher than those for the non–Hispanic white population. These findings underscore the importance of disaggregating the data by ethnic groups when evaluating environmental exposure in the AAPI population.

The strikingly higher EPI scores for Japanese concentrated tracts is an interesting finding, but should be considered in light of the fact that these enumerated tracts only contain a very small subset of the total statewide Japanese population. The rest of this population is dispersed in census tracts with fewer than 100 Japanese individuals. Despite the small representation of the Japanese population in these enumerated tracts, the substantially higher exposure potential observed in these tracts, with more than 70% falling into the highest MGC EPI quintile, suggests a disproportionate exposure potential among Japanese women living in these areas. Furthermore, those who live in tracts in the highest MGC quintile also live in tracts with the highest proportion of linguistically isolated AAPI speakers. Together, these findings indicate fairly dramatic potential disparities in socioeconomic and environmental factors, underscoring broader questions about environmental exposures for more recently immigrated or less assimilated ethnic groups. It also raises questions about factors that may influence the

Figure 4. Population of Asian groups in enumerated tracts and quintiles of MGC EPI scores in the greater Los Angeles area. Enumerated tracts are census tracts for which the total population of a specific AAPI group is greater than 100 and thus have been enumerated in the 2000 census. Each dot represents 50 females, and the percentage for each AAPI group indicates the percent of enumerated tracts in California that are represented on the map (no Hmong or Laotian population was enumerated in this area). Quintiles of MGC EPI scores were based on EPI scores for all 7,049 census tracts in California. The cities labeled are those with an Asian population of at least 15,000.
Air pollution in the Los Angeles area historically has been among the highest in the United States, partly due to traffic emissions in the area (43). Consistent with this, our study showed that this area has the highest MGC EPI scores in California. The fact that about 90% of the enumerated tracts for Japanese and Koreans, and about 50% of the enumerated tracts for Cambodian and Vietnamese were in this area, whereas none of the enumerated tracts for Hmong and Laotian were located in this area partly explains our findings of high exposure potential for enumerated Japanese and Korean populations compared with Cambodian and Vietnamese, and the low-exposure potential for Hmong and Laotian populations.

Our findings for geographic concentrations by ethnicity and by other sociodemographic factors are consistent with the concept of "ethnic enclaves," referring to a high concentration of coethnic individuals, often immigrants, who are geographically concentrated usually for purposes of immigrant adaptation and economic support (44, 45). Ethnic enclaves for AAPI populations have inspired names such as Chinatown, Japantown, Koreatown, and Little Saigon (46, 47). There is a growing body of literature focusing on protective effects against some health problems (48, 49) as well as environmental concerns within these enclaves (47, 50–53). Although our study was not specifically designed to characterize environmental exposures for Asian-specific ethnic enclaves, our results suggest a need to consider broader features of the ethnic enclave concept in relation to environmental exposures and how that may influence a variety of health outcomes.

The disproportionate distribution of air pollution in areas with low-income and minority populations has created concerns around environmental injustice (54–56). Several studies have identified socioeconomic and racial disparities in cancer risk from exposure to HAPs, using cancer risk estimates by the U.S. EPA NATA program and socioeconomic and demographic data from U.S. Census at census tract level (57–60). Many of these studies have focused on African American and Latino populations, and found that these two populations and low-income populations had higher cancer risk; none of these studies examined exposure or cancer risk disparity among AAPIs. Morello-Frosch and Jesdale used similar data to study residential segregation and estimated cancer risks associated with HAPs exposure in U.S. metropolitan areas and found that AAPIs as a group had higher estimated cancer risk than Non–Hispanic whites or blacks (61). Although few studies have evaluated potential disparities for the smaller and more diverse disaggregated AAPI groups, there has been a slowly growing body of literature suggesting that several of these groups face excess exposures to environmental hazards (28, 62–64) similar to other minority populations. Although our study is only exploratory in nature, the differences in estimated ambient air concentrations across and within the AAPI groups warrant further examination to identify potential disparities in environmental exposure by race and sociodemographics, which may inform future research directions in environmental-related adverse health outcomes.

Building on an existing study of breast cancer risk associated with estimated residential exposures to MGCs in California, the primary purpose of the present analysis was to assess whether there were ecologic differences in exposure potential to these MGCs across the different AAPI groups. Both a strength and a limitation of this analysis is that we used a rank summary (EPI score) of estimated concentrations of the 24 MGCs as the EPI. Although specific to breast cancer concerns, the EPI score may not necessarily indicate potential breast cancer risk because it gives equal weight to compounds with relatively low and with relatively high estimated concentrations and cancer potency. Cancer risks as estimated by the U.S. EPA in 2002 are only available for 21 out of the 24 MGCs, and as used in other studies in the literature (57–61) reflect general cancer risks (not specific to breast cancer). We conducted a sensitivity analysis using cancer risks from those MGCs included in U.S. EPA estimates in 2002. This yielded similar results to those using the EPI score, identifying Japanese and Koreans to be potentially at highest estimated cancer risk, although with more modest magnitude of differences.

Our focus was limited to evaluating exposure potential differences for those tracts with geographically concentrated AAPI groups. As such, the observations for differences between these geographically concentrated groups do not necessarily represent the experience of each ethnic group as a whole, but nonetheless reflect differences for communities of individuals that may represent particular social and cultural similarities that could not be addressed in the present study. Thus, while we report higher EPI scores for Japanese and Korean women living in enumerated tracts (i.e., tracts with sufficient counts of these ethnic-specific populations), we emphasize that this only applies to a small fraction of these ethnic-specific populations (approximately 10% for Japanese and 33% for Korean women) in California.

Although the current analyses were partly motivated by emerging evidence that breast cancer risk may vary considerably between AAPI groups as well as the results from our earlier study that suggested young California-born Japanese and Filipina women had uniquely elevated risks of breast cancer (14), these analyses were not intended to directly evaluate breast cancer risk per se. Rather, the objective was to assess the heterogeneity of potential environmental exposures of concern for the large and growing mixture of Asian ethnicities in California. It is important to note that while our decision to focus on MGCs as the environmental exposure of interest was predicated on a novel statewide study of breast cancer in which we are seeing some evidence for excess risks among women living in areas with high levels of ambient MGCs (65), this group of chemicals represents...
of the Asian population has been influenced by immigration and geographic concentration. However, the heterogeneity of the Asian American population, particularly within the context of cancer epidemiology, necessitates further research to fully evaluate the potential exposure differences among specific subgroups. The limitations of using ambient pollutant concentrations estimated by NATA to examine potential exposure should be noted. Comparisons of the predicted ambient concentrations with geographically limited ambient air quality monitoring data showed that modeled ambient levels by NATA are generally lower than measured ambient levels for many HAPs, both in the United States (67) and in California (68). These underestimates may be due to several reasons, including missing emission sources, underestimated emission rates, poorly characterized background concentrations, and imprecise model-to-monitor spatial comparisons (67). Changes in the emissions or meteorologic characteristics from 2000 to 2002 may also add to the uncertainty of potential exposures to the populations of interest. Furthermore, because the predicted concentrations by NATA are for outdoors only, using this metric as an exposure potential ignores other sources of exposure for some pollutants, such as indoor air, diet, and use of personal care products. A study comparing volatile organic compounds (VOC) predicted by NATA with measured personal exposure from nonsmoking adults in an urban community found that NATA estimates were reasonably accurate as a surrogate for personal exposures for VOCs emitted primarily from outdoor sources, otherwise they were generally lower than measured personal exposures (69). Finally, it is worth noting the limitations in inferences that can be drawn from ecologic analyses, such as this one. Future studies will need to consider a broad spectrum of individual, behavioral, and environmental risk factors.

The need for disaggregation of data for the heterogeneous AAPI population is critical for identifying potential disparities, not just in health outcomes, but also in exposures that may influence these health problems. Although further research clearly is needed to fully evaluate the preliminary differences in exposure potential found for some geographically concentrated AAPI populations, our results strongly support the need to disaggregate data by race/ethnicity. Although sometimes it may be necessary to aggregate data to have sufficient numbers for valid statistical compilations, it is equally important to acknowledge the heterogeneity and complexities of the populations we are studying so that we do not miss important variations that could provide new insights into the etiology of cancer and other health outcomes.

Acknowledgments

The authors thank Dr. Scarlett Gomez and her colleagues at the Cancer Prevention Institute of California (Berkeley, CA) for their review and suggestions on the article.

Grant Support

Funding support for this study was provided by CDMRP Department of Defense Breast Cancer Research Program award # W81XWH-10-1-0134 (to R. Liu, D.O. Nelson, S. Hurley, A. Hertz, and P. Reynolds).

Received May 1, 2014; revised July 30, 2014; accepted August 15, 2014; published online November 3, 2014.


Disaggregating Data on Asian American and Pacific Islander Women to Provide New Insights on Potential Exposures to Hazardous Air Pollutants in California

Thu Quach, Ruiling Liu, David O. Nelson, et al.


Updated version
Access the most recent version of this article at:
http://cebp.aacrjournals.org/content/23/11/2218

Cited articles
This article cites 52 articles, 8 of which you can access for free at:
http://cebp.aacrjournals.org/content/23/11/2218.full.html#ref-list-1

Citing articles
This article has been cited by 2 HighWire-hosted articles. Access the articles at:
/content/23/11/2218.full.html#related-urls

E-mail alerts
Sign up to receive free email-alerts related to this article or journal.

Reprints and Subscriptions
To order reprints of this article or to subscribe to the journal, contact the AACR Publications Department at pubs@aacr.org.

Permissions
To request permission to re-use all or part of this article, contact the AACR Publications Department at permissions@aacr.org.