Enhancing the Measurement of Health Disparities for Vulnerable Populations

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This article presents a mechanism for tracking and reporting health disparities data that are based on a general model of vulnerability. We briefly discuss the origins of this model and describe its focus on the cumulative impact of multiple risk factors on health-related outcomes. We then demonstrate how the model can be applied to inform the collection and reporting of health disparities data by providing three examples. Since national and state datasets contain information on a wide range of risk factors, researchers and policy makers would benefit from examining the multiple risks that affect vulnerable populations simultaneously, as we have demonstrated in the three examples. These examples suggest that the determinants of health and healthcare problems are multifactorial and that they can be studied in an integrative approach using risk profiles. This research methodology can strengthen our existing knowledge of health disparities and aid in the recognition of points of intervention to successfully improve health and healthcare for vulnerable populations.

KEY WORDS: health disparities, insurance enhancing the measurement of health disparities for vulnerable populations, race/ethnicity, SES, vulnerable populations

A large body of literature documents health and healthcare disparities in the United States and delineates the causal pathways that lead to these disparities. However, although this body of literature collectively demonstrates that the causes of disparities are multifaceted, many studies have tended to focus on single categories of vulnerability, such as minority race/ethnicity, low income, or lack of insurance coverage. Even studies that include other risk factors commonly use these variables as controls to reveal the specific effect of the one key variable of interest. A more realistic and accurate approach should account for situations in which vulnerable populations experience multiple, interrelated factors simultaneously.

We present a mechanism for tracking and reporting health disparities data that are based on a general model of vulnerability. We discuss the origins of this model and describe its focus on the cumulative impact of multiple risk factors on health-related outcomes. We then demonstrate how the model can be applied to inform the reporting of health disparities data by providing three examples. Finally, we discuss the implications of using such an approach.

The General Model of Vulnerability

Vulnerability has been defined as a multidimensional construct reflecting a convergence of many risk factors at both the individual and community levels, which influence health and healthcare experiences. Vulnerable populations typically experience risks in clusters, and groups predisposed to multiple risk factors are more vulnerable to poor outcomes than groups affected by a single risk factor. The general model of vulnerability...
(Figure 1) encourages us to more comprehensively and explicitly examine the contributions of multiple risks, allowing us to assess whether the collective impact of several risks adds up to more than the sum of its parts.24

The general model of vulnerability was derived from previous foundational works that delineated individual or community risk factors for poor health and healthcare access.25–28 Aday’s comprehensive model of vulnerability incorporates both individual and community risk factors for health and well-being, thus presenting a more comprehensive and accurate reflection of reality.29 Finally, Aday and Andersen’s highly cited access-to-care framework categorizes the predisposing, enabling, and need factors that influence individuals’ ability to obtain healthcare.30 The general model of vulnerability provides the next logical step and features some distinctive characteristics from these previous models. It emphasizes a convergence of multiple individual and community risks, which can have a cumulative effect on outcomes. In other words, the model considers those who experience multiple risks to be more vulnerable to poor outcomes than those with one or no risks. The model also considers predisposing, enabling, and need factors for poor quality of care and poor health outcomes, not just for poor access to care.

● Operationalizing the General Model of Vulnerability

Certain risk factors tend to have an impact on a wide variety of health and healthcare outcomes, including the ones in the three examples below. Race/ethnicity has been linked to health and healthcare through several pathways, including socioeconomic status, cultural factors, discrimination, and healthcare system characteristics.31–37 Socioeconomic status (ie, income, education) is associated with health-related outcomes through material deprivation of resources, stress, and opportunities for social participation.38–42 Health insurance influences access to, and utilization of, healthcare and quality of care.43–48 In addition to these common risk factors, other risk factors are relevant to specific outcomes of interest; these are also included in each of the three examples.

One approach for measuring and presenting the effects of multiple risk factors is to use interaction terms in statistical models. Interaction terms allow the relationship between a factor of interest and an outcome to vary depending on additional factors. However, these are often difficult to understand by anyone other than experienced researchers. In addition, interaction terms usually only account for the moderating effects of one or two additional variables, which is inadequate for models attempting to simultaneously consider numerous factors. To avoid these complications, we employ an alternative approach to account for multiple risk factors, where we create “risk profiles” to characterize individuals according to the presence or absence of certain vulnerable characteristics. Risk profiles enable us to summarize the number and types of risk factors experienced by individuals, are easier to comprehend than interaction terms, and are thus a preferable approach to account for multiple risk factors. Risk profiles also allow us to visualize whether the effects of combining risk factors are additive or multiplicative, which is not
always obvious from analyses that control for other risk factors or analyses containing interaction terms.

**Example 1: Disparities in unmet healthcare needs among adults**

A primary goal for the United States is to reduce or eliminate disparities in healthcare. Using data from the 2000 National Health Interview Survey, risk profiles were created for five common measures of patient-reported unmet healthcare needs, all of which were due to concerns over costs. These included lack of medical care, delayed medical care, delayed filling of prescription, delayed mental healthcare, and delayed dental care. Several risk factors for these unmet healthcare needs were selected on the basis of Aday and Andersen’s access to care model. These included individual-level predisposing (ie, race/ethnicity) and enabling factors (ie, income, health insurance, regular source of care). The analyses were also adjusted for demographic and community factors, including age, gender, marital status, education, employment, health status, metropolitan statistical area, and geographic region.

Table 1 presents the independent effects of risk factors on having delayed or missed healthcare. Controlling for demographic and community characteristics, each risk factor was associated with greater odds of having unmet needs. Compared with Whites, racial/ethnic minority groups had reduced odds of missing needed medical care or delaying medical care, prescription filling, mental health care, and dental care. Low-income adults had increased odds of reporting unmet healthcare needs than high-income adults. Lacking private health insurance and a regular source of care were also associated with unmet healthcare needs.

Figure 2 depicts the relationship between the risk profiles and the likelihood of delaying needed medical care, after controlling for demographic and community covariates, for the total sample and for each racial/ethnic group separately. It shows a stepwise increase across all racial/ethnic groups in the likelihood of delaying care with increasing numbers of risk factors. The largest jump in probability of unmet needs occurs between 1 and 2 risk factors. Compared with having none of the risk factors included in the model, having a single risk factor roughly doubles the probability of having unmet needs. However, adding a second risk factor can triple the likelihood of having an unmet need compared with no risk factors.

In addition, Whites are more likely to express delays in needed medical care than other racial/ethnic groups. This may be because Whites have different perceptions of health needs and feel more entitled to medical care, making them more likely to report unmet needs. On the other hand, minorities may have lower expectations from the healthcare system because of negative prior experiences, discrimination, and poorer quality of care, and thus are less likely to report unmet healthcare needs. Some racial/ethnic minority groups may also have lower health literacy, contributing to less frequent reports of unmet needs.

Another important finding is that some of the risk factor combinations appear to have multiplicative effects, rather than simply additive effects, depending on racial/ethnic group. Understanding these potentially multiplicative effects deserves particular research and policy attention. These profiles of multiple risk factors capture a more comprehensive view of unmet healthcare needs: regardless of race/ethnicity, having low income, lacking insurance coverage, and not having a regular source of care combine to create substantial

### Table 1: Associations of independent risk factors with missed or delayed care due to costs (N = 32,374)*

<table>
<thead>
<tr>
<th>Race/ethnicity (ref White)</th>
<th>Delayed needed medical care OR (95% CI)</th>
<th>Did not get needed medical care OR (95% CI)</th>
<th>Delayed filling a prescription OR (95% CI)</th>
<th>Delayed mental healthcare OR (95% CI)</th>
<th>Delayed dental healthcare OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>African American</td>
<td>0.56 (0.49–0.65)</td>
<td>0.76 (0.65–0.88)</td>
<td>0.73 (0.63–0.85)</td>
<td>0.57 (0.42–0.78)</td>
<td>0.66 (0.57–0.76)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.39 (0.32–0.46)</td>
<td>0.45 (0.37–0.55)</td>
<td>0.47 (0.40–0.57)</td>
<td>0.41 (0.30–0.54)</td>
<td>0.46 (0.40–0.54)</td>
</tr>
<tr>
<td>Asian</td>
<td>0.40 (0.26–0.62)</td>
<td>0.36 (0.22–0.60)</td>
<td>0.42 (0.26–0.68)</td>
<td>0.30 (0.11–0.79)</td>
<td>0.41 (0.28–0.60)</td>
</tr>
<tr>
<td>Low income (ref high)</td>
<td>1.50 (1.31–1.71)</td>
<td>1.58 (1.36–1.84)</td>
<td>2.12 (1.79–2.51)</td>
<td>1.77 (1.34–2.34)</td>
<td>1.65 (1.44–1.89)</td>
</tr>
<tr>
<td>Health insurance coverage (ref private)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public coverage</td>
<td>1.67 (1.41–1.98)</td>
<td>1.93 (1.58–2.35)</td>
<td>1.65 (1.37–1.99)</td>
<td>1.35 (0.96–1.90)</td>
<td>1.89 (1.61–2.22)</td>
</tr>
<tr>
<td>No RSC (ref having an RSC)</td>
<td>1.31 (1.14–1.51)</td>
<td>1.37 (1.17–1.60)</td>
<td>1.20 (1.03–1.40)</td>
<td>1.14 (0.87–1.49)</td>
<td>1.44 (1.27–1.63)</td>
</tr>
</tbody>
</table>

Abbreviation: RSC, regular source of care.
*2000 National Health Interview Survey.
Logistic regression models for each measure of missed or delayed care were conducted adjusting for age, gender, marital status, education, employment, health status, metropolitan statistical area, and geographic region.
barriers to accessing needed health services. One in five US adults has multiple risk factors for unmet healthcare needs and these barriers create up to a fivefold increase in rates of unmet needs.\textsuperscript{50} 

**Example 2: Disparities in receipt of recommended preventive services**

Another national priority involves improving the delivery of primary and preventive services to vulnerable populations. In this example, the outcome of interest was receipt of blood pressure screening during the past year. The risk factors examined included three enabling characteristics: low income (household income less than 200% of the federal poverty line), health insurance, and regular source of care. Low education (less than high school), a predisposing factor, was also examined. Data came from the 1996 Medical Expenditure Survey. Vulnerability risk profiles for the total sample and for racial/ethnic groups (results not shown) were created on the basis of these factors.\textsuperscript{56} Findings for each racial/ethnic group were similar to those for the total sample.

Figure 3 shows that there is a declining pattern in blood pressure screening by the number of risk factors. It also demonstrates that the particular combination of risk factors may have larger or smaller effects on the receipt of a blood pressure screening. For example, among individuals with a two risk factor profile, only 54 percent of those without insurance and a regular source of care had a screening in comparison with 86 percent of those with low income and low education.

This example demonstrates that a substantial proportion of US adults have multiple risk factors and these factors are associated with more than a twofold difference in the proportion of those receiving preventive care between the highest and lowest risk profiles.

**Example 3: Disparities in children's health status and developmental risk**

*Child health* is defined as “the extent to which children are able or enabled to develop and realize their potential, satisfy their needs, and develop the capacities that allow them to interact successfully with the biological, physical, and social environment.”\textsuperscript{56,p1} This definition...
is distinct from that of adult health because it considers important developmental processes.

Children are considered a vulnerable group because they often have multiple risk factors for poor health such as living in poverty and lacking insurance coverage. We hypothesized that having a greater number of risk factors would be associated in a dose-response manner with poorer child health status and risk of developmental delays. There are four strong and consistent predictors of poor child health, all of which were included in the models that are as follows: child minority race/ethnicity, lower family social class (based on poverty status and maternal education), child uninsured, and poor maternal mental health (measured by Mental Health Inventory scores, with the bottom tertile representing poorer mental health). All multiple logistic models were adjusted for child age and gender, maternal age and employment, and single parent household. Data came from the 2000 National Survey of Early Childhood Health.

Table 2 demonstrates that each of the four risk factors was independently associated with poor child health, after adjusting for covariates. African American and Latino children were more likely than White children to have poorer health status. Children from lower social class families were more likely than those from higher social class families to have poorer health status. Uninsured children were more likely to have poorer health status and more likely to be at higher risk of developmental delays. Both bottom and middle tertiles of maternal mental health scores were associated with lower child health status and higher risk of developmental delays.

Figure 4 shows a stepwise increase in the proportion of children in lower health status associated with increasing numbers of risk factors. Multiple risk factors are prevalent in the United States, with about 3.1 million young children aged 4 to 35 months having two or more risk factors. This suggests that addressing disparities in the health status of vulnerable children requires the recognition of multiple risk factors.

What Can Be Learned From Analyzing Multiple Risk Factors?

We have analyzed nationally representative data from three sources to explore the negative influence of multiple risk factors on healthcare access, receipt of preventive care, and children’s health. Certain methodological approaches should be considered when conducting research on vulnerability. It may be useful to stratify analyses by immutable factors such as race/ethnicity.
### TABLE 2  
Association of independent risk factors with child health status and developmental risk among children aged 4 to 35 months ($N = 2068$)*

<table>
<thead>
<tr>
<th>Risk factors</th>
<th>GFP status b</th>
<th>HRDD</th>
<th>GFP or HRDD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Child race/ethnicity (ref White)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>African American</td>
<td>1.76 c (1.07–2.91)</td>
<td>1.22 (0.81–1.85)</td>
<td>1.52 d (1.07–2.17)</td>
</tr>
<tr>
<td>Latino</td>
<td>2.21 a (1.46–3.35)</td>
<td>1.53 e (1.08–2.19)</td>
<td>2.00 b (1.46–2.74)</td>
</tr>
<tr>
<td>Other</td>
<td>1.93 (0.86–4.34)</td>
<td>1.46 (0.69–3.06)</td>
<td>1.75 (0.93–3.27)</td>
</tr>
<tr>
<td><strong>Family social class</strong> (ref higher)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>1.98 f (1.10–3.56)</td>
<td>1.53 (0.94–2.48)</td>
<td>1.56 f (1.00–2.41)</td>
</tr>
<tr>
<td>Middle</td>
<td>1.32 (0.80–2.19)</td>
<td>1.19 (0.81–1.74)</td>
<td>1.23 (0.87–1.73)</td>
</tr>
<tr>
<td><strong>Child health insurance</strong> (ref private)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Public insurance</td>
<td>1.55 (0.97–2.46)</td>
<td>1.05 (0.68–1.64)</td>
<td>1.38 (0.94–2.03)</td>
</tr>
<tr>
<td>Other insurance</td>
<td>0.99 (0.61–1.61)</td>
<td>1.37 (0.87–2.16)</td>
<td>1.43 (0.96–2.13)</td>
</tr>
<tr>
<td>Uninsured</td>
<td>2.50 e (1.33–4.69)</td>
<td>2.75 e (1.59–4.74)</td>
<td>3.21 e (1.91–5.41)</td>
</tr>
<tr>
<td><strong>Maternal mental health</strong> (ref top tertile)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle tertile</td>
<td>1.79 b (1.20–2.65)</td>
<td>1.77 c (1.23–2.54)</td>
<td>1.72 c (1.25–2.38)</td>
</tr>
<tr>
<td>Bottom tertile</td>
<td>1.71 g (1.20–2.65)</td>
<td>1.47 h (1.04–2.09)</td>
<td>1.89 h (1.35–2.64)</td>
</tr>
</tbody>
</table>

Abbreviations: GFP, good, fair, or poor health; HRDD, higher risk for developmental delays.

*2000 National Survey of Early Childhood Health.57

Logistic regression models are adjusted for child age and gender, maternal age and employment, and single parent household.

bCompared with “excellent” or “very good” health status.

cP < .05.

dP < .01.

eP < .001 for the odds ratio of the category versus the given reference group.

fBased on maternal education level and family poverty status.

gBased on Mental Health Inventory scores (bottom: 0–72 points, middle: 73–84 points, top: 85–100 points).

### FIGURE 4  
Proportion of Children in Good, Fair, or Poor Health (Versus Excellent or Very Good Health) by Risk Factor Combination*

*2000 National Survey of Early Childhood Health.57 No statistically significant differences were found among the risk factor combinations within each risk profile category (ie, 1 risk factor, 2 risk factors, etc). However, differences were statistically significant between the combinations within a given risk factor category (eg, 1 risk factor) and the combinations within another risk factor category (eg, 2 risk factors), P < .05.
and to create risk profiles using factors that are more amenable to policy interventions (e.g., insurance coverage, regular source of care). It is also informative to consider both the number and type of risk factors. In the case of unmet healthcare needs, the analysis of multiple factors demonstrates a dose-response relationship in the likelihood of delaying care as the number of risk factors increases, regardless of race/ethnicity. One in five US adults experiences multiple risk factors for unmet healthcare needs, so using the vulnerability model to address these needs will lead to a more effective approach.

In addition to this gradient relationship, certain combinations of risk factors may create more detrimental risk profiles than other combinations, and it is important to identify these vulnerability risk profiles. For instance, for blood pressure screening, a two risk profile of being uninsured and having no regular source of care is far worse than other two risk profiles. This information can guide interventions by identifying the most disadvantaged populations.

Achieving equity in the access to and quality of care for all Americans is a tremendous challenge for the nation. One strategy for reducing disparities is to measure health and healthcare indicators and their related risk factors. However, these data are frequently reported by focusing on single risk factors rather than in a manner that emphasizes the cumulative effects of multiple risk factors as proposed by the general model of vulnerability. Since national and state datasets contain information on a wide range of risk factors, researchers and policy makers would benefit from explicitly examining the multiple risks that affect vulnerable populations simultaneously, as we have demonstrated in the three examples above. These examples suggest that the determinants of health and healthcare problems are multifactorial and that they can be studied in an integrative approach using risk profiles. This research methodology can strengthen our existing knowledge of health disparities and provide guidance on potential policy interventions to target limited resources toward the most vulnerable groups.

REFERENCES