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Review of Inequality Indicators and Distributional Analysis Methods for EJ Assessment of an AQMP

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Objectives

- SCAQMD wishes to analyze the effect of its control measures on any baseline inequalities in health risks between Environmental Justice (EJ) areas and the rest of the South Coast Air Basin (SCAB) population.
- To accomplish this, SCAQMD asked IEc to identify and evaluate potential metrics for characterizing inequality that could be applied in a distributional analysis of health risks before and after implementation of the 2016 Air Quality Management Plan (AQMP).

Objectives

- Using inequality indicators, SCAQMD will perform a distributional analysis of mortality and morbidity risk associated with $PM_{2.5}$ and O_3 exposure.
  - Risk estimates will be generated by BenMAP-CE, comparing:
    - Baseline scenario
    - Mitigation strategy / policy scenarios from 2016 AQMP
  - Inequality indicators will be applied to EJ and non-EJ groups for baseline and policy scenarios. Change in inequality indicator values will be analyzed. Overall changes in population health risk inequality will also be estimated.
- Inputs to BenMAP for mortality and morbidity risk calculations include:
  - SCAQMD-provided air quality values
  - SCAB baseline health data
  - Concentration-response functions
  - Local population characteristics

Methods

- Understand SCAQMD goals
- Review of inequality metric and distributional analysis literature
  - Review of literature, e.g., Fann et al. (2011), Post et al. (2011), Maguire and Sheriff (2011), Sheriff and Maguire (2013), Harper et al. (2013)
    - Examples of the use of inequality indicators in health benefits analysis
    - Guidance or review articles recommending inequality indicators for health benefits analysis, e.g., Levy et al. (2006)
    - Literature identified by Dr. Sam Harper of McGill University and Dr. Jon Levy of Boston University
- Developed set of potential inequality indicators and criteria to serve as the basis for choosing appropriate indicators for SCAQMD's distributional analysis.

Background

- Distributional analyses have focused on:
  - $PM_{2.5}$ exposure, mortality risk, asthma-related hospitalizations
  - Allow analysis of efficiency and equality of control scenario
- Inequality indicators:
  - Are derived from economics literature for analysis of distribution of wealth or income
  - Convert a distribution to a single index value to provide a concise and easily utilized metric to order a set of outcomes

Considerations

- What is the appropriate reference group or value for analysis of inequality in the SCAB region?
- Should the indicator compare relative inequalities between groups or absolute inequalities between groups?
- Should EJ and non-EJ groups be considered as ordinal or nominal?
- Does the indicator need to be subgroup decomposable?
- Should an indicator include an explicit inequality aversion parameter to allow SCAQMD to determine the sensitivity of the indicator to changes in different parts of the risk distribution?

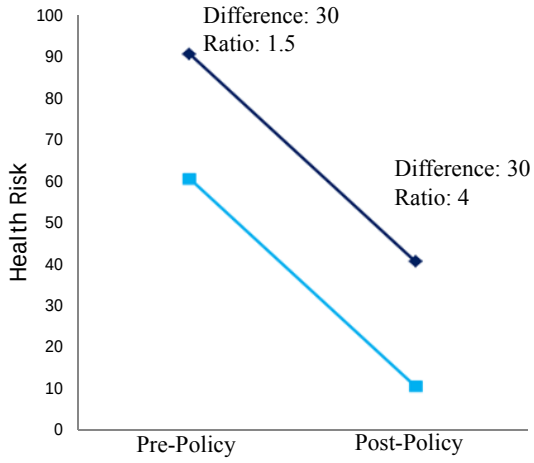
Inequality Indicators

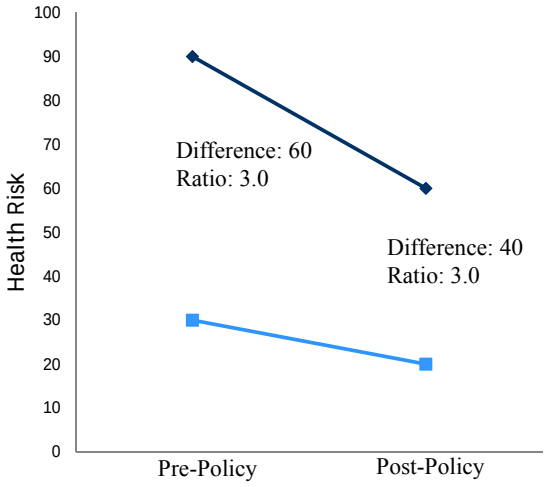
INEQUALITY INDICATOR	REFERENCE GROUP	ABSOLUTE OR RELATIVE INEQUALITY?	ACCOMMODATES ORDERED SOCIAL GROUPS?	SUBGROUP DECOMPOSABLE?	ADJUSTABLE INEQUALITY AVERSION PARAMETER?
Atkinson Index	Average	Relative	Yes	Yes	Yes
Gini coefficient	Average/ those better off	Relative or Absolute	No	No	No
Theil index	Average	Relative	No	Yes	No ($\varepsilon = 1$)
Mean log deviation	Average	Relative	No	Yes	No ($\varepsilon = 0$)
Kolm-Pollak index	Average	Absolute	Yes	Yes	Yes

Reference Group

Options	Considerations
Average health risk of SCAB population	Intuitive comparison; changes over time
Health risk of best-off in SCAB population	Maximum health potential; changes over time
Health risk of other non-SCAB EJ communities	Depends on other area's definitions; changes over time
Goal or target health risk	Must be realistic

Relative v. Absolute Measures of Inequality



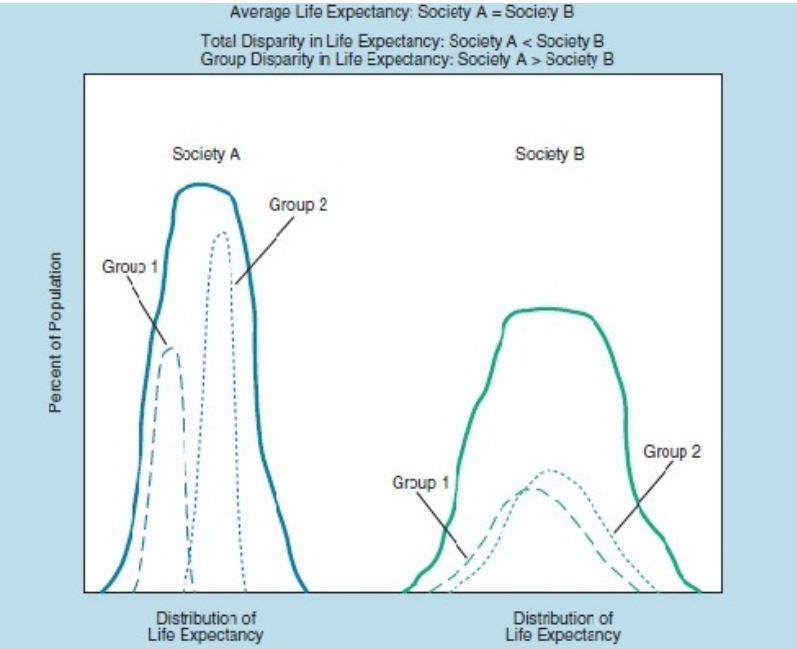


Options	Considerations
Absolute measure	Difference between values; affected by multiplication of risk
Relative measure	Ratio of values; affected by addition or subtraction of risk

Categorization Type

Options	Considerations*
Ordinal groups (e.g., income, education)	EJ status can be considered to be ordinal, but is not necessarily so; ordinal groups allow quantification of health gradients; however assumes more well-off areas are inherently different than EJ areas, which may or may not be the case
Nominal groups (e.g., race, ethnicity, gender)	EJ status can more conservatively be considered nominal
*Depending on other choices, categorization type may not be a necessary decision to make, as some inequality indicators can accommodate both ordinal and nominal groups.	

Subgroup Decomposable



Explicit Value Judgment

- Inclusion of an inequality aversion parameter:
  - Allows the user to assess robustness of results to value judgments about the desirability of equality in a given population
  - Higher values mean a stronger preference of the population for equality
  - Allows differential weighting of transfers at the bottom of the distribution

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Kolm-Pollak index	Average	Absolute	Yes	Yes	Yes

Recommendation

- We recommend use of the Atkinson index with the Kolm-Pollak index as sensitivity analysis measure, based on:
  - Comparison group should be the average of the health risks of the SCAB population.
  - Both absolute and relative inequality should be considered. Absolute inequality can be assessed through use of the Kolm-Pollak index; relative inequality can be assessed through use of the Atkinson index.
  - Index should include an adjustable inequality aversion parameter.
  - Index should be subgroup decomposable.
  - Index does not need to accommodate ordered social groups, as EJ is not an inherently ordered measure based on its many parameters.
- Using two indices allows sensitivity analysis, though we can consider whether including additional indices would provide more insight.

Atkinson Index

- Generalized entropy indicator
- Ranges from 0 (perfect equality) to 1 (maximum inequality)
- Based on the true outcome (rather than ranking of outcomes)
- Measure of relative inequality
- Subgroup decomposable to between-group and within-group components
- Accommodates ordered and non-ordered groups
- In reference to an average member of the population
- Utilizes an explicit parameter ε to allow greater sensitivity to the high risk end of a distribution over the low risk end with increasing ε, where high values indicate greater aversion to inequality

Kolm-Pollak Index

- Based on the true outcome (rather than ranking of outcomes)
- Measure of absolute inequality
- Additively subgroup decomposable to between-group and within-group components
- Accommodates ordered and non-ordered groups
- In reference to an average member of the population
- Utilizes an explicit parameter ε to allow greater sensitivity to the high risk end of a distribution over the low risk end with increasing ε, where high values indicate greater aversion to inequality

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