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Guide for Staff with Research or Analytical Responsibilities: Advancing Equity through Quantitative Analysis

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This content was initially created to inform federal staff at the U.S. Department of Health and Human Services. In an effort to increase collaboration and share promising practices, the Office of the Assistant Secretary for Planning and Evaluation has made this tool available for both public and private partners. Potential audiences that may be interested in these materials include, but are not limited to, state and local governments, tribal governments, and other private or non-profit organizations focused on programs and policies relating to health and human services. Links and references to information from non-governmental organizations are provided for informational purposes and are not an HHS endorsement, recommendation, or preference for the non-governmental organizations.

Purpose

This guide presents key considerations and selected approaches for advancing equity through quantitative analysis. It includes actionable strategies and links to examples and seminal resources, but it is not intended to provide a general introduction to quantitative methods.

What is equity?

The consistent and systematic, fair, just, and impartial treatment of all individuals, including individuals who belong to underserved communities that have been denied such treatment, such as Black, Latino, and Indigenous and Native American persons, Asian Americans and Pacific Islanders and other persons of colors; members of religious minorities; lesbian, gay, bisexual, transgender, queer, and intersex (LGBTQI+) persons; persons with disabilities; persons who live in rural areas; and persons otherwise adversely affected by persistent poverty or inequality. *Definition adapted from Executive Order 13985.*

Embedding an equity framework into research and evaluation activities is critical , as no one, no matter where they live or were born, how they identify, or their circumstances, should face barriers to their optimal health, social, economic, well-being, or other goals. Advancing equity through quantitative analysis involves an explicit consideration of the power dynamics and contextual factors that marginalize communities and contribute to inequitable outcomes

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throughout all stages of the research and analysis process. Specific steps will differ according to your objectives but might include the following:

1. Planning and designing quantitative analysis with an equity lens and focus

2. Identifying and comparing subgroups

3. Assessing and addressing data quality and small sample sizes

4. Modeling subgroup and distributional differences in regression equations

Examples of quantitative analyses for which this guide may be useful

- Descriptive statistics
- Regression analyses
- Trend analyses
- Distributional analyses
- Benefit-cost analyses

This guide outlines each of these steps, offering specific strategies and considerations along with resources for further reading.

For more information on approaches to using data in assessing equity, please consider the following resources:

- Executive Order 13985 describes ways federal agencies can advance racial equity and support underserved communities, including by identifying methods to assess equity: https://www.federalregister.gov/documents/2021/01/25/2021-01753/advancing-racial-equity-and-support-for-underserved-communities-through-the-federal-government
- A report from the Office of Management and Budget that describes promising practices and frameworks for assessing equity and expanding use of these practices across the federal government: https://www.whitehouse.gov/wp-content/uploads/2021/08/OMB-Report-on-E013985-Implementation_508-Compliant-Secure-v1.1.pdf
- A book chapter that describes ways of measuring health disparities and the mechanisms underlying those disparities using statistical tools and causal inference: doi.org/10.1002/9781119374855.ch12

1. Planning and designing quantitative analyses with an equity lens and focus

It is important to acknowledge that, even though we seek to generate objective evidence that is neutral and informed by expertise, we recognize that all research and analysis is inherently subjective and vulnerable to bias. It reflects the perspectives of those conducting the research, and people who do research are often removed from the experiences and conditions of the people and groups that the research will affect.

- **Identify and manage bias.** Recognize your relationship to the social, historical, or political context of your study and to the people you are researching or analyzing. For example, the research team may not be a part of the community that their study focuses on. As a result,

the research team may not have intrinsic or full insight into what it's like to be a member of that community or how identity and culture may impact the community's responses. Therefore, it is important for research teams to consider and assess their potential biases, the gaps that might appear resulting from the team's distance from the community they study, and whether the research methods they chose are appropriate for that community. Find ways to reduce the team's potential bias by seeking more context and input from community members throughout the study.

Examples of research questions focused on equity

- Is this policy effective and beneficial for all subgroups?
- Are there different effects that would reduce or increase inequities between and among subgroups?
- What measurable factors are correlated with observed disparities?
- Is there heterogeneity in the distribution of benefits and costs within each subgroup?

- **Consider context from the beginning and throughout the research or analysis process.** Throughout the entire research or analysis process, consider the historical and cultural context and the policy environment that may contribute to current systemic barriers and disparities.[i] When discussing findings, place them within this broader context. Contextualizing findings can help make findings actionable.
- **Engage experts, including people with lived experience, with programs and issue areas.** This can help you understand inequities and barriers and inform the research design and analytic questions. Engaging people with lived experience is a core component of equitable evaluation.
  - Consider frameworks such as participatory action research as an approach for collaborating with people with lived experience in every aspect of the analysis, from selecting research questions to interpreting results. Among other benefits, the perspectives of people with lived experience can help address data limitations and check assumptions about research questions, statistical models and analytic methods, and interpretation of results. Information drawn from people's lived experience can help contextualize your analysis and findings and ensure that the research does not cause harm.
  - In addition to engaging people with lived experience, seek input on study plans from partners and team members with diverse perspectives (such as people on interdisciplinary teams or who work in other agencies).

- **Include research questions focused on equity.** Develop questions focused on systems (e.g., policies, practices, and institutions) rather than just the individual. Ask explicit questions about systemic barriers and disparities to ensure that the research and analytical methods address equity.

For more information on ways to include community members in conducting research, please consider the following resources:

- A set of tools and a learning session on equitably engaging people with lived experience in HHS work: http://aspe.hhs.gov/equity-tools
- A brief identifying ways to engage people with lived experience in federal research, programming, and policymaking: https://aspe.hhs.gov/reports/lived-experience-brief
- A book chapter on participatory action research describing the benefits of this approach and several illustrative studies: https://www.academia.edu/3991129/Participatory_Action_Research
- A guidebook with concrete ways for organizations to partner with community members as authors when conducting new research: https://chicagobeyond.org/researchequity/
- A set of tools on conducting equity assessments: http://aspe.hhs.gov/equity-tools
- A toolkit with step-by-step instructions and a worksheet for government agencies and other organizations to implement a racial equity tool, including examples from two cities: https://racialequityalliance.org/wp-content/uploads/2015/10/GARE-Racial_Equity_Toolkit.pdf

2. Identifying and comparing subgroups

Subgroup analyses can provide information about whether programs and policies generate different impacts on some subgroups. They can reveal advantages and disparities that may be rooted in historical power imbalances. The choice of relevant subgroups depends on the research topic.

- **Engage people with lived experience to help identify and consider the most relevant subgroups.** Such individuals may be able to help identify key subgroups and offer some insights into or perspective about subgroups for which data may be missing or limited.
  - Given the importance of intersectionality, consider including how groups interact; after all, population groups are not homogeneous. Intersectionality is the idea that people belong to more than one group and may experience overlapping health and social inequities as well as overlapping strengths and assets.[ii] For example, a study examining equitable access to home and community-based services for older Americans by race might examine outcomes separately for people of different races living in urban and rural areas.
- **Examine how different data sources define subgroups.** The U.S. Department of Health and Human Services (HHS) has set forth data collection standards for race, ethnicity, sex, primary language, and disability.[iii] However, data sources differ in the domains they include and the specificity and wording of questions. These differences can affect responses and estimates for various subgroups.

- **Carefully select which measures to use.** Different measures can sometimes lead to different conclusions about a program's impacts, including those related to equity. Select measures that could lead to more actionable findings.
  - **To make direct comparisons across groups, use statistics that measure differences across specific groups.** Comparing means or medians across groups and using measures such as odds ratios or risk ratios can help assess disparities by providing direct measures of comparison across groups. The box to the right shows an example of how odds ratios and risk ratios might lead to distinct findings on differences across specific groups.
    - Conduct tests of significance for these measures to assess whether estimated differences across groups are statistically significant or could be because of chance. Commonly used tests include *t*-tests (for comparisons across numerical, continuous variables) and chi-square tests (for comparison across discrete or categorical variables).
  - **Be aware of limitations of composite measures.** Composite indices such as the Social Vulnerability Index can help identify disparities across geographic areas by combining information across several dimensions of subgroups. The composition index, which measures under- or over-representation of certain groups within a population, is one of the most common composite indices used to measure disparity or disproportionality. However, such composite indices are not appropriate for measuring subgroup differences. For example, using the composition index to calculate the rate of fetal alcohol syndrome among Native Americans living on a reservation might suggest a low or high incidence rate within that geographic community, but it cannot tell us whether the rate is low or high relative to other demographic or geographic communities. Similarly, using the Social Vulnerability Index to examine whether geographic areas with higher social vulnerability scores have lower rates of Paxlovid use, an antiviral therapy, cannot directly tells us whether Black Americans experience lower rates of access than other Americans.

Example use of risk ratio and odds ratio

$$Risk\ ratio\ (RR) = \frac{Percentage\ of\ Mexican\ American\ adults\ with\ developmental\ disabilities\ with\ COVID-19\ infection}{Percentage\ of\ Black\ adults\ with\ developmental\ disabilities\ with\ COVID-19\ infection}$$

RR = 1: No difference in COVID-19 risk among groups; RR > 1: COVID-19 risk among Mexican American older adults greater than among Blacks adults; RR < 1: COVID-19 risk among Mexican American older adults lower than among Black adults.

$$Odds\ ratio\ (OR) = \frac{Number\ of\ Mexican\ American\ adults\ with\ developmental\ disabilities\ with\ COVID-19\ infection}{Percentage\ of\ Black\ adults\ with\ developmental\ disabilities\ with\ COVID-19\ infection}$$

OR = 1: No difference in odds of COVID-19 infection among groups; OR > 1: Odds of COVID-19 infection among Mexican American adults greater than among Black adults; OR < 1: Odds of COVID-19 infection among Mexican American adults lower than among Black adults.

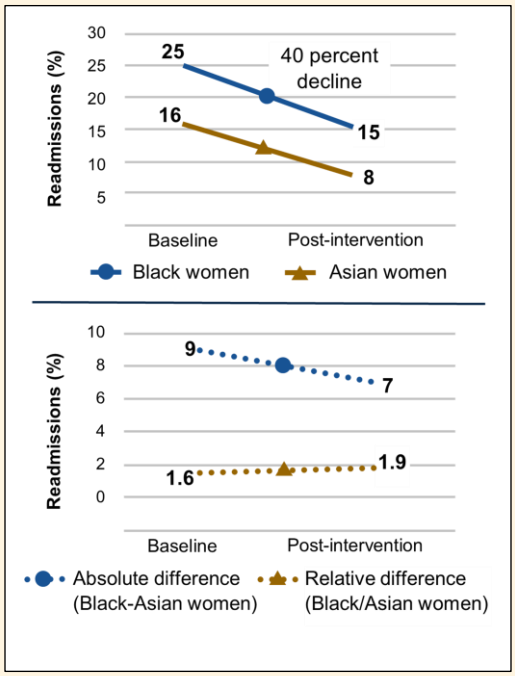
- **Think carefully about the reference groups you use.** Avoid automatically defaulting to demographic groups (e.g., White, heterosexual) just because they have been used in the past. Consider whether reference groups can encode judgments and bias and opt, when possible, to make pair-wise comparisons across several groups to present information more neutrally.
  - Consider, too, comparisons of each group's outcomes to any of the following: a fixed, desirable outcome (a benchmark) if one is available from clinical evidence, impacts of previous policies, or an aspirational policy statement (such as Healthy People 2030).[iv]

Example use of a benchmark as a reference group

In assessing the impact of the menthol smoking ban on smoking rates by race and gender, compare each group's smoking rates and reductions with a Healthy People 2030 benchmark (the target for 2030 is 6.1 percent cigarette smoking in adults, down from 14.2 percent in 2019).

- **Select measures to align with the study's research questions.** Unit changes and differences may be more relevant in some contexts, whereas relative rates may be more relevant in others. For example, interventions aimed at reducing maternal mortality might find absolute declines more relevant than relative rates, but an intervention aimed at reducing pay inequities may find changes in relative incomes more informative.
- **Include several measures or comparisons to provide a richer picture of the impacts of interventions.** The choice of measures for making comparisons affects the conclusions about equity and can lead to different interpretations. For example, in the graphic below, unit and percentage changes suggest different implications for equity, as do absolute and relative differences. Consider comparing both unit changes and percentage changes over time and comparing both absolute differences and relative differences between groups.
  - Be mindful of the limitations of any single measure when relying on subgroup findings in a study for which you do not have access to the underlying data. Any single estimate could be driven by outliers, statistical change, or mismeasurement. To the extent possible, consider whether it seems reasonable given the context.
  - Think about the substantive magnitude of implied impacts, even if they are statistically significant, to avoid overemphasizing estimated impacts that are very small.

Example of interpreting subgroup differences and impacts on equity



Unit versus percentage changes

- Black women have a higher rate of post-hospitalization readmissions than Asian women, but both groups experience declines.
- Black women experience a larger unit decline in readmissions (10 percentage points) than Asian women (7 percentage points).
- But Black women experience a smaller percentage decline in readmissions (40 percent) than Asian women (50 percent).

Absolute versus relative differences

- The absolute difference in readmissions between Black women and Asian women declines after the intervention (from 9 percentage points to 7 percentage points). The relative difference between Black women and Asian women increases after the intervention (from 1.6 percentage points to 1.9 percentage points).

For more information on measuring and comparing subgroups, please consider the following resources:

- An explanation of the U.S. Department of Health and Human Services' data standards for race, ethnicity, sex, primary language, and disability: https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=3&lvlid=54
- A journal article with statistical analysis and applied examples of using absolute and relative measures in evaluations of interventions to reduce disparities: https://stacks.cdc.gov/view/cdc/36169
- A useful source for benchmarks, Healthy People 2030, which has a collection of national objectives to improve health and well-being: https://health.gov/healthypeople

3. Assessing and addressing data quality and small sample sizes

Poor data quality introduces bias, particularly for smaller groups and subgroups whose sample sizes may be small. **Characterizing data quality and gaps is important to reduce or eliminate measurement bias and to highlight areas for additional research.**

- **When selecting data for analysis, consider who is included in and excluded from possible data sources.** Is it possible that the data do not reflect certain population groups, such as workers earning unreported income, people without a landline, people who are incarcerated, or immigrants who are undocumented?
- **Acknowledge when subgroups might not be identifiable in data.** When summarizing research or analysis results, it is important to document known data gaps, supplement the database with other data sources, and discuss who might have been excluded from the research or analysis. Notably, LGBTQI+ populations and within-race group identities are not yet widely captured in many data sources. Input from people with lived experience and a mixed-methods approach can be particularly valuable here. For example, if the quantitative data exclude a specific subpopulation, people with lived experience may be able to offer some insights into the experiences of that subpopulation.
- One way to address equity in data sets is through imputation. Imputation uses one data set to add characteristics that another data set is missing. It is useful when a data set you want to work with does not include key characteristics such as race, ethnicity, or sexual orientation**.**
  - When imputing characteristics from another data set because the characteristics are not included in your primary data set, first assess whether those data are biased. Document all the analytic decisions and check after imputation whether the imputed information is sufficiently accurate.
  - Engage people with lived experience about assumptions and model specifications and use their responses to test whether the approach to imputing data shows bias.
  - Consult resources for addressing equity in imputation methods. For example, Ethics and Empathy in Using Imputation to Disaggregate Data for Racial Equity, A Case Study Imputing Credit Bureau Data summarizes lessons researchers learned from a case study in which they proactively incorporated equity when imputing race and ethnicity.[v]

Common data quality issues

- Missing data
- Duplicate data
- Selection bias
- Nonresponse bias

TIPS

Imputation can pose risks of bias. Only do it if you can focus on equity throughout every step of the process.

When imputing missing data, examine whether the rate of missing data varies across subgroups of interest, and, if it does, consider doing the imputations separately by subgroup.

- Sample sizes for some subgroups might be small. To find out whether the sample is large enough to detect meaningful differences, conduct power analyses for comparisons across both groups and smaller subgroups to assess whether your sample is suited to detecting meaningful differences. Identify groups that cannot be represented accurately with the available data and consider analyses to identify trends and comparisons to benchmarks, even if doing so lacks statistical precision.
  - When you do not have enough power to estimate impacts on the primary outcomes, you can consider examining impacts on intermediate outcomes. Intermediate process outcomes, such as how many people received a service, might be sufficiently powered to detect impacts because programs often have larger impacts on intermediate process outcomes.

Example of impacts on an upstream outcome that could inform underpowered outcomes of interest

An evaluation of a policy intended to reduce risky sexual behavior may be underpowered to estimate impacts on Latino men. However, a positive impact on the upstream outcome of participating in school-based programs may indicate that the program has a positive effect on the group.

When analyses are underpowered, limit emphasis on statistical significance and critical values.

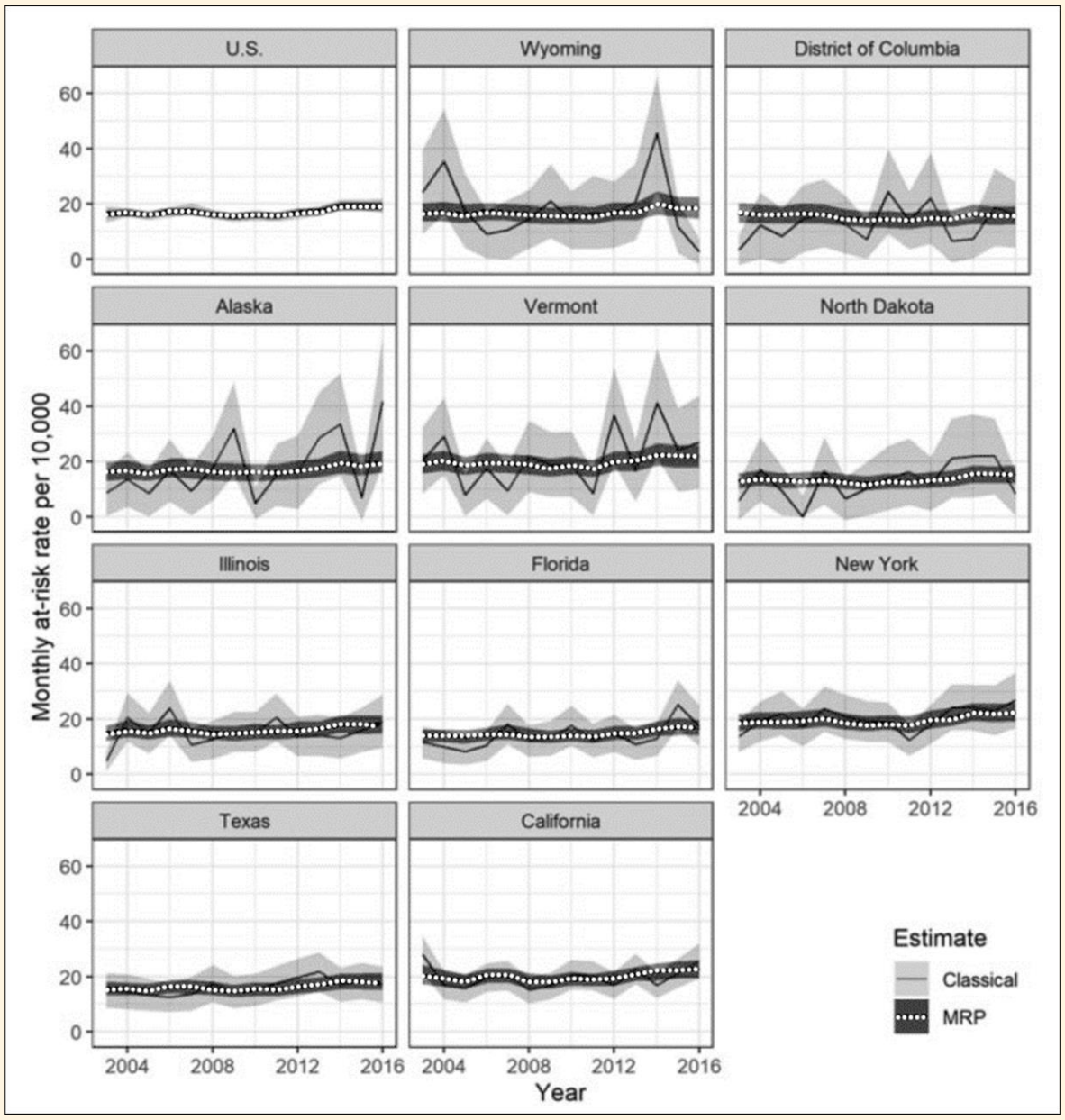
Advanced tool: Multilevel regression with poststratification (Bayesian modeling)

Sometimes sample sizes for subgroup analyses, analyses with interactions of subgroups, and state or local analyses by subgroups are too small to produce precise estimates. Statisticians have developed approaches to generate more reliable estimates in these cases. **Consult with statisticians to identify new approaches when standard analyses are underpowered because of small sample sizes.**

- If the sample size is too small for precise estimates, consider using a Bayesian modeling technique called **multilevel regression with poststratification (MRP)**. MRP is a two-step approach that can be particularly helpful for subgroup analyses, analyses with interactions of subgroups, and local area estimates.
  - In the first step, MRP generates estimates for subgroups in the primary data set. To improve the precision of each subgroup estimate, it draws on information from similar subgroups.
  - In the second step, MRP uses a larger data set that represents the full population of interest so it can reweight the estimates from the first step. This allows you to interpret the estimates as population estimates.
  - As an example, researchers have used MRP to estimate the election turnout and voting patterns of small electoral subgroups[vi] and to estimate someone's risk of leaving a job because of a medical condition across states, years, age, education, gender, race, and ethnicity.[vii]

Example of using Bayesian modeling to improve precision: MRP helps model the risk of someone leaving a job because of a medical condition across states, years, age, education, gender, race, and ethnicity (Ben-Shalom et al. 2021)

The figure below shows annual time series for the monthly rate of people leaving their job because of a medical condition (per 10,000 working-age adults) using both MRP and classical methods for the United States as a whole and for the five smallest and five largest states (based on the population ages 18 to 64). For each series, the shaded area shows a 90 percent uncertainty interval. Because of the large number of observations in the national sample (top-left panel), the annual series for the monthly rate is virtually the same for the MRP and classical approaches. But the state-by-year estimates show a clear advantage of the MRP approach over the classical approach in that the trends are much more stable. The decrease in volatility in the MRP estimates is more dramatic for smaller states than for larger states. Researchers can use a similar approach to model subgroup outcomes.



For more information on improving data collection, quality, and precision for underrepresented groups, please consider the following resources:

- A roadmap that summarizes whether and how race and ethnicity data are collected across federally administered health systems and public health databases as well as recommendations for improving the data: https://www.ncqa.org/wp-content/uploads/2022/01/GIH-Commonwealth-Fund-federal-data-report-part-2-1.pdf
- An article on expanding data collection on sexual orientation, gender identity, and intersex status: doi.org/10.1056/NEJMp2032447
- A case study of using ethics and empathy in data imputation: https://www.urban.org/research/publication/ethics-and-empathy-using-imputation-disaggregate-data-racial-equity-case-study-imputing-credit-bureau-data
- A study that illustrates the use and benefit of multilevel regression with poststratification for generating more precise state-level estimates: doi.org/10.1093/jssam/smab005

4. Modeling subgroup and distributional differences in regression equations

Researchers often use regressions to identify the impact of a program on different groups because doing so allows them to control for the fact that differences in other population characteristics, such as family income, health conditions, and education, might affect outcomes. By controlling for variation in these other characteristics, regression analysis can help researchers isolate the impact of a program more precisely. However, it is important to realize that programs might produce different effects for different groups, necessitating the use of modeling approaches that reveal those differences.

Among the approaches to specifying regression equations to estimate whether the impact of a program or policy differs across subgroups, the most common approach includes using what are called interaction terms of policy or treatment indicators with subgroup indicators, as the box below illustrates.

- **Research questions should drive the regression specification.** In considering which covariates to include or whether to include additional interactions, it is important to think about whether the research is asking about gross differences or net differences.
  - For example, studies of earning inequities by gender often control for age and education, because earnings differ by age and education across all genders. Some studies also control for years of experience and whether someone has children. These controls might be important when testing for discrimination in pay compensation, but

Example application of regression analysis

Research suggests that COVID-19 vaccines appear to have lower efficacy rates over time among some populations, including older people. What this finding means for creating policy might change depending on whether the difference is because older people have a higher prevalence of health conditions and not because of some other aspect of aging. Regression analyses can help identify more specific risk groups and, in turn, develop more precisely focused policies or campaigns.

controlling for factors that drive the gender gap could hide real gaps in earnings related to how a lack of adequate and affordable child care falls disproportionately on mothers.

- Involving people with lived experience when specifying and refining research questions can further help guide decisions about regression specifications.

Example of using interaction terms to estimate subgroup impacts of COVID vaccination on hospitalization

In a regression analysis with population data, you could interact indicator variables for vaccination status, gender, and age group by using the following equation:

$$hospitalization_i = \beta_0 + \beta_1 \times vaccinated_i + \beta_2 \times female_i + \beta_3 \times agegrp2_i + \beta_4 \times agegrp3_i + \beta_5 \times vaccinated_i \times female_i + \beta_6 \times vaccinated_i \times agegrp2_i + \beta_7 \times vaccinated_i \times agegrp3_i + X_i'\gamma + \varepsilon_i$$

In the equation, the variables *hospitalization*, *vaccinated*, *female*, *agegrp2*, and *agegrp3* are all indicator variables equal to either 0 or 1 based on the individual's status. The reference age group is *agegrp1*. The coefficients on the interaction terms capture the difference in the impact of vaccination between females and males (β_5), age groups 2 and 1 (β_6), and age groups 3 and 1 (β_7). The term X is a set of additional individual-level control variables that could affect hospitalization, such as education, region of residence, or comorbidities.

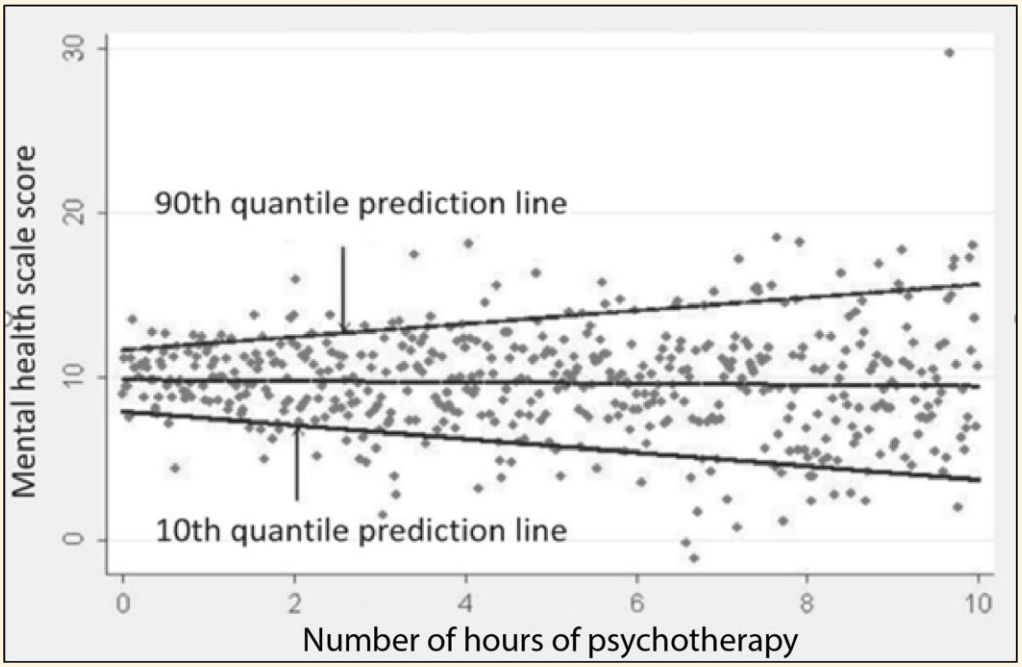
- **Be careful of overcontrolling when selecting covariates.** Including underlying drivers of outcomes can wash away or hide important disparities. Comparisons of models with and without covariates or subsets of covariates can determine the extent to which certain characteristics drive some of the gross differences.

Advanced tool: Quantile regression

- Some programs or policies might have different impacts for people with higher or lower values of the outcome than the mean. It is easy to overlook these impacts when considering only the mean of the outcomes, as most regressions do. **Consider using quantile regression to estimate impacts at several points on the distribution.**[viii] Quantile regression can be a useful approach for studying equity impacts of interventions or programs because it allows you to estimate specific impacts for people who appear to have had disparate outcomes.
- **Use quantile regression to check whether null effects at the mean are hiding meaningful effects at other points on the distribution.** For example, suppose telehealth coverage significantly reduces emergency department visits among people who visit the emergency department frequently, but it also increases visits among people who visit it less frequently. Standard regression at the mean might estimate no impact of telehealth on visits because the different effects at opposite ends of the distribution cancel each other out. Quantile regression, by contrast, shows the impact separately for frequent emergency department users and infrequent emergency department users, which helps reveal meaningful effects that might otherwise be hidden. As an example, research has found that higher minimum wage increases family incomes primarily at the bottom of the income distribution.[ix]

Example of quantile regression: Relationship between hours of psychotherapy and mental health

Using quantile regression, the figure below shows the estimated relationship between hours of psychotherapy and a mental health score from a hypothetical intervention. It illustrates that, despite no relationship at the median, quantile regression reveals a negative relationship at the lower end of the distribution of the score and a positive relationship at the higher end of the distribution. Quantile regression provides greater flexibility than other regression methods do when identifying different relationships at different parts of the distribution of the dependent variable.



Lê Cook, B., and W.G. Manning. "Thinking Beyond the Mean: A Practical Guide for Using Quantile Regression Methods for Health Services Research." *Shanghai Archives of Psychiatry*, vol. 25, no. 1, 2013, pp. 55–59.

For more information on the statistical qualities and applications of quantile regression, please consider the following resources:

- A slide deck from a workshop that provides an introduction to quantile regression from the statistician that developed it as a method: http://www.econ.uiuc.edu/~roger/courses/RMetrics/L1.pdf
- A study that illustrates how quantile regression can show the impact of minimum wages differing across families with different levels of income: doi.org/10.1257/app.20170085

Additional resources

Center for Evaluation Innovation, Institute for Foundation and Donor Learning, Dorothy A Johnson Center for Philanthropy, and Luminare Group. "Equitable Evaluation Framing Paper." Equitable Evaluation Initiative, July 2017. Available at https://static1.squarespace.com/static/5a73584b8fd4d2dbcaa08405/t/5fbdb0633c02f22b9dc97d37/1606266980696/Equitable+Evaluation+Framework+Framing+Paper_200904.pdf.

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