

## ASSOCIATION VS CAUSATION; DISPARITY VS. DISCRIMINATION

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*Association is not causation. This claim is central to the teaching of statistics. This paper reviews the phrases used to distinguish these in the everyday media. These phrases are grouped into an A-B-C classification: A indicates association, C indicates causation, and B indicates in-between. This classification is extended to claim that disparity (association) is not discrimination (causation). Finally, disparate impact is distinguished from systemic discrimination. Statistical educators have no expertise in deciding whether an association is causation, whether a disparity is discrimination, or whether a disparate impact involves systemic discrimination. But they do have expertise in analyzing the effects of context on the size and direction of a statistical association or disparity.*

### ASSOCIATION VERSUS CAUSATION

Almost all introductory statistics courses today start by noting that “correlation does not imply causation” or “association is not causation.” “Imply” is problematic because it generally means “supports”—as opposed to “sufficient” in mathematics. Arguably, association is more inclusive than correlation because association includes covariation and two-group comparisons. See Figure 1.

#### ASSOCIATION (statistical)

Comparison (Two-groups)	Type	Co-Variation (Two factors)
Women live longer than men	Ordered	As height increases, weight increases
US women live five years (6.6%) longer than men.	Arithmetic	For each additional inch in height, weight increases by five pounds

Figure 1. Association: two-group comparison and two-factor covariation

Most examples demonstrating the difference involving confounding. Most students have never heard the word 'confounding.' Even after they learn that confound and confuse are synonyms, they have never thought about a confounder. There is no equivalent, e.g., a confuser.

Students need simple examples. Consider that people who shave their faces are typically taller than those who shave their legs. So, if you want to grow taller, shave your face. Obviously, this conclusion is false. The inference is confused, i.e., confounded, by gender. Men are more likely to shave their face; men are more likely to be taller.

Students should understand the everyday English used to describe and distinguish association and causation. These words and phrases should be based on empirical research.

#### *Association Versus Causation in Everyday Media*

Some 2,000 news stories were analyzed in their usage of keywords indicating association and causation (Schield & Raymond, 2009). The results were summarized into a three-group A-B-C classification: ‘A’ words signify pure association; ‘C’ words signify pure causation; and ‘B’ words signify ‘Between’ association and causation. ‘Between’ words have a causal connotation but in fact only assert an association. ‘Between’ words are much more common in everyday media than words indicating pure association or pure causation. See Figure 2.

In this study, 74% of the news stories included words involving association or causation. Of those, 21% involved Association words (association, synonyms, or static two-group comparisons); 66% involved Between words such as action verbs (cuts, ups, increases, etc.) or changeable two-group comparisons and covariation (e.g., As  $x$  increases,  $y$  increases); and 15% involved Causation words causes, results, or phrases indicating sufficiency (e.g., stops, “will happen”). Static two-group comparisons involve two groups with typically static characteristics such as gender: women live longer than men on average. Changeable two-group comparisons are those involving changeable characteristics such as: men who eat nuts have fewer health problems [than men who do not eat nuts].

**Semantics: Association is not [necessarily] Causation**

<b>A: Association</b>	<b>B: Between</b>	<b>C: Causation</b>
Asserts an association; Says "what"	Asserts an association but suggest causation	Asserts causation; Asserts "how" *
associated/association correlation	increases, raises, ups; cut "As x ↑, y ↓"; "more x, less y"	cause, create, produce effect, result, consequence
Two-group comparisons: "Women live longer than men" "Men more likely to drink beer"	before/after; linked, factor leads to; causal factor due to, because of	Sufficient: prevent, stop "If X, then Y will happen" Contra-factual

Based on common usage by many today, but not "etched in stone" for all.

\* Other words OK in context. Schild V0K

Figure 2. A-B-C classification in the natural world

*Benefits of Association*

Although the foregoing distinctions between association and causation are important, students need to recognize the benefits of identifying association. Association is the doorway to knowledge, to science, and to improved decision-making. Associations can be extremely valuable.

- Associations support generalizations. Suppose that eating lemons cured scurvy in a few sailors. Perhaps eating lemons would cure scurvy for most—perhaps even all—sailors: a generalization.
- Associations support predictions even without knowing their causes. In ancient times, people used associations to predict tides, seasons, and eclipses long before they understood the solar system.
- Associations support specification. Suppose there is an association between some symptoms and a cure. If your symptoms are similar to those having a certain condition (scurvy), then perhaps your condition may be improved by using the same cure (lemons).
- Statistical associations may support causal connections. For 17th century German monks, colic (abdominal blockage) was more prevalent among wine drinkers than non-drinkers. In 17th century England, colic was more prevalent among cider drinkers than non-drinkers. In both cases, neither wine nor cider caused colic but rather something connected to both. Both wine and cider were sweetened with lead acetate. Colic was a result of lead poisoning.

Nevertheless, claiming causation requires an argument. Citing an association is not sufficient.

**DISPARITY VERSUS DISCRIMINATION**

Discrimination is of two kinds: direct and indirect. (Brown et al., 2021). Direct discrimination is explicit and generally intended. Consider this for-hire sign: "Asians, Jews, or females need not apply." Indirect (systemic) discrimination is subtle and may be unintended. Consider this for-hire sign: "Janitorial applicants must have a high school degree." Typically, both result in a disparity by race, gender, etc. Thus, a disparity is often used as evidence for claiming discrimination.

Association and disparity both describe a more factual or more readily observable connection or difference. Causation and discrimination both describe something less factual and more unobservable. Thus, disparity is to discrimination as association is to causation. Association and causation keywords can be classified into ABC groups. So can disparity and discrimination keywords.

As displayed in Figure 3, the cognitive causation group involves moral judgments about human causation: unfair, unjust, inequitable, racism, sexism, discrimination, or bias.

The 'Between' group is the most widely used group used to introduce discrimination. These 'Between' words seem to have a moral connotation. They seemingly imply something that is unfair, but by themselves, they are purely descriptive. Only when they are used in the context of an ethical premise that is often hidden or assumed (e.g., Any substantive disparity involving race, gender, etc. that is not biological must involve systemic discrimination), do they take on an ethical element.

For some, finding a disparate impact on a protected class is obviously and necessarily discrimination with prejudice. But for the U.S. legal system, a disparate impact is just the first step in considering discrimination. A common second step is determining whether the difference in rates exceeds some minimum amount. The 80–20 rule requires that a rate for a protected minority must be

at least 20% less than that for the reference class before the burden of proof shifts from those arguing discrimination to those accused of discriminating (Disparate Impact, 2022). Satisfying the four-fifths rule is just a second step for proving discrimination in the U.S. legal system. A third step involves seeing whether the business practices causing the disparate impact had a business necessity. Were there other practices that could produce the desired business outcome that would yield less disparity? In popular use, it is all too common to mistakenly treat group disparities as proving discrimination.

**Differences or Disparities are not [necessarily] Discrimination**

<b>A: Association</b>	<b>B: Between</b>	<b>C: Causation (moral)</b>
Math Differences: Count/Rate/Amount	Descriptive Differences with a Moral Connotation	Immoral Differences: Evaluative or Judgemental
different, unequal	unequal/inequality	inequity/inequitable/injustice
Rank: first, second, last	disproportional	unfair/unjust/undeserved
Superlatives: highest/lowest	discriminate: discern difference	discriminate: with prejudice
Comparatives: more, higher,	disparity / disparate impact	discrimination*
times as much, percent more	bias (tendency: non racist/sexist)	biased, racist, sexist

\* Discrimination: direct/intended (racist/sexist) vs indirect/unintended; individual vs social (systemic or structural)  
Based on common usage by many today, but not "etched in stone".

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Figure 3. A-B-C classification of human (conceptual) causation

Equating disparity with bias and discrimination may seem plausible. It may still be unjustified for three reasons: (a) discrimination and bias are equivocal; (b) disparities can be influenced by confounders; and (c) not all race–gender disparities are treated as discrimination.

*Discrimination and Bias Equivocations*

Discrimination is equivocal. Discrimination can be descriptive: discriminating shoppers get good value for their money. Discrimination can be evaluative: a discriminatory law required those who practice Judaism to wear a six-pointed star. This descriptive–evaluative nature of discrimination can be seen in definitions. Some list the descriptive definition first; others list it second. (Schild, 2020).

Bias is equivocal. Bias can be descriptive: she had a bias (tendency) toward action. Bias can be evaluative: many East Europeans are biased against gypsies. Dictionary definitions of bias are typically descriptive followed by evaluative with the caveat 'usually' or 'especially' (Schild, 2022).

- A test or process may be descriptively biased when it produces different outcomes for different groups, but group membership can be related to the outcome of interest. For example, a test for proficiency in long distance running may select more east-African Black athletes because they tend to have less leg mass and more red blood cells. A test for longevity may select more women than men if women have more estrogen, and estrogen combats cholesterol and heart attacks. Saying these tests are biased is to use 'bias' descriptively.
- A test or process may seem unfairly biased when it produces different outcomes for different groups, and group membership is not obviously related to the outcome of interest. Why are men more prevalent among those receiving Nobel Prizes or among grand life-masters in duplicate bridge? Why are men more prevalent among those who have Down syndrome, are autistic, mentally ill, or are homeless? What might seem to be gender bias may be explained if the standard deviation in IQ is greater for men (14.9) than for women (14.1) even though the two groups have the same IQ on average (Dreary et al., 2004).

*Disparities and the Influence of Confounders*

The Black–White income gap is often mentioned as a sign of racial discrimination. Statistical educators have no expertise in deciding whether an observed association is causation or whether an observed disparity is discrimination. But they have expertise in analyzing the effects of context on a statistical association or disparity. As displayed on the left in *Table 1*, White US families earned an average of \$118,000 in 2020, 45% (\$37,000) more than Black families who earned about \$82,000

(Current Population Survey, 2020). This journalistically-significant disparity could be due to discrimination.

Table 1: United States 2020 mean incomes for Black and White Families

Mean Income: 2020		----- Family Structure -----			----- Standardized -----	
Families	All	Married	Unmarried	%Married	% Married	All
White	\$118,388	\$133,585	\$66,800	77.2%	73.1%	\$115,628
Black	\$81,537	\$114,860	\$52,564	46.5%	73.1%	\$98,110
Gap	\$36,851	\$18,725	\$14,236		Combined	\$17,518

<https://www.census.gov/data/tables/time-series/demo/income-poverty/cps-finc/finc-01.html>

In the center of *Table 1*, families are separated according to whether the family is headed by a married couple or not. Notice that the Black–White income disparities are much smaller for families with each kind of family structure: an \$18,700 difference for families headed by a married couple and a \$14,200 difference for families headed by an unmarried individual. Some may wonder how these gaps of less than \$19,000 can yield a gap of more than \$36,000 when combined.

The big difference is in the mixture: the mix! Married couples head 77% of White families but only 47% of Black families—a big difference. This Black–White disparity is a crude association: a mixed-fruit comparison or an apples and oranges comparison. To create an apples and apples (a same fruit) comparison, we need to standardize.

Standardization is shown on the right side of *Table 1*. When combined, 73% of these families are headed by a married couple. Using that percentage for both groups generates a mean income of \$116,000 for White families and \$98,000 for Black families. After taking family structure into account, the Black–White income gap drops from \$37,000 to \$18,000: a decrease of more than 50%.

Does this decrease prove that much, if not most, of the original Black–White income gap is not due to discrimination? No! First, statisticians have no expertise in saying whether a disparity is caused by discrimination. Second, statisticians recognize that discrimination in some other area could create the observed disparity in family structure. For example, suppose that the criminal justice system discriminates against Black men and women; prisoners are less likely to get married or to stay married.

Consumers of social statistics should always think hypothetically about what else should be taken into account (controlled for) when considering an observed disparity. Teaching confounding and standardizing requires different techniques than teaching statistical inference (Schild, 2021).

*Some Race–Gender Disparities may not be due to Discrimination*

Is it possible that some race–gender disparities are not racist or sexist? Consider this data:

- The ratio of opposite-sex to same-sex households headed by a married couple is 99:1 (Walker & Taylor, 2021). Same-sex marriage has been legal in all states since 2015. Is this discrimination?
- The male–female ratio of U.S. [state and federal] prison inmates as of 2018 is 93:7 (Carson, 2020). If half of the population is male, is this gender discrimination? One explanation is that men commit more crimes than women. In 2019, the male–female ratio on reported offenses was 4.33 million to 1.67 million, or 2.6:1 (Morgan & Truman, 2020). Maybe men commit more violent crimes. The male–female ratio on violent crime was 233 thousand to 62 thousand, or 3.8:1. Maybe men are more likely to murder. The male–female ratio on murder or non-negligent manslaughter is 5,461 to 771, or 7.1:1. These comparisons do not fully explain why men are 14 times as prevalent in prison, but they show that choice of the basis for comparison is critical.
- The male–female ratio of U.S. arrests is 75:25 (Criminal Justice Information Services Division, n.d.). Is the disparity due to sexual discrimination? Note that some crimes are not reported. In the U.S. victimization survey, crime victims noted that 75% of their victimizers were men (Morgan & Truman, 2020) If 75% of victimizers are men, it is hard to argue that a 75:25 gender arrest disparity is biased.
- Black individuals are at least twice as likely to be arrested (26%) as their prevalence in the population (13%). Could this disparity be due to racial discrimination? Absolutely! Is there an

alternate explanation? Perhaps Blacks commit more crimes per capita. In the victimization survey, victims reported that 25% of their victimizers were Black (Morgan & Truman, 2020). Does this prove that Blacks are not discriminated against in arrests? Absolutely not. Perhaps the victims are racially biased in their reporting or in their willingness to report.

## CONCLUSION

The phrase "correlation does not imply causation" is central to the teaching of statistics, but it takes practice to enable students to understand the full meaning and to recognize it when it is presented in everyday media. "Disparity is not sufficient for discrimination" is a logical application of "association is not sufficient for causation." Statistical educators are the appropriate faculty to note the similarity and to help students distinguish two things that are all-too-often treated as synonymous.

By noting that (a) discrimination and bias are equivocal, that (b) race–gender disparities can be influenced (confounded), and that (c) not all disparities are grounds for discrimination, students may realize why one must give reasons for why a disparity is strong evidence for causation or discrimination. Given this exposure, students may recognize a wider range of possible explanations and develop a more nuanced understanding of what should be done—if anything—to reduce an undesirable disparity. Hopefully, this exposure will raise the level of social discourse and facilitate a more productive exchange of views.

To repeat, statisticians have no expertise in whether an association is causation or whether a disparity is discrimination. But they do have expertise in evaluating the quality of the data involved.

Nothing in this paper is designed to show that discrimination—specifically systemic discrimination—does not exist. Statisticians are not judges in such matters. The statistician's role is to question and evaluate the statistics involved in such arguments.

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