AGAINST ALL ODDS
EPISODE 27 – "COMPARING TWO MEANS"
TRANSCRIPT

FUNDER CREDITS

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INTRO

Pardis Sabeti
Hello, I'm Pardis Sabeti and this is *Against All Odds*, where we make statistics count.

It's an age-old battle of the sexes. Are men or women worse drivers? However adamant you are in your opinion of male and female drivers, a statistician needs more persuasive evidence.

One way to analyze the question would be to see which gender, on average, gets the most moving violations. We could take a sample from all the licensed drivers in one state, and then look at the number of tickets each person received in one year. We'd calculate the mean number of tickets received by members of each gender and compare the two numbers to see which group is more of a menace behind the wheel. That is, of course, assuming there's no gender bias of officers giving tickets for similar offenses.

Comparing two populations is a major part of statistics. And we can use inference to move beyond just looking at two sample means, like in our driving example. We can go on to figure out whether the difference between the two groups is statistically significant. If it is, we can then calculate a confidence interval for the difference of the population means.

That's what researchers did when they decided to investigate how many calories are necessary to power daily life in two groups of people with very different lifestyles.

Herman Pontzer is an anthropologist who's interested in how energy is used by different primate species, particularly human beings.

> **Herman Pontzer**
> One of the most important types of populations we can look at to ask these sorts of questions is a hunting and gathering population because that's the lifestyle that our species evolved in, so it's the most immediately relevant to our evolution and our lifestyle today.

Pardis Sabeti
He teamed up with other researchers and headed to Tanzania to work with the Hadza, a group of traditional hunter-gatherers who live in a way very similar to our ancient ancestors.

> **Herman Pontzer**

> They don't have any crops, no industry, no mechanized tools. Men hunt with bows and arrows and women forage for plant foods and dig for root vegetables using digging sticks, a very simple lifestyle. And they also collect honey. They live in grass huts … in small camps…about 20 or 30 people per camp… and they live in a very open dry savannah region in northern Tanzania.

Pardis Sabeti
The researchers recorded the physical activity of the Hadza by having them wear heart rate monitors and GPS units like the ones worn by joggers to track their workouts. The Hadza also wore portable respirometry gear that measured their oxygen intake and their carbon dioxide output as they went about their business.

Hadza are a lot more active and cover a lot more ground than their Western counterparts, which wasn't a surprise. And everyone had always assumed this physically demanding forager lifestyle would require much more energy than the relatively inactive daily life of a Western office worker. In fact, one suspected cause of the Obesity Epidemic in the West is our more sedentary modern lifestyle. The idea is that rising societal rates of obesity are at least partially due to all our labor-saving devices and our physically cushy lifestyle.

But the Hadza's actual energy expenditure had never been tested. Was the assumption correct that the Hadza used more calories throughout their grueling day? Pontzer and his team already had data on how many calories typical Americans and Europeans burned in their daily lives. Now they needed to measure how many calories it took to power the Hadza through their daily tasks. They used a safe technique that relies on the subjects drinking something called doubly labeled water.

> **Herman Pontzer**
> The person drinks some water where the H, the hydrogen, has been enriched with a rare isotope of hydrogen. And the oxygen has also been enriched with a rare oxygen isotope.
>
> And then we collect urine samples over about two weeks, every couple of days we get a urine sample. We take those urine samples and we freeze them and then we ship them back to the lab. And once they're here we analyze them using mass spectroscopy and we measure how much of each of those rare isotopes are in their urine samples.

Pardis Sabeti
As the concentration of the special traceable hydrogen and oxygen isotopes in the urine goes down over time, Pontzer can use those numbers to figure out how much carbon dioxide the subject has exhaled over the course of the study. Carbon dioxide is a byproduct when a body burns calories, so this CO_2 number told the researchers how much caloric energy the Hadza were expending.

Here's where the scientists encountered the shocker. They didn't find any statistical difference when they compared the mean daily energy expenditure of the Hadza and the Westerners. The result seems counterintuitive, since they knew the Hadza were much more active! How could it take the same amount of calories to power foraging and hunting while hiking up to twenty miles a day as it does to power sitting at a desk all day and lounging on a couch all evening? The researchers suspect that the Hadza's bodies are allocating a smaller percentage of those daily calories to run-of-the-mill cellular function and more to physical activity.

> **Herman Pontzer**
> The things they do take the same number of calories it would take for us to do them but they're just doing different things. They're doing more activity, and perhaps less immune function, perhaps less basic cellular activity, we don't really know what they're turning down yet, that's something we would like to know in the future. But we think that it's a difference in energy allocation, not a difference in energy efficiency.

Pardis Sabeti
Hadza are typically smaller and lighter than their Western counterparts, so Pontzer and his colleagues used sophisticated statistical techniques in their analysis to control for the effects of body size, age and sex. To keep things simple as we follow their comparison, we'll look just at women with comparable body sizes from the Hadza and Western groups. We want to infer from our sample data what the difference of means of the entire Hadza and Western populations is.

First, the scientists calculated the mean "Total Energy Expenditure" for each group in calories. Here's the sample mean, sample standard deviation, and sample size for each group. Is the difference between these sample means significant? Is there a real difference or could the difference we see be due simply to chance variation?

We can set up a significance test to figure that out. Our null hypothesis is that mean "Total Energy Expenditure" for the population of Hadza women is the same as the mean "Total Energy Expenditure" of the population of Western women. Our alternative hypothesis will be that the mean TEEs for these groups are not the same.

We need to fill in the blanks in the formula for the two-sample *t*-statistic. We have our sample means, we know our *n*'s and our *s*'s for each sample. Under the null hypothesis the difference of the population means is zero. Do the math and we find that $t = -.94$. Like all the other *z*- or *t*-statistics we've encountered, this one tells us how far the difference in sample means is from 0 in standard deviation units.

Software can figure out the degrees of freedom, or we can just go with a very conservative approach that uses the smaller sample size minus one, which in this case would give us 16. As usual we look up the corresponding *p*-value in the table. In this case $p = .3612$. That means that assuming the null hypothesis is true, we have a 36% chance of seeing a *t*-value as extreme as the one we calculated. That's pretty likely, so we have insufficient evidence to reject the null hypothesis. It looks like there's no significant difference between the "Total Energy Expenditure" of Hadza women and Western women.

Thinking back to the obesity epidemic in the West – rising obesity rates tell us something is out of balance between the amount of calories that we take in and the amount we burn off. Based on this study and others, metabolism seems to hold quite constant among different populations of people with varying activity levels. Because of this finding, Pontzer and his colleagues place the blame for rising societal levels of obesity more on people eating too much than on our modern mechanized lifestyle. But don't throw away your running shoes!

> **Herman Pontzer**
> It's still really important to exercise, because there are so many good benefits and important benefits from exercise from, again, your immune system, mental health, to preventing heart disease and diabetes--exercise is really important. But in terms of staving off obesity, you want to focus on what you eat. And try to eat less, and eat less sugar.

Pardis Sabeti
This study focused on habitual lifestyles; it didn't look at what adding additional exercise to a typical Westerner's day would mean for how many calories they'd burn up. But evidence does suggest that over time, bodies adjust to increased exercise regimens. Even if you ship out to live with the Hadza, after an initial bump in how many calories you'd incinerate to keep up, eventually over time your metabolism would likely adjust to look much like theirs.

For *Against All Odds*, I'm Pardis Sabeti. See you next time!

PRODUCTION CREDITS

Host – Dr. Pardis Sabeti

Writer/Producer/Director – Maggie Villiger

Associate Producer – Katharine Duffy

Editor – Seth Bender

Director of Photography – Dan Lyons

Sound Mix – Richard Bock

Audio
-- Jonathan Goldman
-- Timothy Wessel

Animation – Jason Tierney

Title Animation – Jeremy Angier

Web + Interactive Developer – Matt Denault / Azility, Inc.

Website Designer – Dana Busch

Production Assistant – Kristopher Cain

Teleprompter – Sue Willard-Kiess

Hair/Makeup - Amber Voner

Additional Footage and Stills

- Pond5/Tomeksfx
- Pond5/Fmarsicano
- Pond5/Dapoopta
- Pond5/seryoga1
- Pond5/micjayger
- Pond5/Pederpad
- Pond5/Burlingham
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- Lee McEachern
- Herman Pontzer
- Brian Wood

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- Pond5/Jakerbreaker
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Additional Sound:
Freesound.org/FatLane

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Based on the original Annenberg/CPB series *Against All Odds*,
Executive Producer Joe Blatt

Annenberg Learner Program Officer – Michele McLeod

Project Manager – Dr. Sol Garfunkel

Chief Content Advisor – Dr. Marsha Davis

Executive Producer – Graham Chedd

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