Regression to the Mean and Changes in Risk Behavior during Longitudinal Cohort Studies

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SCHARP
Longitudinal measurement of behavior

- Many HIV prevention trials observe reductions in rates of risky behaviors over followup
  - Reduced rates of unprotected sex
  - Reduced drug use

- Often these changes are attributed to the positive effects of study participation (safe sex counseling, attention, access to care)

- An alternative explanation may be “Regression to the Mean”
Regression to the Mean

• RTM is a statistical phenomenon that occurs under the following conditions:
  – Subjects are selected for high or low values of some (variable) measure
  – Repeated measurements are made on the same subject (unit)
• Relatively high (or low) observations tend to be followed by subsequent observations that are closer to the mean \textit{even in the absence of any intervention}
  – E.g. Select people with high blood pressure; subsequent measures will be lower (on average)
Regression to the Mean

- Francis Galton examined the relationship between heights of fathers and sons

Фathers who are above average in height have sons who are also above average, but not as far above average (on average)
**Regression to the Mean**

- Two measures with same mean and variance*

<table>
<thead>
<tr>
<th>Correlation = 1</th>
<th>Correlation = .7</th>
<th>Correlation = 0</th>
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<td><img src="image2" alt="Graph" /></td>
<td><img src="image3" alt="Graph" /></td>
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- Pick high X’s (mean 95) … note that mean of Y’s *inevitably* declines as correlation gets smaller
- This is a phenomenon of *averages* … not every Y is smaller
“Omega-3 helps eczema”

By Nic Fleming, Medical Correspondent
6:00PM GMT 27 Mar 2008

A diet rich in omega-3 can help eczema sufferers reduce the severity of their symptoms, according to new research.

Patients with the most common atopic, or allergic, form of eczema given purified fish oil supplements cut their symptoms by almost a fifth.

The results of a randomized, double-blind, controlled trial published in the April 2008 issue of the "British Journal of Dermatology" show that one of the omega-3 fatty acids, docosahexaenoic acid, significantly improved symptoms of atopic eczema. Study results published in 2008 in the "Asia Pacific Journal of Clinical Nutrition" also found that docosahexaenoic acid was associated with a reduced prevalence of atopic eczema in pregnant women.
Enrolled individuals with high SCORAD score
Randomized to receive 8 weeks Omega-3 fatty acids (DHA) or placebo
Followed them for 20 weeks and repeated SCORAD measurement at 4, 8, 20 weeks
New developments in metabolic science has led to the unimaginable... weight-loss!

Scientists Predict End of Obesity by 2018

Within the Next 5-Years; Experts predict "weight loss clinics will be shuttered... diet doctors will be obsolete... and virtually no one in this country will ever be fat again!" Here's why...

By: Don Westein, Health Editor

After years of painstaking research, scientists have announced a weight loss discovery so radical it could end America's obesity epidemic by 2018.

"This is a real game-changer!" Says John P., a nutritionist from Phoenix, AZ. Some say, Garcinia Cambogia is going to put millions out of work. Referring to the countless jobs in the diet industry. But just think about the millions of lives that will be saved from sickness and disease that comes from being fat!

Famous TV Heart Surgeon: This is the "Holy Grail for people with Weight problems!"

Why is Garcinia Cambogia wowing the scientific community?

For one thing, it's not another diet craze that's in one day and out the other.

It's a remarkable substance derived from a pumpkin-seed! But not just any pumpkin seed will do. It has to be grown only in specific regions and cultivated under just the right conditions. The very best of the crop is "Garcinia Cambogia 2000".

Garcinia Cambogia wipes away fat so completely, that it has caught the attention of scientists and weight loss experts all over the globe. It works like nothing else seen before. Simply take as directed and eat reasonably. You can almost see your excess fat melt off your body. It's just that effective!

Experts predict, the data is so compelling... "Weight-loss centers could be forced to shut down. Diet doctors could be out of business!" Garcinia Cambogia will be a miracle drug that turns "good carbs" into "bad carbs". HCA builds an "impenetrable wall" so fat can't get absorbed by your body... so you simply can't gain weight. Then, the HCA breaks up the fat you already have and forces it out of your body.

Think about it. A pill that stops fat from being made, as it obliterates the fat you already have. Incredibly, the pounds and inches just roll off you.

Not Just for the Wealthy

Until recently, only the rich, famous and powerful have been able to try Garcinia Cambogia. But now, for the first time ever, the manufacturer has made this revolutionary perfected Garcinia Cambogia and made it available to the general public. They call it Garcina Cambogia 2000. And since the country's obesity rate is at an all-time-high; it couldn't have come at a better time.

Unlike other products on the market that do little or nothing for your weight problem; Garcinia Cambogia 2000 contains the precise doses of Garcinia and HCA; cultivated in optimized conditions and perfected for rapid and permanent weight loss. The result? You'll see changes in your appetite almost overnight!

As new pill gains popularity, scenes like this will become rare and unusual.

You'll feel great, you'll sleep great, and look great. And even be able squeeze into your favorite pair of skinny jeans again!

Healthier Heart

And here's fantastic news for your heart. The HCA concentration in Garcinia Cambogia 2000 is proven to lower LDL 'bad cholesterol' by a whopping 31%. So you can enjoy the benefits of a healthy heart, great blood pressure numbers, and normal blood sugar too. That's great news for people have been overweight for years and put unnecessary stress on their heart.

Clinical Studies Don't Lie!

In a recent study published in the American Journal of Diabetes, Obesity and Metabolism, scientists discovered that Garcinia Cambogia causes significant weight loss, lowers food intake and body weight gain, as well as tackling fat storage! The study found that participants who were given the HCA supplement lost an average of 23% of their body weight in 12 weeks, compared to those on a placebo who gained an average of 11%.

When you take Garcinia... After just a few bites of your meal, you'll feel stuffed to the gills.

- Johan Stifling, Clinical Therapist

Your Body... Perfected

There's a surprise side benefit in your weight loss! With the help of Garcinia Cambogia, you can now improve your mood, increase your energy levels, and even boost your metabolism. It's like you're getting a double dose of benefits for the price of one!

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Sports Illustrated Cover Jinx
HPTN 064

• Longitudinal cohort of 2099 US women from 10 sites in 6 cities
• Followed every 6 months up to 12 months
• Incidence measurement, no intervention
• Enrollment criteria:
  – 18 – 44 years of age
  – Reside in specified census tract
  – At least one episode of unprotected vaginal and/or anal sex with a man in past 6 months
  – One additional risk criterion (e.g. drug use, binge drinking, hx of STI, etc)
### HPTN 064

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<th>Enrollment</th>
<th>6 mo</th>
<th>12 mo</th>
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<tr>
<td>UPS in past 6 mo</td>
<td>.96</td>
<td>.83</td>
<td>.77</td>
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- How much of the change is due to RTM?
Screening

Pre-Study

On-Study

0 mo

6 mo

12 mo

Hypothetical

$X_0$

$X_6$

$X_{12}$

Study Effect

$P(X_6, X_{12} | X_0 = 1)$

+ model

HIV Prevention Trials Network
HPTN 064

- Of 4126 women screened and otherwise eligible, 3094 had UPS in last 6 months – 75%
- Estimated on-study prevalence of UPS in last 6 mo if no selection – 74%
- Participation in study is associated with decline in prevalence of UPS from 75% to 74%
- (Almost) entire change from baseline is due to RTM
  - Key assumptions/issues:
    - 2099 who enrolled are random sample from the 3094 eligible
    - No unique model for multivariate binary data
Conclusions

• Analyses that examine changes in behaviors over time in cohorts selected for high or low levels of those behaviors should anticipate regression to the mean effects

• Information on prevalence of the behavior in the pre-study, unselected population is needed to quantify how much of the change is due to RTM

• New methods have been proposed for studying RTM for binary outcomes
ACKNOWLEDGEMENTS

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