Spotting Bad Science 103: The China Study

"Eating foods that contain any cholesterol above 0 mg is unhealthy."
-T. Colin Campbell, The China Study

The China Study we will dissect is not actually a study at all. It's a book. The research it claims to present was well designed, to the extent that a large-scale observational study can be. Given the constraints, it was good science. The subsequent book, in contrast, has been used as a vehicle for convincing the public of black-and-white conclusions that aren't justified by the China-based studies for which the book is titled.

Dr. T. Colin Campbell, Jacob Gould Schurman Professor Emeritus of Nutritional Biochemistry at Cornell University, is the principle scientific author of The China Study book. He is a world-renowned scientist and knows the limitations and potential misuses of his data. These limitations are addressed in pages including 54-82 of the 894-page China Project monograph, as well as page 1155S, from which the following is drawn (bolding mine):

First, this study is ecological and includes 6,500 individuals residing in 130 villages. Thus according to widely held assumptions, **any inferences concerning cause-and-effect relationships should be considered to be hypothetical only**, with validation to be provided only by intervention or prospective analytic studies on individuals.

But a discussion of limitations is absent from the mainstream book, leaving those who want the full picture the option—seldom exercised—of reading a research report of almost 900

pages. Most readers will, as intended, assume that the Chinese data proves vegan diets to be superior to omnivore diets, even though no vegan diet was observed in China.

Campbell's sin is not bad science through incompetence, but sensationalism through omission and generalization.

Please note that, despite using The China Study as a principle example, this book is not anti-vegetarianism. In fact, two chapters were written specifically for those who require meat-free diet options. Choosing to be a vegetarian is fine. Fudging data or misrepresenting them to convert others, on the other hand, is deception and bad science.

It's in this context that we will look at the famous China Study.

The following critique is authored by Christopher Masterjohn, who experimented with lacto-ovo and strict vegetarianism for one year each and is currently pursuing a doctorate (PhD) in Nutritional Sciences at the University of Connecticut. He has published in peer-reviewed journals including the American Heart Journal and the Journal of the American College of Cardiology, on topics ranging from the molecular mechanism of vitamin D toxicity to the effects of vitamin E on heart disease and blood vessel function.

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The China Study Hits Shelves

Campbell's book *The China Study: Startling Implications for Diet, Weight Loss, and Long-Term Health* hit shelves in January 2005 and takes readers on a tour through Campbell's early post-graduate animal experiments, which he interpreted to implicate animal protein as a primary cause of cancer, and then through the massive epidemiological study after which the book is named.

The latter is a brief tour, as only 39 of 350 pages in the book are devoted to data from studies performed in China.

The bold statement on page 132 that "eating foods that

contain any cholesterol above 0 mg is unhealthy,"[5] is drawn from a broad-and highly selective-pool of research. Chapter after chapter reveals a heavy bias and selectivity with which Campbell conducted, interpreted, and now presents his research.

Let's look at both tours in order.

Dietary Protein and Cancer

Campbell's formed his first hypotheses about protein intake while he was studying the relationship between aflatoxin (AF), a mold-related contaminant often found in peanut butter, and cancer in the Philippines.

Campbell was informed by a colleague that, although the areas with the highest consumption of peanut butter had the highest incidence of liver cancer, it was the children of the "best-fed families," who consumed the most protein, who were getting liver cancer.

Whether the best-fed Pilipino families ate the many staples of modern affluent diets like refined breads and sugars isn't mentioned.[6]

This observation was corroborated by a study in which AF was fed to two groups of rats: one consuming a 5% protein diet and the other consuming a 20% protein diet. Every rat in the latter group got liver cancer or its precursor lesions, and none in the former group got liver cancer or precursor lesions.[7] Campbell went on to investigate the possible relationship between nutritional factors, including protein, and cancer, a study that proceeded for 19 years with NIH funding.[8] His conclusion was revolutionary and provocative: while chemical carcinogens may initiate the cancer process, dietary promoters and anti-promoters control the regulation of cancer foci,[9] and it is nutritional factors, not chemical carcinogens, that are the ultimate deciding factors in the development of cancer.[10]

Campbell began his studies using AF as an initiator of cancer

foci and the milk protein casein as the promoter protein of study. His results corroborated the earlier results of other researchers: a dose-response curve existed for AF and cancer on a 20% casein diet, but disappeared on a 5% casein diet.[11]

He found that adjusting the protein intake of the same rats could turn cancer promotion on and off as if with a switch,[12] and found casein to have the same effect when other cancer initiators, such as the hepatitis B virus, were used.[13] Rather than throwing a blanket accusation at all protein, Campbell acknowledged that the study of other proteins would be required before generalizing, just as the study of other cancer initiators would be required before generalizing to them. Wheat and soy protein were both studied in lieu of casein, and both were found not to have the cancer-promoting effect of casein.[14]

Campbell's reluctance to make unwarranted generalizations ends here.

After briefly describing some research finding a protective effect of carotenoids against cancer, Campbell concludes this chapter of *The China Study* by broadly emphasizing: "*nutrients from animal-based foods increased tumor development while nutrients from plant-based foods decreased tumor development.*"[15] (Campbell's italics.)

Casein = All Animal Protein?

The generalization from the milk protein casein to all "nutrients from animal-based foods" is unsupported by his data.

Campbell dedicates an entire chapter of *The China Study* to casein's capacity to generate autoimmune diseases.[17] In contrast, whey protein, another milk protein, appears to have a protective effect against colon cancer that casein does not have.[18] Any effect of casein, then, cannot be generalized to other milk proteins, let alone all animal proteins.

Other questions, such as what effect different types of processing have on casein's capacity to promote tumor growth, remain unanswered. Pasteurization, low-temperature dehydration, high-temperature spray-drying (which creates carcinogens), and fermentation all affect the structure of casein differently and thereby would affect its physiological behavior.

What powdered, isolated casein does to rats tells us little about what traditionally consumed forms of milk will do to humans and tells us nothing that we can generalize to all "animal nutrients." Furthermore, Campbell fails to address the problems of vitamin A depletion from excess isolated protein, unsupported by the nutrient-dense fats which accompany protein-rich whole foods in nature.

Lessons from China — The China Project Itself

In the early 1980s, along with Chen Junshi, Li Junyao, and Richard Peto, T. Colin Campbell presided over the mammoth epidemiological study referred to as the China Project, or China Study. The New York Times called the China Study "the Grand Prix of epidemiology," and it gathered data on 367 variables across sixty-five counties and 6,500 adults.

From the more than 8,000 statistically significant associations found in the China Study, Campbell somehow draws a single unifying principle:

"People who ate the most animal-based foods got the most chronic disease. . . . People who ate the most plant-based foods were the healthiest and tended to avoid chronic disease." [19]

The study utilized recall questionnaires, direct observation and measurement of intakes over a three-day period, as well as blood samples.[20] The blood samples were combined into large pools for each village and each sex.[21]

One of the benefits of the China Study's design was that the genetic stock of the study subjects had little variation, while there was wide variation among cancer and other disease rates.

While the dietary surveys were conducted in the autumn of 1983,[22] the mortality rates were taken a decade earlier in 1973 through 1975. [23] Rural areas were thus deliberately selected to ensure that the people in the area had for the most part lived in the area all their lives and had been eating the same foods native and traditional to that area, so that the mortality data would reliably match the dietary data.

One of the major weaknesses of the China Study was that nutrient intakes were determined from food composition tables, rather than measured directly from foods.[24]

Artful Omission

By the title, one would expect *The China Study* to contain objective and complete information derived from the China Study. Page one touts "real science" above "junk science" and "fad diets." Yet Campbell consistently presents only half the story -- at best -- through the duration of the book.

In Part II, Campbell presents evidence incriminating animal products as the cause of nearly every disease. He cites the Papua New Guinea Highlanders as an example of a traditional society without the occurrence of heart disease. But what of George Mann's and other researchers' extensive study of the heart-healthy Masai, or the healthy primitives of Weston Price, who relied extensively on fatty animal foods?

Campbell cites several health care practitioners, including Dr. Caldwell Esselstyn Jr. and Dr. Dean Ornish, who claim to have been able to reverse heart disease with plant-based diets,[34] but fails to add that the programs of Ornish and Esselstyn involved more than abstention from animal foods, especially the program of Ornish, of which diet is only a small part. This is not seen as a confounding factor that detracts from our

ability to incriminate animal foods in heart disease.

In *The China Study's* discussion of diabetes, Dr. Campbell concludes that "high-fiber, whole, plant-based foods protect against diabetes, and high-fat, high-protein, animal-based foods promote diabetes."[36]

He discusses the possible role of cow's milk (an animal food) in causing Type 1 diabetes via an autoimmune reaction,[37] but makes no mention that wheat gluten (a plant food) has been implicated in Type 1 diabetes by a similar process.[38] Also omitted is the role of fructose consumption (from plant foods) in causing insulin resistance,[39, 40] and the increase in high fructose corn syrup consumption that has paralleled the increase in diabetes.

Campbell discusses the suspected role of animal foods in causing prostate cancer, but makes no mention of the potent preventative role current research is attributing to vitamin A, a nutrient found in animal foods.[42] He devotes 19 pages of *The China Study* to discussing the role of cow's milk in causing autoimmune diseases,[43] but no pages to the role of wheat gluten in causing autoimmune diseases.[44]

Campbell discusses the potential protective effects of plant foods,[45] but makes no mention of the protective effect of DHA, an animal-based nutrient.[46] **[Following added by Tim]** This is a critical omission worth underscoring, as Dr. Campbell was co-author of a DHA review based on the China Study monograph data entitled "Fish consumption, blood docosahexaenoic acid and chronic diseases in Chinese rural populations". The abstract conclusion?

"A strong inverse correlation between DHA in RBC [red blood cell count] and cardiovascular disease (CVD) was found. ... RBC docosahexaenoic acid [DHA] itself also correlated negatively and significantly with most chronic diseases and appeared to be more protective than either eicosapentaenoic or the omega-3 docosapenataenoic acids. These results demonstrate the protective nature of fish consumption and DHA, found in high fat Western diets, operates at a low level

of fat. This finding suggests the protective effect of fish consumption as validated by red cell DHA is universal."

The most curious of lopsided statements is one found on page 220, where Campbell writes, "Folic acid is a compound derived *exclusively* from plant-based foods such as green and leafy vegetables."[47] (My italics.) This is a fascinating statement, considering that chicken liver contains 5.76 mcg/g of folate, compared to 1.46 mcg/g for spinach.[48] Even a cursory look through the USDA database reveals that the most folate-dense foods are organ meats.

But Do the Data Match Up?

What is most shocking about the China Study is not what it found, but the contrast between Campbell's representation of its findings in his book, and the data contained within the original monograph.

Campbell summarizes the statistically significant correlations found in the China Study in the following statement: "people who ate the most animal-based foods got the most chronic disease."[26] He claims that, although it is "somewhat difficult" to "show that animal-based food intake relates to overall cancer rates," that nevertheless, "animal protein intake was convincingly associated in the China Study with the prevalence of cancer in families."[27]

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Figure 1
Associations of Selected Variables with Mortality for All Cancers in the China Study Total Protein +12%
Animal Protein +3%
Fish Protein +7%
Plant Protein +12%
Total Lipids -6%

Carbohydrates +23%
Total Calories +16%
Fat % Calories -17%
Fiber +21%

Fat (questionnaire) -29%*
* statistically significant ** highly significant *** very highly significant
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(Data taken from the original monograph of the China Study.)

But the actual data from the original publication paints a different picture. Figure 1 shows selected correlations between macronutrients and cancer mortality. Most of them are not statistically significant, which means that the probability the correlation is due to chance is greater than five percent ($p > 0.05$).

It is interesting to see, however, the general picture that emerges.

Sugar, soluble carbohydrates, and fiber all have correlations with cancer mortality about seven times the magnitude of that with animal protein, and total fat and fat as a percentage of calories were both negatively correlated with cancer mortality.

The only statistically significant association between intake of a macronutrient and cancer mortality was a large protective effect of total oil and fat intake as measured on the questionnaire. As an interesting aside, there was a highly significant negative correlation between cancer mortality and home-made cigarettes.[28] Campbell's case for the association between animal foods and cancer within the China Study is embedded within an endnote. Campbell states: "Every single animal protein-related blood biomarker is significantly associated with the amount of cancer in a family."[29]

Let us repeat and underscore at this point: Correlation (association) does not equal or even imply causation. If it did, based on Campbell's own data, we might start smoking home-rolled cigarettes to lower our risk of cancer.

Following his endnote, these biomarkers were "plasma copper, urea nitrogen, estradiol, prolactin, testosterone, and, inversely, sex hormone binding globulin, each of which has been known to be associated with animal protein intake from previous studies."[30] Since Campbell does not cite these

"previous studies," the reader is left in the dark regarding the reliability of his assumptions.

[Gary: delete from here to [end] make this piece stronger?]

Blood biomarkers are generally associated with food intake patterns, rather than specific foods. Since food intake patterns differ in different populations, an association found between a biomarker in one population cannot necessarily be generalized to another.[31]

For example, people who eat more whole grains in a given population might have higher levels of vitamin C, even though whole grains do not contain vitamin C. This would be true in one population where people who eat whole grains tend to eat more fruits and vegetables, but untrue in another population.

In other words, if the "previous studies" that Campbell doesn't cite were conducted in America, their data would be irrelevant to a study conducted in China, where food intake patterns could be very different.

[End]

As we will see below, the China Study's own data indicated that these were *not* reliable biomarkers. It isn't at all clear why this roundabout and extremely unreliable way of measuring animal protein consumption is superior to the direct methods of the study, such as the food questionnaire and the dietary observations-- especially when they directly contradict each other.

Of the biomarkers measured, estradiol, sex hormone-binding globulin, testosterone, and prolactin showed conflicting positive or negative correlations to animal protein depending on the age and sex of people studied.[32]

Only urea nitrogen and copper were consistent and significant indicators of animal protein consumption, and of these two *only copper* was significantly related to cancer mortality.[33] It is difficult to see how Campbell can so emphatically draw the

conclusion that animal foods are the cause of most diseases from this data when cereals, vegetables, cereal-based desserts, coffee, tea, and other hot beverages contribute to plasma copper just as much as meat does.

Even if animal protein consumption could be isolated, it bears repeating: when two things tend to be found in association with one another, we say they are correlated.

Firemen, for example, tend to be found near fires, and children who wear larger shoes tend to score better on reading tests. So we say that firemen correlate with fires and that shoe size correlates with reading score. According to the scientific method, this is a form of *observation*. If correlation proved causation, we could conclude that firemen cause most fires or that wearing big shoes makes a child a better reader. In the first case, the opposite is true: fires cause firemen to come to the rescue. In the second case, a third factor we haven't even mentioned yet – growing older – causes both bigger shoe size and better reading ability.

Correlation does not equal or even imply causation.

The Common Absolutist Error: Less is Better, None is Best?

The most egregious error in Dr. Campbell's argument for a vegan diet is his equation of diets that are low in animal products with diets that are completely devoid of them. Based on the conclusion that people in rural China who consume only two percent of calories from animal products are purportedly healthier than those who consume more, Campbell argues that we ought not bother eating any animal products at all.

It isn't difficult to illustrate how this logic is flawed.

By analogy, let's assume we are investigating low- and high-volume zinc consumption and come to the correct conclusion that low but sufficient consumption is better than toxic overconsumption. Since the group that consumed less had

better outcomes, does this mean we should eliminate zinc—an essential mineral—from the diet?

Of course not.

Leaving aside the sensitive meat vs. vegetables debate, the logic doesn't work.

In the context of animal consumption, small amounts of certain nutrient-dense animal products like organ meats and shellfish can make up for much larger amounts of muscle meat and fish. It would take, for example, just over a quarter pound of beef per day to fulfill the minimum requirement for zinc, yet a single serving of oysters per week fulfills the same requirement. One would have to eat two servings of salmon per week to meet the minimum requirement for vitamin B_{12}, but would only have to eat clams once per month to meet the same requirement.

If less is better, that doesn't mean that none is best.

In Conclusion

The China Study contains many excellent points in its criticism of the health care system, the overemphasis on reductionism in nutritional research, the influence of industry on research, and the necessity of obtaining nutrients from foods. But its bias against animal products and in favor of veganism is a pre-existing bias that results in a mainstream book intended—first and foremost—to convert. It displays hallmarks of bad science used in the same fashion by the very industries it criticizes.

Less than a page of comments are spent in total discussing the harms of refined carbohydrate products. Campbell exercises caution when generalizing from casein to plant proteins, but freely generalizes from casein to animal protein. He entirely ignores the role of wheat gluten, a plant product, in autoimmune diseases, so he can emphasize the role of one milk protein, an animal product. The book, while not entirely without value, is not about the actual China Study, nor is it a comprehensive look at the current state of health research.

It would be more aptly titled, *A Comprehensive Case for the Vegan Diet,* and the reader should be cautioned that the evidence is selected, presented, and interpreted with the goal of making that case in mind.

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Resources and Reading:

The full China monograph at the Oxford University's CTSU: http://www.ctsu.ox.ac.uk/~china/monograph/

"The Cornell China Project: Authoritative Proof, or Misinterpretation by Dietary Advocates?" details additional problems with the misinterpretation and overinterpretation of the Chinese studies, including statistical issues, the ecological fallacy, and more: http://www.beyondveg.com/billings-t/comp-anat/comp-anat-8e.shtml

Bad Science
How to Lie with Statistics

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End Notes

[1] Campbell, T. Colin, PhD, with Thomas M. Campbell II, *The China Study: Startling Implications for Diet, Weight Loss, and Long-Term Health,* Dallas: BenBella Books, 2004, p. 4.

[2] http://www.pcrm.org/about

[3] http://www.pcrm.org

[4]http://www.activistcash.com/organization_overview.cfm/oid/23

[5] Campbell, p. 132.

[6] ibid, p. 36.

[7] Ibid, pp. 36-37.

[8] Ibid, p. 48. [9] Ibid, p. 50. [10] Ibid, p. 56.

[11] Ibid, p. 59.

[12] Ibid, p. 62.

[13] Ibid, p. 63.

[14] Ibid, p. 60.

[15] Ibid, p. 66.

[16] Ibid, p. 104.

[17] Ibid, p. 183-201.

[18] Hakkak, et al., "Dietary Whey Protein Protects against Azoxymethane-induced Colon Tumors in Male Rats," *Cancer Epidemiology Biomarkers & Prevention,* Vol. 10, 555-558, May 2001.

[19] Campbell, p 7.

[20] Campbell, p. 73.

[21] Ibid, p. 355.

[22] Junshi, Chen, T. Colin Campbell, Li Junyao, and Richard Peto, *Diet, Life-style and Mortality in China: A Study of the Characteristics of 65 Chinese Counties,* Oxford: Oxford University Press, 1990, p. 6.

[23] Ibid, p 1.

[24] Ibid, p. 16.

[25] Ibid, p. 850.

[26] Campbell, p. 7.

[27] Ibid, p. 88.

[28] Junshi, p. 106.

[29] Campbell, p. 89.

[30] Ibid, p. 376.

[31] Ness, et al., "Plasma Vitamin C: What Does it Measure?" *Public Health Nutr.,* 1999 March 2 (1):51-4.

[32] Junshi, p. 572.

[33] Ibid, p. 106.

[34] Campbell, 125-130.

[35] Diamond, Jared, *Guns, Germs, and Steel: The Fate of Human Societies,* New York: W. W. Norton & Company, 1999, p 149.

[36] Campbell, p 151.

[37] Ibid, p. 146.

[38] Braly, James, M.D., and Ron Hoggan, M.A., *Dangerous Grains, New York: Penguin Putnam,* 2002, p. 124.

[39] Mayes, Peter A., "Intermediary Metabolism of Fructose," Am J Clin Nutr 1993;58(suppl):754S-65S.

[40] Hollenbeck, Clarie B., "Dietary Fructose Effects on Lipoprotein Metabolism and Risk for Coronary Artery Disease," *Am J Clin Nutr* 1993;58(suppl):800S-9S.

[41] Campbell, p. 177-182.

[42] McCormick, et al., "Chemoprevention of rat prostate carcinogenesis by 9-cis-retinoic acid," *Cancer Res.* 1999 Feb 1;59(3):521-4.

[43] Campbell, pp. 183-201.

[44] Braly, 117-133.

[45] Campbell, p 220.

[46] Calon, et. al., "Dohosahexaenoic Acid Protects from Dendritic Pathology in an Alzheimer's Disease Mouse Model," *Neuron,* Vol 43, 633-645, 2 September 2004

[47] Campbell, p 220.

[48] USDA National Nutrient Database for Standard Reference, Release 17.