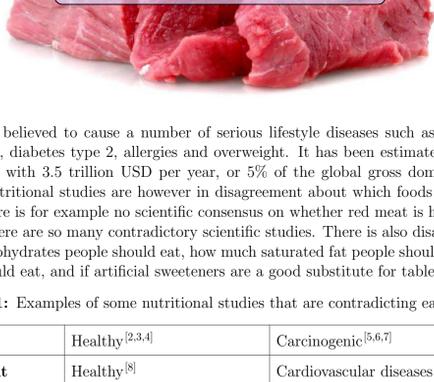


# A NEW WAY TO STUDY NUTRITION AND PHARMACEUTICALS

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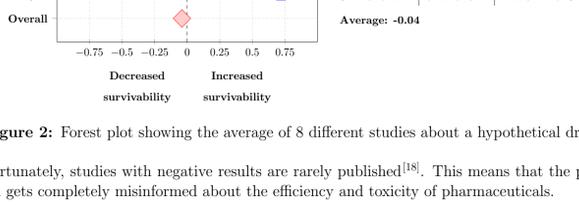
Malnutrition is believed to cause a number of serious lifestyle diseases such as: cardiovascular diseases, cancer, diabetes type 2, allergies and overweight. It has been estimated to impact the global economy with 3.5 trillion USD per year, or 5% of the global gross domestic product<sup>[1]</sup>. Many of the nutritional studies are however in disagreement about which foods are healthy and unhealthy. There is for example no scientific consensus on whether red meat is healthy or causes cancer, since there are so many contradictory scientific studies. There is also disagreement about how much carbohydrates people should eat, how much saturated fat people should eat, how much salt people should eat, and if artificial sweeteners are a good substitute for table sugar or not.

**Table 1:** Examples of some nutritional studies that are contradicting each other

<b>Red meat</b>	Healthy <sup>[2,3,4]</sup>	Carcinogenic <sup>[5,6,7]</sup>
<b>Saturated Fat</b>	Healthy <sup>[8]</sup>	Cardiovascular diseases <sup>[9]</sup>
<b>Salt</b>	Healthy <sup>[10]</sup>	Cardiovascular diseases <sup>[11]</sup>
<b>Carbohydrates</b>	Healthy <sup>[12]</sup>	Weight gain <sup>[13]</sup> , Diabetes type 2 <sup>[14]</sup>
<b>Artificial sweeteners</b>	Good substitute for sugar <sup>[15]</sup>	Weight gain <sup>[16]</sup> , Glucose intolerance <sup>[17]</sup>

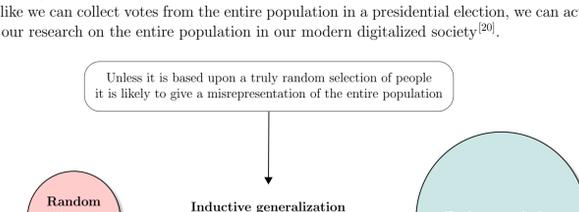
## We cannot necessarily trust pharmaceutical studies

There aren't necessarily so many contradictory studies published about pharmaceuticals, but we have good reason to be suspect about the studies that are published about pharmaceuticals. It would be counterproductive for companies to invest money in advertisements that disfavored their products. If a scientific study shows benefits from the use of a product, it is good advertisement for the company, while if a scientific study shows negative consequences from the use of a product, it is bad advertisement. So we should not be surprised that the pharmaceutical industry wants to keep us from learning about negative consequences associated with their products. Since big pharmaceutical companies often are funding research on their own drugs, they do not always publish studies that show a drug to be disadvantageous<sup>[18]</sup>. Let us consider a scenario where a new drug against cancer is manufactured. Three different studies are published in medicinal journals, and they are all showing that it increases survivability. The average of these three studies will then also indicate that it increases survivability (Figure 1).



**Figure 1:** Forest plot showing the average of 3 different studies about a hypothetical drug.

However, there are 5 more studies which are not published about the drug. These studies show that the drug decreases survivability. If they were available, the average would indicate that the drug actually decreases survivability (Figure 2).

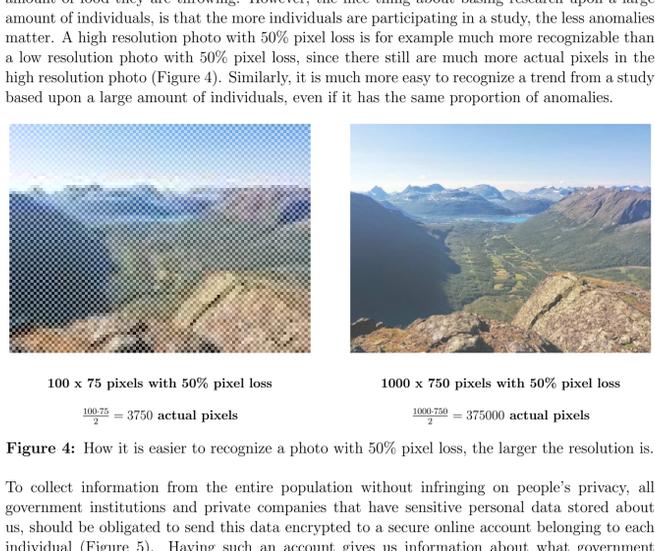


**Figure 2:** Forest plot showing the average of 8 different studies about a hypothetical drug.

Unfortunately, studies with negative results are rarely published<sup>[18]</sup>. This means that the public often gets completely misinformed about the efficiency and toxicity of pharmaceuticals.

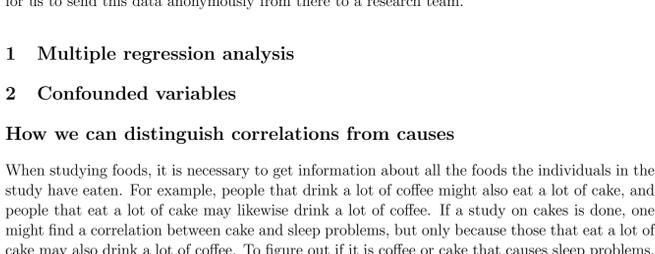
## Why nutritional studies often are unreliable

In order to be representative of the general population, most nutritional studies strive to use a random selection of people. But then they also need to be certain that the selection truly is random, otherwise it will give a misrepresentation of the general population<sup>[19]</sup>. Unfortunately, it is practically very difficult to get a truly random selection of people. This is why the estimates from election polls can be significantly different the results in real elections, and one of the main reasons why there are so many contradictory nutritional studies. There is however another option. Just like we can collect votes from the entire population in a presidential election, we can actually base our research on the entire population in our modern digitalized society<sup>[20]</sup>.



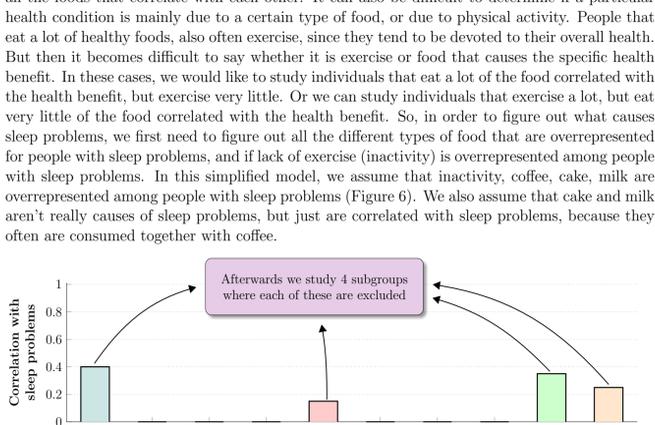
**Figure 3:** How a random selection of people can be used to estimate the entire population, but can give a completely wrong estimate if it isn't truly random. Unfortunately, it is very difficult in practice to get a completely random selection of people. This problem can be avoided by using the entire population instead of a random selection of people.

Another problem with many nutritional studies, is that they are based on self-reporting. But unfortunately people do not necessarily have a good overview of how much they are consuming of different foods. If we instead base our studies on the groceries people are buying, we avoid the problem with self-reporting, but another problem arises. In families for example, one person often buys food for the entire family. This problem can be circumvented however, if we obtain information about how many people are living together. If we only use individuals that are living alone in our studies, there is a high likelihood that most of the purchased groceries are consumed by the individual that is buying them. Families can also be considered as units, where we look at all the groceries bought by the family, and the overall health situation for the family. There might however still be anomalies. Some people might be living with other people in secrecy, and some people might give away some of their food to pets or other people. People might also differ in the amount of food they are throwing. However, the nice thing about basing research upon a large amount of individuals, is that the more individuals are participating in a study, the less anomalies matter. A high resolution photo with 50% pixel loss is for example much more recognizable than a low resolution photo with 50% pixel loss, since there still are much more actual pixels in the high resolution photo (Figure 4). Similarly, it is much more easy to recognize a trend from a study based upon a large amount of individuals, even if it has the same proportion of anomalies.



**Figure 4:** How it is easier to recognize a photo with 50% pixel loss, the larger the resolution is.

To collect information from the entire population without infringing on people's privacy, all government institutions and private companies that have sensitive personal data stored about us, should be obligated to send this data encrypted to a secure online account belonging to each individual (Figure 5). Having such an account gives us information about what government institutions and private companies know about us, and we can get a better overview of our own lives. We may use this personal data for our own endeavors, or we may use this personal data to participate in research anonymously.



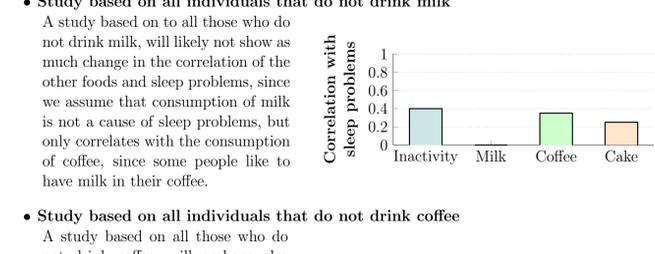
**Figure 5:** There should be a law that enforces all government institutions and private companies to make all sensitive personal data that is stored about us available to us in a secure online account. If we want to use this sensitive personal data for research purposes, it should be possible for us to send this data anonymously from there to a research team.

## 1 Multiple regression analysis

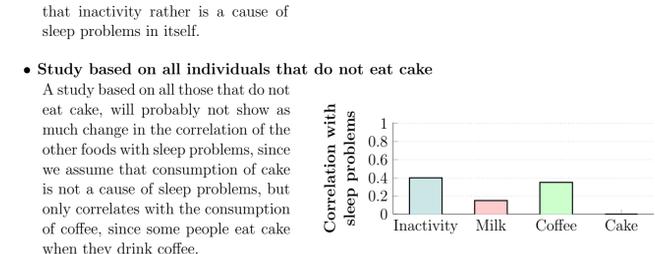
## 2 Confounded variables

## How we can distinguish correlations from causes

When studying foods, it is necessary to get information about all the foods the individuals in the study have eaten. For example, people that drink a lot of coffee might also eat a lot of cake, and people that eat a lot of cake may likewise drink a lot of coffee. If a study on cakes is done, one might find a correlation between cake and sleep problems, but only because those that eat a lot of cake may also drink a lot of coffee. To figure out if it is coffee or cake that causes sleep problems, we need to look at those individuals that either only drink coffee or those that only eat cake.



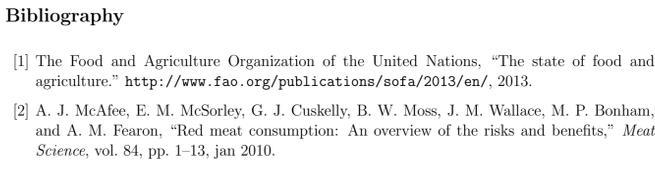
The problem is that we do not necessarily know about all the different foods that correlate with each other. Only by looking at all the foods an individual consumes can we get an overview of all the foods that correlate with each other. It can also be difficult to determine if a particular health condition is mainly due to a certain type of food, or due to physical activity. People that eat a lot of healthy foods, also often exercise, since they tend to be devoted to their overall health. But then it becomes difficult to say whether it is exercise or food that causes the specific health benefit. In these cases, we would like to study individuals that eat a lot of the food correlated with the health benefit, but exercise very little. Or we can study individuals that exercise a lot, but eat very little of the food correlated with the health benefit. So, in order to figure out what causes sleep problems, we first need to figure out all the different types of food that are overrepresented for people with sleep problems, and if lack of exercise (inactivity) is overrepresented among people with sleep problems. In this simplified model, we assume that inactivity, coffee, cake, milk are overrepresented among people with sleep problems (Figure 6). We also assume that cake and milk aren't really causes of sleep problems, but just are correlated with sleep problems, because they often are consumed together with coffee.



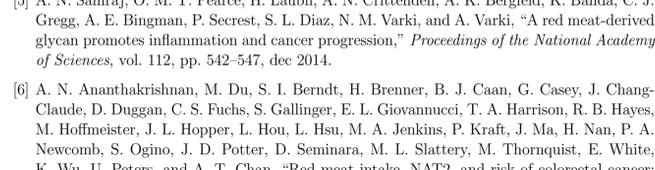
**Figure 6:** Study to figure out what is overrepresented among people with sleep problems. All foods should be included in such a study. It should also include if people are exercising or their activity level. After we have figured out what is overrepresented among people with sleep problems, we perform new studies on subgroups where each of the factors are excluded.

The easiest way to figure out if a type of food causes a health condition will be through studying individuals who only consume the particular food, but none of the other foods (or other things) that correlate with the health condition. If the food still correlates with the health condition, we can assume that the food is involved in causing the health condition. It may however be difficult to find enough such individuals if there are a large number of foods that correlate with a health condition. Instead, we can exclude people who consume foods that correlate with each health condition separately. When we exclude people who consume a food that both causes a health condition, but also correlates with the consumption of other foods, we will see that the correlation between the health condition and the other foods also decreases.

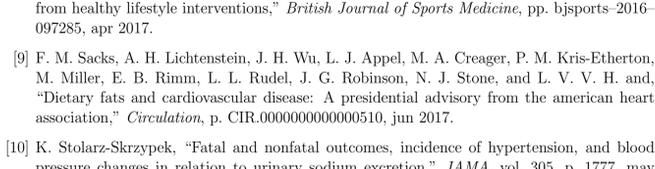
- **Study based on all individuals that are physically active**  
A study based on all those with a high level of physical activity, will likely not show as much change in the correlation of the other foods and sleep problems, since we assume that coffee is also a cause of sleep problems, while consumption of milk and cake mainly are correlated with coffee intake, rather than with inactivity.



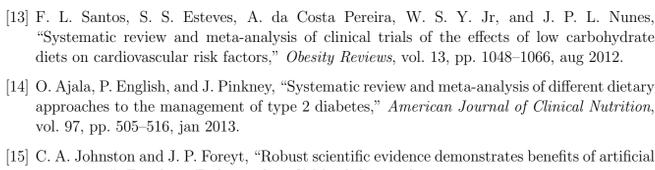
- **Study based on all individuals that do not drink milk**  
A study based on all those who do not drink milk, will likely not show as much change in the correlation of the other foods and sleep problems, since we assume that consumption of milk is not a cause of sleep problems, but only correlates with the consumption of coffee, since some people like to have milk in their coffee.



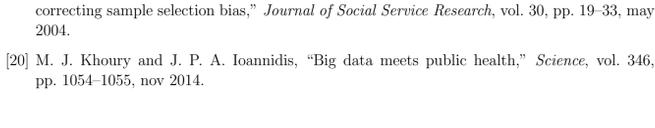
- **Study based on all individuals that do not drink coffee**  
A study based on all those who do not drink coffee, will perhaps also show that milk and cake correlates less with sleep problems, because some people use milk in their coffee and some people eat cake when they drink coffee. Of course, we do not expect to see a significant reduction in the correlation between inactivity and sleep problems, since we assume that inactivity rather is a cause of sleep problems in itself.



- **Study based on all individuals that do not eat cake**  
A study based on all those that do not eat cake, will probably not show as much change in the correlation of the other foods with sleep problems, since we assume that consumption of cake is not a cause of sleep problems, but only correlates with the consumption of coffee, since some people eat cake when they drink coffee.



Based on studying these 4 subgroups, we have learned that both inactivity and coffee are potential causes of sleep problems, while consumption of cake and milk only correlates with coffee intake. Modern computer algorithms will be able to do such studies super fast and will be able to do several other similar calculations that allow us to acquire even more information about how different foods correlate with health conditions and other foods. By also analyzing which kinds of medicines people are purchasing from pharmacies, we can in a similar way get information about how different medicines are affecting us, and about how they interact with different types of food. Since this study also is not intended to have a time limit, the longer it continues, the more certain we can be that the correlations it recognizes are correct. Uncertainty will decrease more and more as we move into the future (Figure 7), unlike how it has been for the past decades with old way of doing nutritional research, which just seems to have made the general population more confused.



**Figure 7:** How the uncertainty of recognized correlations will decrease over time

If we become more certain about which foods are healthy and unhealthy, it will be more justifiable to put taxes on unhealthy foods and to subsidize healthy foods. It is risky to put taxes on unhealthy food, unless we are really certain that it is unhealthy. It is also risky to educate kids about healthy nourishment, unless we are somewhat certain that our ideas about healthy nourishment are correct. That could generate distrust in the government.

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