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Effect of marital status on death rates. Part 1: High accuracy exploration of the Farr–Bertillon effect

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HIGHLIGHTS

- Non-married persons have higher death rates than married persons.
- This holds for all age groups and all diseases.
- Death rate by heart attack is 2.2 times higher for non-married.
- For young widowers the death rate is up to 20 times higher.

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ABSTRACT

The Farr–Bertillon law says that for all age-groups the death rate of married people is lower than the death rate of people who are not married (i.e. single, widowed or divorced). Although this law has been known for over 150 years, it has never been established with well-controlled accuracy (e.g. error bars). This even let some authors argue that it was a statistical artifact. It is true that the data must be selected with great care, especially for age groups of small size (e.g. widowers under 25).

The observations reported in this paper were selected in the way experiments are designed in physics, that is to say with the objective of minimizing error bars. Data appropriate for mid-age groups may be unsuitable for young age groups and vice versa.

The investigation led to the following results. (1) The FB effect is very similar for men and women, except that (at least in western countries) its amplitude is 20% higher for men. (2) There is a marked difference between single/divorced persons on the one hand, for whom the effect is largest around the age of 40, and widowed persons on the other hand, for whom the effect is largest around the age of 25. (3) When different causes of death are distinguished, the effect is largest for suicide and smallest for cancer. For heart disease and cerebrovascular accidents, the fact of being married divides the death rate by 2.2 compared to non-married persons. (4) For young widowers the death rates are up to 10 times higher than for married persons of same age. This extreme form of the FB effect will be referred to as the "young widower effect". Chinese data are used to explore this effect more closely.

A possible connection between the FB effect and Martin Raff's "Stay alive" effect for the cells in an organism is discussed in the last section.

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1. Introduction

Let us first define several terms which will be used throughout this article.

- The marital status of a person refers to one of the following situations: single, married, widowed, divorced. Needless to say, "single" means that the person has *never* been married for otherwise he (or she) would be widowed or divorced. These groups will be designated by the letters s, m, w, d respectively. The case of people who are married but separated or not married but cohabiting will also be considered later on albeit fairly shortly.
- For each of these groups of persons one can define a death rate in the standard way, that is to say by dividing the number of persons who die annually by the size of the group. In addition to the marital status distinction, one can order people by age group. For instance, $d_m(15:24)$ will be the death rate of married persons who are between 15 and 24 year old.
- Finally, we introduce the notion of *death rate ratio* which is the death rate of a given group divided by the death rate of married persons of same age. For instance, the death rate ratio of widowed persons in the age group 15 : 24 will be:

$$\text{Death rate ratio of widowed persons: } r_w(15:24) = d_w(15:24)/d_m(15:24).$$

The expression *death rate ratio distribution of widowed persons* will refer to the curve of r_w as a function of age. Sometimes, death rate ratio distributions will also be named Farr–Bertillon distributions.

1.1. The Farr–Bertillon law

In the social sciences there are very few laws which are valid at any time and in any country. The Farr–Bertillon law[1] which states that for all age-groups married persons have a lower death rate than unmarried persons is one of them. More precisely, in all cases for which reliable data are available this law holds with error bars which are not broader than $\pm 10\%$.

At first sight, our assertion that there are few laws of this kind may seem surprising. For instance, is it not true that the frequency distribution of high incomes follows a Pareto law? Compared with the Farr–Bertillon law there are two major differences, however.

- The Pareto law contains a free parameter, namely the exponent of the power law. The Farr–Bertillon effect contains no free parameter.
- The Pareto law describes a frequency distribution whereas the Farr–Bertillon law is a relationship between two "physical" variables. In short, the Pareto law is of the same kind as the Maxwell–Boltzmann (MB) law which gives the velocity distribution of the molecules of a gas whereas the Farr–Bertillon law is similar (for instance) to Einstein's law which gives the relationship between specific heat and temperature. Needless to say, a relationship between physical variables tells us more about the system than a probability distribution.[2]

The Farr–Bertillon law [1] is named after William Farr (1807–1883) and Louis-Adolphe Bertillon (1821–1883). In 1859 Farr observed the effect on French data. Both Farr and Bertillon were among the main founders of medical demography. Bertillon's strong focus on comparative international investigations led him to recognize the existence of this effect in a broad range of countries [2]. As a matter of fact, in the one and a half century since its discovery, the Farr–Bertillon effect has been observed in *all* countries for which reliable data are available.

1.2. Measurement issues

Why did we stress the need for reliable data? The reason is that many death ratio curves (e.g. in Figs. 2c, 3c, 4, 6a,c,d,f) display huge random fluctuations which for young persons are commonly of the order of 100%. Thus, it can hardly be denied that it is a real challenge to keep the error bars under control. This can only be done by increasing the size, n, of the sample. As in physics it is the $1/\sqrt{n}$ factor which will dampen random fluctuations. However, in contrast to physics, here we cannot increase at will the number of experiments. Instead, we need to select the data with great care. For instance, Table 3b shows that for young people the data from US "Current Population Reports" (CPR) involve random fluctuations of the order of 100%. Thus, CPR data should be discarded, at least for young people. Further discussion will show that even nowadays in advanced countries it remains a real challenge to produce the kind of data that are needed to observe the FB law. It can even be said that present-day data are probably less accurate than those of 50 or 100 years ago for, as will be seen later, present-day statistics rely more and more on surveys based on population samples, that is to say on smaller values of n.

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[1] So far, in the literature the FB law was variously referred to as the "marriage effect", the "widower effect" or the "bereavement effect". Adding to the confusion, some of these expressions were meant to describe special facets; for instance the term "bereavement effect" focuses on short-term rather than permanent effects. Here, as is standard in physics, this law will be designated by the name of its discoverers. We hope that following this usage will clarify its significance.

[2] The MB distribution for the speed of molecules is a consequence of the fact that each velocity component follows a centered Gaussian distribution. Because of the central limit theorem, Gaussian distributions are very common in the natural sciences which means that the exponential shape of the MB distribution only tells us that it belongs to this broad class rather than to the power law class. Actually, all significant physical information (about molecules masses and temperature) is contained in the width of the MB distribution.