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Effect of marital status on death rates. Part 2: Transient mortality spikes

Peter Richmond [a], Bertrand M. Roehner [b,*]

[a] School of Physics, Trinity College Dublin, Ireland

[b] Institute for Theoretical and High Energy Physics (LPTHE), University Pierre and Marie Curie, Paris, France

HIGHLIGHTS

- Transient death spikes follow major condition changes.
- There is a sharp death spike in the days following birth.
- Transfers from home to nursing home result in death spikes.
- The 2–3 months after a marriage are marked by a death spike.

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ABSTRACT

We examine what happens in a population when it experiences an abrupt change in surrounding conditions. Several cases of such "abrupt transitions" for both physical and living social systems are analyzed from which it can be seen that all share a common pattern. First, a steep rising death rate followed by a much slower relaxation process during which the death rate decreases as a power law. This leads us to propose a general principle which can be summarized as follows: *"Any abrupt change in living conditions generates a mortality spike which acts as a kind of selection process"*. This we term the *Transient Shock* conjecture. It provides a qualitative model which leads to testable predictions. For example, marriage certainly brings about a major change in personal and social conditions and according to our conjecture one would expect a mortality spike in the months following marriage. At first sight this may seem an unlikely proposition but we demonstrate (by three different methods) that even here the existence of mortality spikes is supported by solid empirical evidence.

1. Introduction

1.1. Merits and shortcomings of the death rate ratio approach

The present paper is a continuation of Richmond and Roehner [1] which for the sake of brevity, will be referred to as "Paper I".

Paper I described the Farr–Bertillon (FB) effect [2–4] which states that in all age groups the death rates d_s, d_w, d_d of single, widowed or divorced persons were higher than the death rates d_m of married persons. The ratios $r_s = d_s/d_m$, $r_w = d_w/d_m$, $r_d = d_d/d_m$ were called *death rate ratios* (or simply death ratios) with respect to married persons.

* Corresponding author.
E-mail addresses: peter_richmond@ymail.com (P. Richmond), roehner@lpthe.jussieu.fr (B.M. Roehner).

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The important point we note here is that this is not a small effect. Most death ratios are higher than two and they become as high as 5 for young widowers. Gompertz's law [5] allows conversion of death ratios into what may be called "equivalent aging". According to Gompertz's law, after the age of 30, the death rate doubles by 10 years of age. Thus, if the death ratio of a widower of age 30 is equal to 3, Gompertz's law implies that widowhood will push up his death rate to that of a married man about 16 years older.[1]

From a statistical perspective the death ratios are convenient and effective variables. They are convenient because they can be easily computed from the death rates by age and marital status. They are effective in the sense that they remove the massive effect of aging on death rates. Whereas the death rates of both married and unmarried persons increase exponentially with age, their ratios remain bounded within fairly narrow intervals.

However, the death ratios are also fairly opaque variables which do not tell us anything about the actual mechanism of the FB effect. This is because the death ratios provide only a static picture. They do not say how death rates are affected in the course of time by a change in marital status. In other words, they do not tell us how such a transition should be described at the level of a cohort of persons. It is only through a longitudinal analysis in which one follows a cohort in the course of time that one can gain an insight into what really happens.

1.2. Life as an equilibrium state in a domain of the parameter space

The present study is about death rates in various systems and in various situations. Thus, it does not seem unreasonable to explain on what conception of life and death the paper relies. For the purpose of the present paper it will be sufficient to observe that in a biological perspective life can be seen as an equilibrium in which a number of parameters remain confined within fairly narrow limits. For instance the body temperature should remain within (for instance) 30 and 45 °C. The domain of the parameter space which is compatible with life may be referred to as the life envelope.[2] Three observations are in order in relation with the present study.

- In contrast with the case of body temperature for which the limits are rather strict, for many other parameters the limits are fairly elastic. Consider the concentration of hemoglobin in blood. Whereas the reference values (for women) are 12–15 g per deciliter of blood, life remains possible even for levels as low as 4 g/dL. In addition, such boundaries are also subject to inter-individual variations. The notion of frailty which is often used in relation with elderly persons can be seen as a global contraction of the life envelope.
- Biology and medicine focus on biological parameters. Yet, for human beings social factors are also very important. This is shown very clearly by the fact that (as seen in Paper 1) death rates of non-married persons are two or three times higher than death rates of married persons. In other words, a major change in familial and social ties can drastically affect the life expectancy of people. Because, up to now, we have no means for measuring the strength of social interactions, it is impossible to define a range of reference values for such variables, however one should keep in mind the existence of such limits.
- Usually, in the process leading to death it is not just one but several parameters which go beyond their reference intervals. One reason for this is that the parameters are not independent. This collective effect can be summarized by the notion of "will to live". Testimonies suggest that often the "will to live" disappears one or two months prior to the actual occurrence of death. Although this notion has probably an objective significance, we recognize that (so far) it has not been measured and quantified. The transient death spikes analyzed in the present paper may be seen as an attempt to define this notion quantitatively. A mortality spike reflects a change in the will to live for the simple reason that it covers a time interval (usually a few months) which is too short for new diseases to fully develop.

The paper is in three parts. In the next section we develop a system theory perspective which will give us a simplified framework for the analysis of systems of living organisms. It will be seen that, the most visible effect of a state transition in a population is often the occurrence of a transient mortality spike. In this way, simply by shedding the items that are unsuitable in the new situation, the system adapts to the environment change. We then analyze several examples of sharp transitions characterized by such transient mortality spikes. This leads us to the formulation of the "Transient Shock" conjecture. Finally, we test a key prediction of this conjecture according to which one should expect a mortality spike in the months following marriages. For that purpose we explore the death rate of newly married persons in the months following their marriage. The challenge is to see whether there is a mortality spike or not.

2. Systems science perspective

In order to get a broader understanding we will adopt a system theory point of view which means that we will examine several systems during their transition from a state *A* to a state *B*. Establishing connections between systems which, at first

[1] The details of the calculation are as follows. Gompertz's law implies $(1 + a)^{10} = 2$ where a is the annual growth rate; one gets: $a = 0.072$. Now, the number of years x needed for a multiplication of the death rate by 3 is defined by: $1.072^x = 3$ which gives $x = 15.8$.

[2] A similar expression is used in aviation. The flight envelope or service envelope of an aircraft designates the domain of the flight parameters in which the aircraft can fly safely.