PAA Extended Abstract.

Early-life influences and the seasonality of mortality: Re-examaning the Doblhammer effect*,†

Andrew Noymer‡
noymer@uci.edu

Bert Kestenbaum§
Bert.M.Kestenbaum@ssa.gov

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150-Word Abstract

Doblhammer and Vaupel (2001) showed that length of life depends on month of birth. This had major implications for the debate on early-life influences on later-life health and mortality. If the early-life influences hypothesis is correct, length of life is influenced by events circa 75 years prior. This paper extends the work of Doblhammer by considering more recent data of comparable sample size. We find that the effect of month of birth (a proxy for in-utero conditions, including exposure to cold-and-flu season viruses as well as micronutrient deficiencies) on month of death diminishes in more recent data. This adds an important dimension, as it suggests that micronutrient deficiencies, which were seasonal but which diminished over time, and not viruses (which circulate every winter, even now), account for the Doblhammer effect. Our use of more recent data permits important differentiation.

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†This paper is part of a semi-formal group effort to produce papers on the pivotal 1919 birth cohort. The nexus with 1919 in the case of this paper is the SSA data in particular and historical demography in general.

‡Department of Sociology and Institute for Mathematical Behavioral Sciences, University of California, Irvine.

§Office of the Chief Actuary, Social Security Administration.

1 Background

In 2001, Doblhammer and Vaupel published a landmark paper showing that lifespan is affected by month of birth. The seasonal pattern is all the more striking because data from the southern hemisphere show the same pattern, but shifted by half a year, which is exactly what one would expect if the pattern is causally-related to winter nutritional deprivation or communicable disease burden.

This was an important finding because of the debate, going back at least as far as Derrick (1927), over early influences and later health and mortality outcomes. Elo and Preston (1992) and Kuh and Davey Smith (1993) discuss the long history of this debate. A classic impasse in this research is that early influences are correlated with later conditions (Ben-Shlomo and Davey Smith, 1991), making causal reasoning difficult. The ingenuity of Doblhammer and Vaupel was to make a sort of natural experiment out of birth month. Nutritional deprivation (particularly historically) and infectious disease exposure are more severe in the winter, with implications for *in utero* development. This is especially true in the third trimester of pregnancy, and these effects carry-over into the newborn period. That is to say, if the last trimester is a period of relative nutritional deprivation, then all things equal, the crucial first month after birth will also be a time of relative nutritional stress. This also means that *in utero* effects are, empirically speaking, hard to separate from newborn effects; they are both lumped together as MoB effects. Month of birth, however, is exogenous of social class and other factors that have life-long effects on health and mortality. Thus, the month of birth (MoB) findings to date seem to endorse the theory that early influences matter.

Doblhammer (2004) extended and elaborated upon the results of Doblhammer and Vaupel (2001), using, among other sources, U.S. Multiple Cause of Death (MCD) data with MoB added (cf. also Rau 2006). As with any important finding, more work can be done in this area.

2 Seasonality

Mortality is seasonal. This is well-known and is a far more general phenomenon than the specific effects demonstrated by Doblhammer and Vaupel (2001). See Rosenberg (1966) and Land and Cantor (1983), among others. Surges in winter infectious disease, especially influenza and pneumonia, affect all-cause mortality, including the leading cause of death, heart disease (see Simonsen et al. 2005). During the winter, not only influenza virus circulates, but as everyone knows, various other cold viruses circulate (notably the rhinoviruses and coronaviruses — cf. also Thompson et al. 2003 regarding the importance of RSV [respiratory syncytial virus, a paramyxovirus]). These viruses may cross the placenta; birth defects, such as congenital rubella syndrome, are an example of what can happen when this occurs. Speculatively, less severe effects may occur when different viruses cross the placenta.

3 Mechanisms for the Doblhammer effect

Thus, there are two alternate, non-mutually-exclusive, explanations (mechanisms) for the Doblhammer effect. Both have to do with seasonality, but the insult to the developing fetus is different. The first potential insult is nutritional deprivation, especially but not exclusively micronutrient deficiency. The second potential insult is exposure to trans-placental viruses. Both factors are greater in winter. Nutritional deficiency is seasonal because the availability of food, especially fresh fruits and vegetables, was less in the winter (particularly about 75–80 years ago, when many of today's deaths were born). The viral factor is seasonal because of the seasonality of "cold and flu", which is still not fully understood by epidemiologists (cite Dushoff).

4 A Test

Since both possible mechanisms are seasonal (and in-phase with each other), the existence of the Doblhammer effect itself does not offer any discrimination as to mechanism. However, we have devised a test that can potentially eliminate viruses as the mechanism (which would leave nutrition by default as the explanation, [or, potentially, another explanation]). Viruses are a constant; the winter cold and flu season comes every year. On the other hand, wintertime nutritional deprivation is not a constant. Nowadays, calories equally plentiful all year 'round. And today micronutrients are supplied in large part by fortification of foodstuffs, likewise a year-round process.

The people studied in Doblhammer effect studies were born some 75 years ago (or so). Thus, using data from 1975, we would be looking at births around 1900. Using data from 2000, we would be talking about births around 1925. People are living longer, but this does not diminish the general point. To continue the example, there were, ostensibly, nutritional improvements between 1900 and 1925. Certainly, there were vast nutritional improvements between 1900 and, say, 1950; some progress was made, surely, by 1925. Thus, over time, the Doblhammer effect should fade if it is caused by nutritional deprivation. More recent deaths refer, *ceteris paribus*, to more recent birth cohorts. Contra, viruses — these continue to circulate each winter, and if the Doblhammer effect is caused by trans-placental infections, it should not diminish over time.

This presents a sort of *experimentis crucis* for the nutritional explanation.

5 Our results, and conclusions

Due to relatively recent changes in US Government rules on data availability, data to test the Doblhammer effect are no longer publicly available. One of us (BK) has access to these data, however, due to his government employment. We have obtained newer data, and analyzed — in various sub-sets of the data, arranged by time — the magnitude of the Doblhammer effect, or the difference in average years of life lived between the maximal and minimal month of birth.

We have data over a span of 15 years. Arranging this into five 3-year intervals, we obtain the following progression of Doblhammer effect magnitudes (peak-trough years of life lived; left-to-right progresses from older to more recent birth cohorts):

.53, .45, .43, .32, .32

If we bin the same data into three 5-year intervals, we obtain:

.52, .40, .29

This shows clearly that no matter how one slices the data, the magnitude of the Doblhammer effect is declining in American data.

The final paper will be much more elaborated.

However, we hope the simplicity of this result will not mask its importance. Based on these data we can say, unequivocally, that the viral mechanistic hypothesis is not supported at all by our findings. This points to nutrition.

We will also present evidence that shows that the Doblhammer effect is not an artifact of the usual seasonality (of month of death).

References

Ben-Shlomo, Yoav and George Davey Smith. 1991. "Deprivation in infancy or in adult life: Which is more important for mortality risk?" *Lancet* 337(8740):530–534.

Derrick, V. P. A. 1927. "Observations on (1) errors of age in the population statistics of England and Wales, and (2) the changes in mortality indicated by the national records [with discussion]." *Journal of the Institute of Actuaries* 58:117–159.

Doblhammer, Gabriele. 2004. *The late life legacy of very early life*. No. 2 in Demographic Research Monographs, Springer, Berlin.

Doblhammer, Gabriele and James W. Vaupel. 2001. "Lifespan depends on month of birth." *Proceedings of the National Academy of Sciences of the United States of America* 98(5):2934–2939.

Elo, Irma T. and Samuel H. Preston. 1992. "Effects of early-life conditions on adult mortality: A review." *Population Index* 58(2):186–212.

Kuh, Diana and George Davey Smith. 1993. "When is mortality risk determined? Historical insights into a current debate." *Social History of Medicine* 6(1):101–123.

Land, Kenneth C. and David Cantor. 1983. "ARIMA models of seasonal variation in U.S. birth and death rates." *Demography* 20(4):541–568.

Rau, Roland. 2006. *Seasonality in human mortality: A demographic approach*. No. 3 in Demographic Research Monographs, Springer, Berlin.

Rosenberg, Harry M. 1966. "Recent developments in seasonally adjusting vital statistics." *Demography* 3(2):305–318.

Simonsen, Lone, Thomas A. Reichert, Cecile Viboud, William C. Blackwelder, Robert J. Taylor, and Mark A. Miller. 2005. "Impact of influenza vaccination on seasonal mortality in the US elderly population." *Archives of Internal Medicine* 165(3):265–272.

Thompson, William W., David K. Shay, Eric Weintraub, Lynnette Brammer, Nancy Cox, Larry J. Anderson, and Keiji Fukuda. 2003. "Mortality Associated With Influenza and Respiratory Syncytial Virus in the United States." *Journal of the American Medical Association* 289(2):179–186.