

Disentangling Stress from Nutrition as Determinants of the Long Run Effects of Adverse Conditions Around Birth on Economic and Health Outcomes Late in Life.*

Gerard J. van den Berg[†] Anna Hammerschmid[‡]
Johannes C. Schoch[§] Katharina Walliczek[¶]

January 15, 2015

Please do not distribute – preliminary and incomplete

*Acknowledgement: We thank participants at conferences in Mannheim and Essen and at a seminar in Berlin for helpful suggestions. We are grateful to the SOEP team at the DIW Berlin, notably Jürgen Schupp, Elisabeth Liebau, Simone Bartsch, Gerd Wagner, Christine Kurka and Jan Goebel, and to Anne Bohlender and Nico Siegel from TNS-Infratest, for their help in the data collection and the access to the SOEP data. Mevlude Akbulut-Yuksel kindly provided us with one of the bombardment data sets.

[†]Alexander von Humboldt Professor of Econometrics and Empirical Economics, University of Mannheim, IFAU Uppsala, VU University Amsterdam, IZA.

[‡]University of Mannheim

[§]University of Mannheim

[¶]University of Mannheim

Abstract Long-run effects of nutritional shortages early in life are often studied using variation in contextual nutritional conditions (e.g. due to a famine). Exposure to such adverse nutritional conditions is likely to cause stress among the affected households. The combination of a lack of nutrition and an increased stress level may have different long-run effects than the occurrence of one of these factors in isolation of the other. Results in famine studies may therefore be driven by stress exposure. We advance on this by considering various types of adverse contextual conditions early in life and by exploiting the variation in temporal and regional exposure to these conditions, among birth cohorts in Germany born in 1930–1950. This includes exposure to bombardments on the civilian population and exposure to famine. The latter are quantified using data we collected from historical sources on daily bombardments per city and local food rations. The individual outcomes measures we consider include adult height, life satisfaction and the occurrence of high blood pressure at old ages. Moreover, we use the actual retirement pension level as an indicator of economic productivity throughout the adult working life, following the principle that it is related to the flow value of an expected present value of lifetime income. This allows us to capture long-run effects on economic outcomes in an encompassing fashion. We find that the long-run effects depend strongly on the relative importance of the different types of adversities early in life.

Extended Abstract

Recently, social sciences have witnessed an increasing interest in the long-run effects of early life conditions on adult health and socio-economic outcomes. For a concise overview on the impact of early life conditions on later life outcomes, we refer the reader to e.g. Almond and Currie (2011). What has started as an epidemiological strand of literature – and has most famously been theorized about in the seminal work of Barker (1994) – has triggered interdisciplinary academic work mostly for its universal relevance: If early life conditions are found to have significant impacts on late life health outcomes they may induce long-run costs for the affected individuals and a public health system as a whole that may be underestimated when focusing on short term effects only.

Analyzing the impact of early life conditions on later life health is a challenging empirical task. A standard approach is to use aggregate level shocks that affected a fraction of individuals during an early life period. The shock-like variation in early life circumstances can then (a) either be used as an instrument for an individual-level variable if available, or (b) it can be used to compute a reduced form effect of this shock on later life outcomes. The most frequently used approach is the second, mainly for its simplicity and its lower demand on data availability. Within this subset of studies one can find a bulk of work studying the long run effects of early life exposure to famine as a proxy for a nutritional shortage in early life; see Lumey et al. (2011) for a recent survey. Since nutritional deprivation and food insecurity are in principle economic problems, famine studies have also become of special interest in the economics literature (see, e.g., Lindeboom et al. (2010), van den Berg et al. (2011), Neelsen and Stratmann (2011), Jürges (2013)).

Outcomes found to be affected by famine range from chronic diseases and physical indicators such as type II diabetes risk and adult height to mental disorders such as schizophrenia or economic outcomes. Given the broad spectrum of outcomes affected by early life famine one question has yet to be conclusively answered: Is an individual-level nutritional shortage the only channel via which famine affects those outcomes? Or is there another component, such as famine induced psychological stress or stress evoked by factors paralleling the famine, that simultaneously influences long run health? If this is in fact the case, the interpretation of reduced form famine effects may need to be adjusted.

Like malnutrition, the hormonal reaction to stress early in life may have a profound impact on the development of metabolic features or gene expression (Maric et al. (2010)). Moreover, since early life stress and malnutrition are oftentimes found to be correlates of a low socio-economic environment which in general predicts worse later

life health outcomes and metabolic features (Miller et al. (2009), Miller and Chen (2010), Morozink et al. (2010)) it is evident that disentangling the effect of stress and malnutrition is a hard task not only on an aggregate but also on an individual level.¹ Exogenous variation that plausibly shifts only one of these components, i.e. evokes either stress or malnutrition on an individual level, may be a remedy to this problem.

Our study addresses this concern and uses World War II (WWII) and its aftermath in Germany as a unique natural experiment to disentangle the effects of early life famine and early life stress. We combine a detailed micro data set that includes the place of birth of a respondent on a level as fine as the exact municipality with city-level information on the exact timing and intensity of Allied air raids on Germany during WWII and regional-level information on food rations that were distributed during the German famine in the aftermath of the war. Under the assumption that air raids that were experienced very early in life or in utero evoke stress and that famine may have an effect via both, stress and malnutrition, we can use our empirical findings to trace out the distinct effect of each component on a range of outcomes. For instance, if we find one outcome to be significantly affected by stress induced by bombings but not significantly so by exposure to a period of famine, our finding hints at the stress component of famine to be negligibly small. Conversely, if famine exposure has an effect on an outcome while the experience of air raids does not, it follows that a nutritional shortage is likely to be the relevant biological channel for this outcome.

Up to now, conclusive evidence on this matter is scarce even though the problem we outlined above has been acknowledged in the literature on, for instance, the Dutch famine where psychological stressors may have been prevalent also due to war-related factors paralleling the famine (e.g. Roseboom et al. (2001)). Even if a specific stressor may have been identified, it requires a large degree of cross-sectional and temporal identifying variation in this stress inducing factor that is independent of famine exposure to come up with a solid empirical result. Our unique data set provides this information, with the raw data of air raids being measured on a very narrow local level and with daily precision.

Our findings are important for several reasons. First, knowing which outcomes are influenced by a certain type of early life condition may help to determine potential threats to late life health more narrowly and select adequate compensatory measures. Second, we provide reliable empirical evidence on the relevance of severe stress early in life on later life health and economic outcomes. Third, our findings aim to researchers to interpret existing results of famine studies and to design studies in the future.

¹Krabbendam et al. (2005) show that demographic factors pick up part of the effect of self-perceived stress on adverse pregnancy outcomes which again emphasizes the connection between the two variables.

The results are robust to various sensitivity analyses. Most importantly, we show that our main results remain robust when controlling (i) for the potential endogeneity of the place of birth of a respondent; (ii) for selective mortality during the war; and (iii) for exposure to famine and air raids at later ages. The endogeneity of the place of birth is of importance since children and mothers were evacuated from cities on a large scale by state programs during the war. Using additional data on moves of mothers during pregnancy or the first six months of life, we show that we can at least partially control for the degree of selection by including a variable that measures the overall exposure of a particular city to air raids until just before the estimated month of conception. Selective mortality can be addressed since almost half of the casualties directly related to air raids occurred at particular dates in particular cities, namely four so-called ‘firestorms’. Dropping observations born in those cities does not alter the results. Issue (iii) is of particular importance since individuals have been found to be vulnerable also at later stages of their childhood (e.g. Van den Berg et al. (forthcoming), Sparén et al. (2004)). Moreover, observations affected by air raids early in life are those exposed to a famine later in childhood. Explicitly controlling for exposure to adverse conditions later in childhood does not alter the results.

References

- ALMOND, D. AND J. CURRIE (2011): “Human Capital Development before Age Five,” in *Handbook of Labor Economics Vol. 4b*, Elsevier, 1315–1486.
- BARKER, D. J. P. (1994): *Mothers, babies, and disease in later life*, BMJ Publishing Group London.
- JÜRGES, H. (2013): “Collateral damage: the German food crisis, educational attainment and labor market outcomes of German post-war cohorts,” *Journal of Health Economics*, 32, 286 – 303.
- KRABBENDAM, L., L. SMITS, R. DE BIE, J. BASTIAANSEN, F. STELMA, AND J. VAN OS (2005): “The impact of maternal stress on pregnancy outcome in a well-educated Caucasian population,” *Paediatric and perinatal epidemiology*, 19, 421–425.
- LINDEBOOM, M., F. PORTRAIT, AND G. J. VAN DEN BERG (2010): “Long-run effects on longevity of a nutritional shock early in life: The Dutch Potato famine of 1846–1847,” *Journal of Health Economics*, 29, 617–629.
- LUMEY, L., A. STEIN, AND E. SUSSER (2011): “Prenatal famine and adult health,” *Annual Review of Public Health*, 32, 237–262.

- MARIC, N. P., B. DUNJIC, D. J. STOJILJKOVIC, D. BRITVIC, AND M. JASOVIC-GASIC (2010): “Prenatal stress during the 1999 bombing associated with lower birth weight—a study of 3,815 births from Belgrade,” *Archives of Women’s Mental Health*, 13, 83–89.
- MILLER, G. E. AND E. CHEN (2010): “Harsh family climate in early life presages the emergence of a proinflammatory phenotype in adolescence,” *Psychological science*, 21, 848–856.
- MILLER, G. E., E. CHEN, A. K. FOK, H. WALKER, A. LIM, E. F. NICHOLLS, S. COLE, AND M. S. KOBOR (2009): “Low early-life social class leaves a biological residue manifested by decreased glucocorticoid and increased proinflammatory signaling,” *Proceedings of the National Academy of Sciences*, 106, 14716–14721.
- MOROZINK, J. A., E. M. FRIEDMAN, C. L. COE, AND C. D. RYFF (2010): “Socioeconomic and psychosocial predictors of interleukin-6 in the MIDUS national sample.” *Health Psychology*, 29, 626.
- NEELSEN, S. AND T. STRATMANN (2011): “Effects of prenatal and early life malnutrition: Evidence from the Greek famine,” *Journal of Health Economics*, 30, 479–488.
- ROSEBOOM, T. J., J. H. VAN DER MEULEN, A. C. RAVELLI, C. OSMOND, D. J. BARKER, AND O. P. BLEKER (2001): “Effects of prenatal exposure to the Dutch famine on adult disease in later life: an overview,” *Molecular and cellular endocrinology*, 185, 93–98.
- SPARÉN, P., D. VÅGERÖ, D. B. SHESTOV, S. PLAVINSKAJA, N. PARFENOVA, V. HOPTIAR, D. PATUROT, AND M. R. GALANTI (2004): “Long term mortality after severe starvation during the siege of Leningrad: prospective cohort study,” *BMJ: British Medical Journal*, 328, 11.
- VAN DEN BERG, G. J., P. LUNDBORG, P. NYSTEDT, AND D.-O. ROTH (forthcoming): “Critical periods during childhood and adolescence: a study of adult height among immigrant siblings,” *Journal of the European Economic Association*.
- VAN DEN BERG, G. J., P. PINGER, AND J. SCHOCH (2011): “Instrumental Variable Estimation of the Causal Effect of Hunger Early in Life on Health Later in Life,” .