Supporting Information

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SI Text

Three 20th-Century Famines in Austria. All three famines discussed below are well-documented historical facts. In the following, we give a short account of their severity. We abbreviate the provinces' names as follows: Burgenland (B), Carinthia (K), Lower Austria (N), Upper Austria (O), Salzburg (Sa), Styria (St), Tyrol (T), Vorarlberg (V), and Vienna (W).

1919: Starvation embargo. After World War I, the Austro-Hungarian Empire was dismembered, and Austria's population dropped from 52 to 7 million inhabitants (1). Austria lost food supplies from its former member states, and Vienna in particular lost most of its supplies that were imported from Hungary. In Vienna in 1917, people were assigned 40 g of fat per week (2). The situation was worst in large cities and in remote settlements in the mountainous regions (3).

In 1918, the so-called "starvation embargo" against Austria was imposed as a means of exerting political pressure (4), the goal being to forbid the unification with Germany, which was finally regulated by the Treaty of Versailles on June 28, 1919 (5). In this embargo, Austria was systematically cut off from supplies, and urgently requesting food and provisions from Germany. The eastern part of Austria was most affected by hunger. The provinces of western Austria, V and T, were provided with food by the Allies through Switzerland after the war (4). At the beginning of 1919, ∼800,000 Viennese were victims of malnutrition, and an estimated 100,000 were suffering from acute hunger. A comprehensive study among 71,000 school children revealed that 93% had an unsatisfactory general nutritional condition (6). Another study revealed that only 9% were in a good state of health (7). The daily food intake in Austria in 1919 was estimated at 1,271 calories (8). With the peace treaties, the starvation embargo was subsequently lifted, and the Allies provided full food support in July 1919, with the first supplies coming from Italy?*

1938: Extreme poverty in Austria. Since the Great Depression in the 1930s, mass unemployment, low incomes, and the collapse of purchasing power dominated the economic situation in Austria. As a result, in 1936 and 1937, ∼500,000 (∼22%) were unemployed (9). The unemployment situation worsened as the proportion of persons receiving unemployment support by the government dropped from 80% to 50% (of the unemployed persons) between 1927 and 1937. Austria's population was faced with extreme poverty, and the living standard decreased dramatically, resulting in a series hunger marches (10). In response to the world economic crisis, massive inflation, and as a result of a short civil war in February 1934 (11), the Austrian democratic system was replaced by Austrofascism from 1933 to 1938; it moved away from a free market economy, and international trade was restricted (12). Bottlenecks in the food supply of milk products, eggs, bread, and meat were reported, and fat was rationed (13). Other factors included a decline in harvest of wheat and rye during the period 1937–1942 (12). Records revealed that 50% of families had meat only once a week, and 15% none at all (10). Nutrition for the unemployed changed abruptly after the occupation and annexation of Austria into Germany on March 12, 1938. Immediately after this time, food programs were started to help ameliorate the situation for suffering industrial workers. On March 27, 1938, more than 145 railway wagons with 3,000 tons of food were sent to the larger cities, such as Vienna, Graz, Salzburg, and Innsbruck (13). The unemployment rate dropped from ∼500,000 to 276,000 in 1938, to 66,000 in 1939, and 40,000 in 1940 (10). This change was in accordance with the slogan "*Brot und Arbeit*" (bread and work). The labor market benefited from the new high-employment growth strategy; unemployment continued to decline; and unemployment benefits were reestablished (14). In addition, food prices were controlled and fixed by the now-German government to ensure affordable prices for everyone. A substantive number of jobs were created for German rearmament, infrastructure, and weapon factories for preparation of war. Food was officially rationed and only available through food ration cards. These ration cards were effectively subsidies for families to purchase vital staple foods (15). For example, in 1939, each person received ration cards for meat (700 g), oil and fat (60 g), sugar (280 g), jam (110 g), and milk (200 g). Children under 6 y of age; pregnant and feeding mothers; and hard laborers received additional food rations (13). These developments reduced substantially the hunger in Austria within a very short time. Moreover, the German winter welfare organization *Winterhilfswerk* took care of the poorest to grant food aid. A detailed overview is found in Neuber (13).

1947: Massive famine after World War II. Austria suffered severely from the destruction caused by World War II, and its economy shared the fate with many other European countries due to heavy bombardments by the Allied Forces from 1943 to 1945, which had damaged many cities and transportation facilities (16). From 1945 until May 12, 1955, Austria remained under Allied occupation. At the end of September 1945, the daily calorie intake was ∼800. In the city of Wiener Neustadt in N, the daily calorie ratio was at 497 (17). With the availability of food ration cards, calorie intake increased slightly to 1,300–1,500 per day. However, women, the elderly, and children were most affected, and a calorie intake of less than 1,300 was reported. Suffering from the food shortage was particularly evident in Vienna, where supplies provided by the Allies were limited and insufficient. The situation worsened in the May Crisis of 1946, with a reported food intake of less than 1,000 calories per day (18). The situation exacerbated again due to a poor harvest, and the Allies were forced to import most of the required food. Until 1947, e.g., food supply for the Viennese population was mainly covered (80%) by foreign aid. The entire country was particularly dependent on external help to avoid a devastating famine (19).

In 1947, the economy shrank to 61% of its prewar size, with a consumer goods production of 42% of prewar production. Daily rations remained below 1,500 calories until the end of 1947. The food shortage intensified due to shortages of fertilizer and fuel (20). Overall, 70% of all children suffered from malnutrition. Nonetheless, the mere survival of the Austrian population was ensured more or less by food supplies from the Government and Relief in Occupied Areas and the United Nations Relief and Rehabilitation Administration, which were funded mainly by the United States. On July 2, 1948, the situation finally improved with employment of the Marshall Plan. This large-scale US program aimed to rebuild the European economies after World War II, and used a recovery strategy in three stages: (*i*) immediate and direct aid of food and raw materials, (*ii*) reconstruction and adaption of basic industries in 1950–1951, and (*iii*) financial support to manufacturers and to the tourism industry in 1952–1953. Between 1948 and 1952, the United States supported Austria with goods worth ∼$1 billion (17). In 1949, good harvests and an improving continuous grain supply for the population were re-

*Clinchant J (December 28, 1918) Report of the embassy Bern. Resupplying Austria. Archives Nationales Paris F 128087, Paris. German.

ported. Additionally, economic activity strengthened and formed the basis for a sustained robustness of the market (15).

Analysis on a Regional Scale: Nine Provinces of Austria. We present results for the fraction of patients (male and female) as the percentage of the total population for each of the nine provinces as a function of the year of birth in Fig. S1. It is apparent that the eastern provinces of B, N, St, and W show higher fractions of diabetes patients than the western provinces of V and T. Fig. S2 shows the excess risk of diabetes for each province separately. B shows the highest excess risk.

The age dependence in the sex ratios of patient fractions in the provinces is shown in Fig. S3; each shows the same trend as the overall sex ratios shown in Fig. 3, with the notable exception of W. In W, the ratio is constant for 1917–1965, and does not exhibit a peak around 1960.

Patients' place of residence in the diabetes dataset and place of birth need not be the same. It can be assumed that if strong inhomogeneities of excess risk exist on a regional scale at the time of famine, these regional effects will be washed out over time due to migration. To understand how migration between the nine provinces of Austria affects our results on excess risk, we correct the observed excess risks in the following way. Let $N_{m/f}(i,t,\tau)$ be the number of males/females of age τ and living in province $i \in \{1,2,\ldots,9\}$ in year t, where i labels Austria's provinces. Each person included in $N_{m/f}(i,t,\tau)$ is born in one of Austria's provinces or in another country, or the birth place is not classifiable (e.g., because of missing data). We label the provinces of birth by j if the birth place is not known or lies outside of Austria, and we set $j=10$. Let $n_{m/f}(i,j,t,\tau)$ be the number of τ-years-old males/females, which in year t are living in province i and were born in province j. We have $N_{m/f}(i,t,\tau) = \sum_{j=1}^{10} n_{m/f}(i,j,t,\tau)$. We obtained the data $n_{m/f}(i,j,t,\tau)$ for males, females, each i,j,τ, and $t=2012$. From this data we constructed for each sex and age the migration matrices $M_{m/f}(\tau) = (m_{m/f}(i,j,\tau))$, with $m_{m/f}(i,j,\tau) = \frac{n_{m/f}(i,j,2012,\tau)}{\sum_{j=1}^{9} n_{m/f}(i,j,2012,\tau)}$. We make two remarks on the construction of these migration matrices. First, we assume that the matrices $M_{m/f}(\tau)$ have not changed significantly between 2007 and 2012; that is, a τ-years-old person living in province i will equally likely be born in province j in the year 2007 as in the year 2012. Especially for higher values of τ, this is a reasonable assumption. Second, we neglect corrections in the regional diabetes excess risks due to migration from outside of Austria.

Let $E^{obs}_{m/f}(i,t_B)$ denote the observed excess risks for males/females in province i and year of birth t_B (as used up to here), and $E^{corr}_{m/f}(i,t_B)$ the excess risks corrected for migration; they are related by $E^{obs}_{m/f}(i,t_B) = M_{m/f}(2007-t_B)E^{corr}_{m/f}(i,t_B)$. The migration-corrected excess risks can then be obtained by

$$E^{corr}_{m/f}(i,t_B) = \left(M_{m/f}(2007-t_B)\right)^{-1} E^{obs}_{m/f}(i,t_B),$$

where $(\cdot)^{-1}$ is the matrix inverse. By construction, the sum of excess risks for the migration-corrected case equals the uncorrected excess risks for each year of birth.

For the impact of the migration correction on the results, see Fig. S3, where the difference between corrected and observed excess risks, $E^{corr}_{m/f}(i,t_B) - E^{obs}_{m/f}(i,t_B)$, is shown for each province and sex. For K, O, St, T, and V, the migration correction has no significant effect. In B, each of the peaks becomes even more pronounced. Large corrections can also be seen for N, Sa, and W, which are also the provinces with the smallest values of $m_{m/f}(i,i,\tau)$, i.e., people born and living in the same provinces. For example, for N, Sa, and W values of $m_{m/f}(i,i,\tau)$, for the 1918–1919 y of birth, fall in the range 0.67–0.75, whereas in the other provinces they range from 0.83 to 0.89.

The migration-corrected regional excess risks become even larger for the eastern provinces than the observed ones. For example, for males (females) born around the1918–1919 famine in B, the correction increases the excess risk from 38% (28%) to 42% (30%); for the 1918–1919 peak in Sa, the values increase from 12% (20%) to 15% (29%). This difference between males and females in the magnitude of the migration correction for Sa, 1920, may be due to overall higher migration rates for females than males in this particular case. For 66% of the females, province of residence and birth is Sa, whereas 72% of the males born in Sa are currently also living in Sa. For 1920, this finding compares to an average over all provinces of 82% of males and 81% of females, for which province of birth and residence is the same.

Diabetes in Austria. ***Nationwide aspects of diabetes in Austria.*** Worldwide, an estimated 285 million people have diabetes mellitus (21), with the latest estimates approaching as many as 366 million (22); 90% are suffering from the type 2 variety (23). The number of people with diabetes has more than doubled over the past three decades (24) as a result of population aging, urbanization, and associated lifestyles (23, 25). In Austria, diabetes estimates vary widely. Though the International Diabetes Federation (IDF) gives an estimate for 2006 of ∼682,300 people, the Austrian Federal Ministry of Health states ∼350,000 (25), and the Austrian Census estimates ∼390,000 in 2012 (www.statistik.at/web_de/statistiken/gesundheit/gesundheitsdeterminanten/). It is suggested that 13% of females and 14.5% of males in the population aged 60–79 y have diabetes (26). The current prevalence of type 2 diabetes, according to the Austrian Diabetes Initiative (1,935 males and 2,065 females interviewed) is 6% (25), and ∼20–30% are prediabetic. According to the IDF, the prevalence of diabetes is ∼9% in Austria (27). The Austrian Health Survey 2006/2007 estimates the prevalence of diabetes is 5% in males and 6% in females, and increases to 16% in persons over 60 y. Although the epidemic of obesity and type 2 diabetes is less pervasive in Austria compared with other European countries or the United Nations, it is still alarming and associated with a huge increase of direct and indirect health care costs.

The Austrian Diabetes Report estimates that ∼90% of diabetic patients are treated by antihyperglycemic drugs, and ∼10% are treated by nutrition therapy only; ∼10% remain undiagnosed and therefore untreated. Several reports documented that women are more often treated by nutrition therapy only, and that their glycemic control is worse, associated with a more unfavorable cardiovascular risk profile compared with male patients (28, 29).

Undetected diabetes. Screening studies in Austria, including fasting glucose measurements in 2010 and 2011, detected newly diagnosed diabetes in 2% of the participants (30), whereas 6% already had diagnosed diabetes. Based on estimations of the IDF, 9% have diabetes (571,000 persons for the age group 20–79 y; 9,084 diabetic patients per 100,000) in Austria: 5.8% (∼362,100 people) have diagnosed diabetes, whereas another 3% are estimated to have undetected diabetes (208,900 people) (27). These numbers are in accordance with the number of pregnant women with newly diagnosed (undetected) diabetes in early pregnancy (31).

Regional aspects of diabetes in Austria. It has been shown that the highest rates of obese and diabetic females are found in B and for males in W (32, 33). Although the reason for these findings remains unclear, it could in part be due to a better socioeconomic situation and a more active and healthier lifestyle as well as better nutrition in the western part of Austria; also, cardiovascular diseases are somewhat lower in the western area (34). In eastern Austria, there is an increasing number of immigrants with a higher risk of diabetes, which is often detected during pregnancy (31).

Sex aspects of diabetes in Austria. In Austria, general screening for gestational diabetes (GDM) is recommended by use of a 2-h/75-g oral glucose tolerance test between 24 and 28 gestational weeks. At present, no nationwide data of prevalence or incidence rates of

GDM are available, but it is estimated that 5–20% of the pregnant women will develop GDM, and another 4% will have diagnosis of diabetes first detected during pregnancy (35, 36). All women with GDM will receive nutrition therapy and education in blood glucose self-measurements. In addition, ∼30–50% will require antihyperglycemic drug therapy, i.e., insulin therapy, to maintain their blood glucose values within the recommended range. Most GDM-diagnosed women regain normal glucose tolerance after delivery, but have a sevenfold increased risk of developing diabetes later compared with women without GDM (37).

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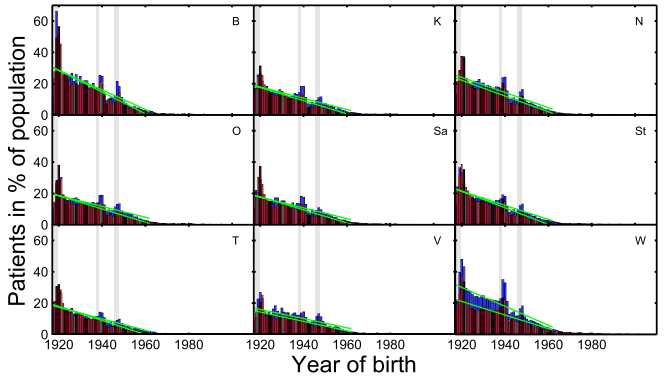

Fig. S1. Same measure as Fig. 1, made explicit for the nine provinces of Austria. The eastern provinces B, N, St, and W show higher peaks in the fractions of diabetes patients born in times of hunger than the western provinces of V and T.

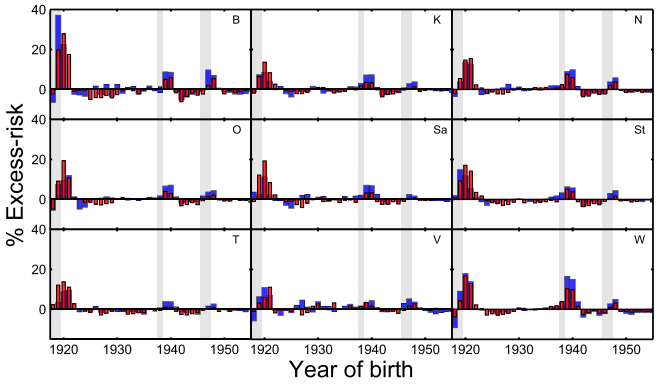

Fig. S2. Excess risk (observed) as in Fig. 2, specified for the nine provinces. The excess risk is most pronounced in the eastern provinces B, W, and N for reasons explained in the text.

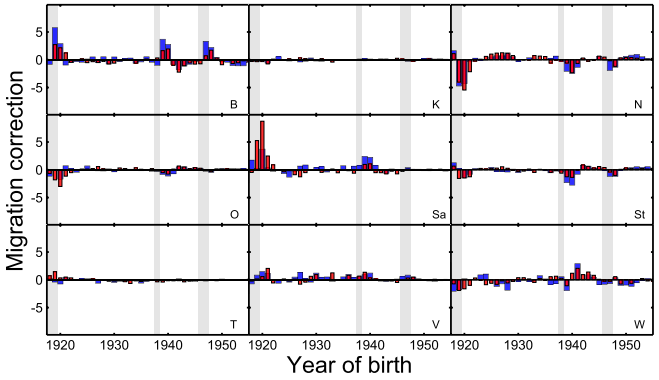

Fig. S3. Migration correction, $E^{corr}_{m/f}(i, t_B) - E^{obs}_{m/f}(i, t_B)$, for the regional excess risks for males and females. In K, O, St, T, and V, this correction has almost no impact. In B, each of the peaks close to famines becomes even more pronounced; the opposite is happening in N, accounting for the fact that many people born in B now live in N. Large corrections can also be seen for Sa and W, which are also the provinces with the smallest percentages of patients born in the same province in which they are currently living.

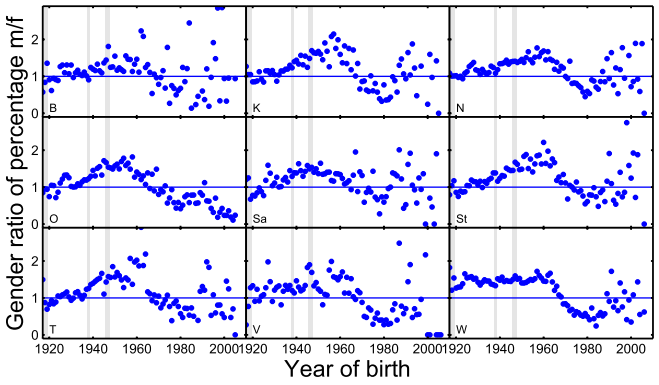

Fig. S4. Same measure for the sex ratio as in Fig. 3, specified for the nine provinces. A peculiarity is noticeable for W, where the ratio does not increase over the interval 1917–1965, but remains constant at ~1.5, meaning that the ratio of males to females under treatment does not change. The diabetes dominance for females born after 1970 is visible in all provinces.