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THE LONG–LASTING MENTAL HEALTH EFFECT OF CHILDHOOD TRAUMA

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ABSTRACT

There has been a revival of warfare and threats of interstate war in recent years as the number of countries engaged in armed conflict surged dramatically, reaching to levels unprecedented since the end of Cold War. This is happening at a time when the global burden of mental health illness is also on the rise. We examine the causal impact of early life exposure to warfare on long–term mental health, using novel data on the amount of bombs dropped in German cities by Allied Air Forces during World War II (WWII) and German Socioeconomic Panel. Our identification strategy leverages a generalized difference-in-differences design, exploiting the plausibly exogenous variation in the bombing intensity suffered by German cities during the war as a quasi-experiment. We find that cohorts younger than age five at the onset of WWII or those born during the war are in significantly worse mental health later in life when they are between ages late 50s and 70s. Specifically, an increase of one-standard deviation in the bombing intensity experienced during WWII is associated with about a 10 percent decline in an individual's long–term standardized mental health score. This effect is equivalent to a 16.8 percent increase in the likelihood of being diagnosed with clinical depression. Our analysis also reveals that this impact is most pronounced among the youngest children including those who might have been in-utero at some point during the war. Our investigation further suggests that measures capturing the extent of destruction in healthcare infrastructure, the increase in the capacity burden of the healthcare system, and wealth loss during WWII exacerbate the adverse impact of bombing exposure on long–term mental health, while the size of war relief funds transferred to municipalities following the war has a mitigating impact. Our findings are robust across a variety of empirical checks and specifications. With the mental health impact of childhood exposure to warfare persisting well into the late stages of life, the global burden of mental illness may be aggravated for many years to come. Our findings imply that prioritizing children and a long–term horizon in public health planning and response may be critical to mitigating the adverse mental health consequences of exposure to armed conflict.

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1 Introduction

Mental health disorders impose an enormous societal burden globally, accounting for one in three years lived with disability, and costing the world economy 2.5 trillion dollars annually–a figure that is projected to rise to six trillion dollars by 2030 (de Menil and Glassman, 2015; Mnookin, 2016). Furthermore, the majority of people with mental illness receive no treatment, even in economically advantaged societies (Alonso et al., 2018; Thornicroft et al., 2017). Accordingly, there is an increased acknowledgement among governments and international organizations of the important role that mental health plays in achieving global development goals and an urgent need to scale up quality mental health services. As a sign of this recognition, mental health was included in the United Nations Sustainable Development Goals (SDGs) in September 2015, and the World Health Organization (WHO) identified mental health as an area of accelerated action in 2018. A critical step towards formulating effective treatments and preventive strategies to diminish the global burden of mental illness requires a thorough understanding of the factors and disturbances that trigger these disorders throughout the life cycle.

In this paper, we provide causal evidence on the long–term mental health effects of childhood trauma induced by exposure to war, leveraging a unique historical dataset on the bombing intensity of Germany during World War II (WWII) and individual data from the 2002–2010 waves of German Socio–Economic Panel (GSOEP). Specifically, we exploit plausibly exogenous city–by–cohort variation in the intensity of childhood exposure to the aerial attacks carried out by Allied Air Forces ("AAF") using a generalized difference–in–differences strategy.[1] Our focus is on individuals who were younger than age five at the onset of WWII or those born at some point during the war. This is an important age group to consider, given the fundamental role that the early years of life play in the formation of long–term outcomes (Almond and Currie, 2011).[2]

One of the main factors motivating our focus on WWII is the fact it is a momentous event in modern history. It is therefore important to understand the long–lasting effects on the mental

[1]Specifically, our measure of bombing intensity is defined as the total number of bombs dropped per square kilometer in each city over the course of the WWII.

[2]Almond and Currie (2011) lay out the mechanisms that illustrate the presence of a causal relationship between shocks in the first five years of life and future outcomes. They then provide an overview of the literature which demonstrates that events during this critical period can have long–term impacts on adult outcomes.

health of populations who survived this tragedy in its own right. Studying the context of Germany is particularly important because of the tremendous physical and human toll that the war took on the German population. Over one and a half million tons of bombs were dropped on German soil, which caused, in addition to massive number of casualties, significant distress and disruptions in daily life among survivors via uncertainty of the aerial attacks as well as the destruction of the dwellings, hospitals, roads, schools and other public spheres (United States Strategic Bombing Survey (USSBS), 1945; Davis, 2006). Interestingly, mental health problems among the elderly appears to be severely overlooked in Germany, where 35 percent of suicide deaths occur among people over the age of 65 despite the fact this age group accounts for only 21 percent of the population (Pladson, 2019). In general, the specific causes of mental illness among older populations are often poorly diagnosed, and psychological ailments detected in these persons are misperceived as normal manifestations of aging (Corcoran et al., 2013).

Our emphasis on warfare is also motivated by the troubling observation that exposure to combat during childhood, or armed conflict in general, is a particularly extreme form of a traumatic experience, and yet it is common worldwide, affecting as many as 426 million children (Ostby et al., 2020).[3] According to United Nations Children's Fund (UNICEF), the number of countries experiencing conflict, involving weapons or violence in 2021 was the highest in 30 years.[4] Parallel to this trend, the number of children living in territories or countries in armed-conflict or emerging from war has been escalating over the last few decades (Ostby et al., 2020). The nature of war has also changed with combat zones becoming increasingly widespread with a destruction caused on a larger scale than before (Levy and Sidel, 2008).

The importance of our analysis is further predicated by the recent invasion of Ukraine by Russia, which has led to millions of Ukrainian children to abandon their schools and to leave their homes to move into bomb shelters, underground metro stations and parking lots, and refugee facilities. The trauma, fear, and anguish Ukrainian children are experiencing likely place an enormous strain on their mental health, which may persist throughout the life course. As in the words of a physician with Doctors Without Borders, "Every child in [Ukraine] is now experiencing multiple

[3]This number refers to the estimated number of children under age 18 who lived within a 50 km of a conflict zone where an actual fighting took place. Of these, more than 71 million are 0–5–year–olds who lived in areas of armed conflict during their entire lifetime (Ostby et al., 2020).

[4]See https://https://www.unicef.org/children-under-attack.

adverse childhood events, and that is one of the uncounted casualties that will ripple throughout generations." (Kondeleon, 2022).

Beyond armed–conflict and warfare, children are also faced with an alarming increase in exposure to terrorism, gun violence, and mass public and school shootings as a common occurrence in their lives (Chrisman and Dougherty, 2014; Kadir et al., 2018; Soni and Tekin, 2020). At a time when the incidences of wars, terrorism, and mass gun violence are on the rise worldwide, it is crucial to understand whether or not an exposure to armed conflict has a deleterious impact on mental health and the extent to which it contributes to the global burden of mental illness.

Broadly, our paper contributes to the literature on the impact of adverse childhood experiences on long–term mental health. While there is an accumulating body of research on the relationship between early childhood experiences and the development of mental health ailments later in life, causal evidence obtained from credible research designs is relatively rare (Adhvaryu et al., 2019; Persson and Rossin–Slater, 2018). Furthermore, there are very few studies considering exposure to warfare as an adverse experience within this literature, despite the growing vulnerability of children to combat and warfare globally. One exception is Singhal (2019), who shows that early–life exposure to bombing during the American War in Vietnam has a deleterious effect on the mental health status of Vietnamese population in adulthood. As another example, Kim (2017) documents that exposure to Korean War in late childhood to early teenage years has a long–run negative impact on indicators of mental health, including depression, fear, insomnia, and loneliness. Finally, Bratti et al. (2015) find that trauma experienced during the war in Bosnia and Herzegovina between 1992 and 1995 war significantly increased the likelihood of depression six years after the conflict.[5]

Our paper offers complementary evidence to these studies, but it also breaks new ground by incorporating information on the role of potential pathways, such as the loss of wealth during the war, damage to healthcare infrastructure, loss of healthcare personnel, the number of child patients, out–of–wedlock births, change in the infant mortality rate, and the amount of war relief payments paid to municipalities in 1948 to help with reconstruction. Furthermore, our treatment measure

[5]There is a related and larger literature on the impact of warfare on mental health that relates to the conditions of individuals directly involved in armed-conflicts, like military personnel or child soldiers or direct victims of wars like wounded civilians (e.g., Annan et al., 2011; Blattman and Annan, 2010; Cesur Sabia, and Tekin, 2013; Gade and Wenger, 2011; Lyk-Jensen et al., 2016). The findings from this literature consistently point to a negative effect of combat exposure on mental health among affected populations.

defined as bombing intensity allows us to explore a response–dose relationship, in which the impact of exposure to warfare on mental health may be progressively increasing in the severity of bombing. Finally, the wars occurred in Vietnam, Bosnia and Herzegovina, and Korea are relatively recent incidents compared to WWII. As a result, we are able to study potential effects that might persist into much later in life than could be examined by those more recent wars. In fact, the need to study the "long–term" consequences of exposure to war trauma has been acknowledged (Chrisman and Dougherty, 2014).

Aside from these contributions, our paper is closely related to two strands of literature. The first is the "fetal origins" literature in economics that relates early life pre– and post–natal environment and conditions to health and well–being in adult life. This research documents that early life exposure to conditions like malnutrition, extreme weather, disease, income shocks, maltreatment, and maternal stress has long–lasting effects on a variety of outcomes, including educational attainment, labor market productivity, and physical and mental health.[6] This paper adds to this literature by quantifying the long–term effect of exposure to warfare following conception and during early years of life on mental health in late adult years. Second, our paper also contributes to the accumulating literature on the immediate and long–term consequences of combat exposure on long–term outcomes. The studies in this literature show that exposure to warfare as a child has deleterious effects on later life outcomes including physical health, human capital, labor market productivity and earnings, risk–aversion, and trust and social engagement.[7]

Our research design pays careful attention to accounting for confounding factors as well as ensuring that our results are not simply an artefact of the pre–war or post–war cohort specific

[6]Examples include Almond and Mazumder (2011) for malnutrition, Almond (2006) and Bleakley (2007; 2010) for disease environment, Adhvaryu et al. (2016), Bozzoli and Quintana-Domeque (2014), Currie (2009), and Hoynes et al. (2016) for income, Currie and Tekin (2012) for maltreatment, and Persson and Rossin-Slater (2018) for maternal bereavement and stress. See Almond and Curie (2011) for an extended review.

[7]See Akbulut-Yuksel (2014; 2017), Akresh et al. (2012), Akresh et al. (2021), Conzo and Salustri (2019), Kim and Lee (2014), Mansour and Rees (2012), Kesternich et al. (2014), Minoiu and Shemyakina (2014), and Ramirez and Haas (2021) as examples. Kesternich et al. (2014), who examine the long–run effects of WWII on socioeconomic status and health of older individuals in thirteen European countries, consider the likelihood of depressive symptoms among other outcomes. Using data from the Survey of Health, Aging, and Retirement in Europe (SHARE), the authors show that living in a war country during the period of WWII is associated with a higher likelihood of expressing depressive symptoms at older ages. While we too focus on WWII in our analysis, our paper is different from Kesternich et al. (2014) in important dimensions, including data source, measurement of mental health, the research design. Importantly, mental health is only one of the many outcomes considered in Kesternich et al. (2014), and expressed as a dummy variable based on whether the respondent suffers from more than three depression symptoms in EURO-D scale. In contrast, we rely on a measure derived from the 12-item Center for the Epidemiological Studies of the Short Form (CED-D), a main scale used to measure depressive symptoms internationally. Furthermore, the empirical design in Kesternich et al. (2014) is based on comparing the outcomes between European countries which suffered destruction (Austria, Belgium, Czech Republic, France, Germany, Greece, Netherlands, and Poland) versus countries not affected by the war (Denmark, Switzerland, and Sweden). In contrast, we use within-country variation in the intensity of warfare in Germany across cohorts.

trends in long–term mental health. For example, our empirical analysis controls for city and year fixed effects, linear state trends, and the interaction of prewar city level indicators with linear trends. Furthermore, we perform several placebo experiments in which we demonstrate that the cohort–specific effects of the wartime exposure on long–term mental health are only significant for the cohorts who were five and younger at the time of the war, while there is no discernible effect for the older or younger birth cohorts.

We find that exposure to warfare within the very early years of life increases the likelihood of poor mental health much later in life. According to our analysis, a one-standard deviation (82.7 bombs per square kilometer) increase in bombing intensity results in approximately 10 percent decline in the long–term standardized mental health score of an individual who was younger than five years of age at the onset of WWII or born during the war, relative to someone else in the control cohort. This effect translates into a 16.8 percent rise in the likelihood of being clinically depressed. Our analysis also reveals that this impact is particularly strong among the youngest children and those who might be in-utero at some point during the war. Our examination into mechanisms suggests that measures capturing the extent of destruction in healthcare infrastructure and the loss in wealth during WWII exacerbate the negative impact of bombing exposure on long–term mental health, while the size of war relief funds transferred to municipalities following the war in 1948 has a mitigating impact. Our findings are robust to numerous empirical checks and specifications. For example, we test the robustness of our results to measurement and sampling errors, and changes in sample composition that could be associated with parental investment, selective wartime and long–term mortality and fertility. These results reveal that there is no meaningful variation in the long–term mortality rates and in the size of the wartime cohorts across cities with varying wartime intensity. Our results also indicate that the bombing intensity in a given city fails to predict a battery of parental characteristics including mother's age at birth, parental education, father's occupation, or whether the child's father died during the WWII. Overall, our paper highlights the importance of prioritizing children and adopting a long–term approach in public health planning and response in alleviating the psychological wounds of exposure to armed conflict.

The remainder of the paper is organized as follows. Section II provides a brief background of AAF bombing of German cities over the course of WWII. Section III discusses the historical city–

level bombing data and individual–level survey data used in the analysis. Section IV describes the identification strategy and estimation framework. Section V presents the main results, extensions, and robustness checks. Section VI concludes the paper.

2 Background on Allied Bombing of German Cities during WWII

> The Navy can lose us the war, but only the Air Force can win it. Therefore, our supreme effort must be to gain overwhelming mastery of the Air. The Fighters are our salvation, but the bombers alone provide the means of victory. (Churchill, 1940)

As Churchill indicated in the quote above, the Bomber Command's area offensive was the only offensive action in Germany between June 1940 and June 1944 (Werrell, 1986), supporting and overseeing all the different branches of the armed forces. In the Bomber Command's offensive area campaign during WWII, more than 1.25 million tons of mostly high explosive bombs were dropped over Germany (Davis, 2006). After February 1942, the majority of the AAF's air strikes were carried out at night using area bombing instead of precision bombing (Davis, 2006; USSBS, 1945). An area bombing strategy, also known as "carpet bombing" or "morale bombing", involved continuous night attacks to German cities without a particular target designed to defeat the enemy by demoralizing its citizens. During these aerial attacks, fire was typically ignited in the center of each city with the goal of eventually completely destroying it.

Area bombing was initially premised on the inability to accurately configure the Norden Bombsight in European weather. As summarized in Gladwell (2021, p.104), during World War II, the AAF's leading bombing technology was the Norden Bombsight, which required a clear sighting of the target to achieve precision.[8] However, with frequent cloud cover and overcasts over Germany, this process proved to be a difficult task. A report from Bomber Command admitted that even in the best weather conditions, 50 percent of inexperienced crews would miss the target (Gladwell, 2021). The seasons in Germany also conspired against Bomber Command. Summer, with the clearest weather, also brought shorter nights, which limited how far missions could penetrate deep into Germany at night, while long winter nights hampered operations due to cold weather and

[8] For the precision bombing with Norden Bombsight, once the target is located, information including wind direction, airspeed, temperature, the curvature of the earth had to added to the Bombsight.

overcast skies. Another major challenge in carrying out precision bombing was the advanced early warning system in the German aircraft, which enabled them to detect the approaching attacks by the short range of the RAF's Spitfire V aircraft.[9] Consequently, striking the city centers using the navigation aids was easier and more technologically manageable, compared with the small targets aimed with precision bombings against the risk of being hit by the German aircraft.

Due to the massive bombing campaign, the German cities were repeatedly attacked by the Allied Air Forces over the course of the war and experienced significant disruptions in daily life, exacerbated by the uncertainty of the aerial attacks and the destruction of homes, schools, hospitals, and other public spaces.[10] However, the intensity of the bombing varied significantly across cities, as shown in Figure 1. In fact, as the figure illustrates, the targeted cities were not necessarily chosen for their significance for the war effort, but rather for their visibility from the air, determined by weather conditions or the visibility of noteworthy landmarks such as cathedrals (Friedrich, 2002). Furthermore, the distance to the RAF's air bases in Mildenhall, UK, which were also used later in the war by American aircraft, significantly contributed to the bombing intensity in a given town. Thus, the bombing was concentrated in northern and western Germany – areas that were more easily accessible from the AAF bases in the UK. Taken together, given these historical accounts, it appears that the intensity of bombing in German cities was affected by both time-invariant characteristics of those cities such as size, proximity to the British air bases, and existence of easily identifiable landmarks and random factors such as weather conditions and visible landmarks. Therefore, it is plausible to assume that the cross–city variation in the intensity of WWII bombing is essentially exogenous after controlling for fixed city–specific characteristics.

3 Data and Descriptive Statistics

Our analyses are performed using the individual and household data from the German Socio–Economic Panel (GSOEP). As a representative survey of West Germans residing in private households, GSOEP provides detailed information on individual and household characteristics, including

[9]This early warning technology enabled the German aircraft to climb to higher altitudes than the AAF aircraft, and they were able to engage their bombardiers from above, taking them out of the sun (Davis, 2006).

[10]This extensive bombing campaign, for instance, led to the destruction of 91 percent of Wurzburg's built-up residential area; in Cologne, it was 90 percent; in Hamburg and Wuppertal, it was 75 percent (Diefendorf, 1993; Gladwell, 2021).

parental characteristics, childhood environments, and whether an individual lost their father or mother during the war years. Furthermore, the survey includes information on the city of residence since 1985, which allows us to assign the wartime exposure of the affected individual at a finer granularity.[11] We focus on individuals born between 1923 and 1960 in our analysis and consider those who resided in West Germany at the start of the GSOEP data in 1985.[12] This is necessitated by the fact that we have the postwar city-level data for the West Germany only. Furthermore, the residents of the former East Germany were subjected to a substantially different political regime until the reunification of Germany. As a result, their mental health trajectory might have been significantly different than those of West Germany residents. Excluding residents of the former East Germany also helps with the homogeneity of our analysis sample.

The GSOEP measures physical and mental health quality with a generic health–related quality–of–life instrument with 12–Item Short Form Survey (SF–12V2), derived from the 36–Item Short Form (SF–36) Survey Instrument. [13] These health measures have been demonstrated to be reliable and valid in clinical and population–based applications across countries (Vilagut et al., 2013; Ware et al., 1996). The GSOEP reports the mental health measures bi–annually since 2002; therefore, we use 2002–2010 waves of GSOEP in our analysis. Our sample includes individuals whose interviews are flagged as complete and valid, meaning that the respondent completed all twelve questions required to calculate the SF–12 scale. The mental health dimension of the instrument comprised of the four items — emotional problems, vitality, social functioning, and mental health— of the Mental Health Inventory, which has been validated in tests of sensitivity and specificity relative to other screening tools for depression and other mental disorders (Ware et al., 1995). Our main variable of interest for mental health is denoted by the Mental Component Summary (MCS) and is an index ranging between 0 and 100 with the higher score indicating less dysfunction or impairment. MCS is calculated from four subscales mentioned above using explorative factor

[11] We acknowledge that the affected cohorts might have moved over time. However, it appears like a large proportion of movers resettle in a different town within the same city, rendering their exposure to the bombing unchanged (Hochstadt, 2011). Regardless, our difference-in-differences analysis yields lower bound estimates as a result of possible location misalignment caused by those who moved to other cities. Results where individuals no longer residing in their childhood town were excluded are available upon request. Furthermore, our results remain virtually unchanged when we drop city states, including as Berlin, Bremen and Hamburg where individuals are more likely to move.

[12] The cohorts born before 1923 were dropped from the main analyses due to the likelihood of selective mortality and small sample size.

[13] The SF–36 is a widely used, well-researched, and validated measure of physical and mental health, based on a set of generic, coherent, and easily administered questions.

analysis. To facilitate the interpretation of coefficients in our analysis, we normalize the MCS scores by subtracting the mean and dividing by the standard deviation.

We further supplement our main analysis by exploring different threshold levels of MCS used to diagnose mental illness. More specifically, individuals with a MCS score lower than 42 are classified as clinically depressed in the medical literature (Ware et al., 1995).[14] Incorporating these insights, we generate a binary indicator for clinical depression, which takes on the value of 1 if an individual has a MCS score of below 42, and zero otherwise. The health measurement model of SF-36 and SF-12 surveys along with the specific questions including in these instruments are described in Appendix.

We focus on the impact of the Allied Forces aerial attacks at the level of the smallest geographical unit publicly provided in GSOEP, called the Raumordnungsregionen (RORs or cities for short). RORs are similar to the metropolitan statistical areas (MSAs) in the United States. Unlike MSAs, however, RORs include both urban and rural areas, thereby providing complete coverage of Germany regardless of urban density. Germany is divided into 75 RORs as shown in Figure 1. Similar to Miguel and Roland (2011), our measure of bombing intensity is defined as the total number of bombs dropped per square kilometer in each city during the WWII. Data on the Allied aerial attacks are obtained from Davis (2006), who provides a full account of the European Campaign of the Allied Air Forces during the WWII. Data documented in Davis (2006) were compiled from the Bomber Command night raid reports, weekly operations and intelligence reports as well as the Air Ministry War Room monthly operations summaries on night and daylight raids. The data cover all Allied aerial attacks to Germany and other European countries, and include the exact date of each attack, the targeted city and the type of the target within the city, the total number of bombs dropped, the type of the bombs dropped (i.e., high explosives, incendiary bombs, fragmentation bombs), visibility conditions during the attack, and the number of airplanes involved in each aerial attack. Davis (2006) documents that the Allied Air Forces collectively dropped 1,250,804 tons of bombs over Germany during the WWII campaign with the majority of these bombs being high

[14] The literature suggests that threshold level for clinical depression might vary by age, gender and country of origin. For example, Vilagut et al. (2013) find that while MCS-36 cutoff point of 42 is applicable to US norms, MCS-12 cutoff point of 45.6 is more valid in Europe. Furthermore, Yu et al. (2015) suggest that the optimal cutoff values of MCS for Eastern populations are higher (i.e., 48–50) than those reported for Western populations (i.e., 42–45). We tested the sensitivity of our results to slightly different cut-off points in the literature and our results remained very similar.

explosive bombs. As proposed in Davis (2006, p.15), we aggregate the total number of bombs dropped in each city during the WWII to improve the accuracy of the data and use the aggregated figure as a measure of the intensity of WWII bombing exposure in a given city. We then normalize the total number of bombs dropped by the area of the given city, measured in kilometer square.

We also use information from various years of the German Municipalities Statistical Yearbooks to compile the municipality level historical data in an effort to obtain a picture of the prewar conditions as well as the conditions in the immediate aftermath of WWII. The richness of this historical data set allows us provide insights into the mediators explaining the estimated long–term mental health effects of the warfare. More specifically, we collected municipality level data on the prewar characteristics including population, city area in 1939, per capita income in 1937, and the number of mental health and children hospitals in 1938 from the 1939 German Municipalities Statistical Yearbook. Moreover, we also gathered measures capturing changes in a number of municipality characteristics that occurred during the war, including the percent per capita loss of wealth over the course of WWII measured as the change in the savings kept in bank accounts, the destruction of hospitals measured as the percent change in the number of hospitals between 1937 and 1948, the loss of healthcare personnel defined as the percent of nurses and midwives killed or displaced in WWII, change in the infant mortality rate between 1946 and 1938 and the percent of out-of-wedlock pregnancies during the war. Finally, we have several post-war characteristics compiled from the first post-war German Municipalities Statistical Yearbook published in 1949. These include the number of child patients in 1948 and a variable representing the size of per capita war relief fund released in 1948. All these measures are aggregated at the municipality–level, using the 1985 RORs reported in the GSOEP data and merged with the individual level data provided in the GSOEP using these ROR boundaries.

In Table 1, we present descriptive statistics on city characteristics for the full sample in column 1, and separately for cities with above and below average exposure of bombing intensity during WWII in columns 2 and 3, respectively. Column 1 shows that on average 24,884 tons of bombs were dropped on German soil during the WWII campaign, which corresponds to about 114 tons of bombs per square kilometer. This immense bombing campaign led to the destruction of 37 percent of the housing stock by the end of the war. Furthermore, the data also show a significant degree of variation in bombing intensity across cities, where the bombs per square kilometer ranges from 176 tons among the most stricken cities summarized in column (2) to 63 tons among less affected cities in column (3). The summary statistics presented in Table 1 also underscore the importance of accounting for the fixed city characteristics in our estimations, because prewar population density and income per capita are larger in areas more severely hit during the AAF aerial attacks. The results of a simple cross–city analysis exploring the WWII bombing intensity across cities could yield lower bound estimates of childhood exposure to war if pre–war city–level incomes and population are associated with long–term mental health. We therefore instead exploit city–by–cohort variation in exposure to aerial attacks during WWII to credibly isolate the true long–term mental health effects of the WWII among the exposed cohorts. We note, however, that ex ante the differences in city characteristics might also lead to the differential trends in mental health in the future. We test whether our results are sensitive to the inclusion of the various trends through placebo experiments as well as the inclusion of state–specific trends and the interaction terms between year of birth dummies and the pre–war city characteristics in our analysis. These exercises do not yield any evidence of differential pre–war or post–war cohort–specific trends across cities.

Table 2 summarizes the characteristics of individuals and households from the GSOEP. As illustrated in the table, around 20 percent of the sample exhibit symptoms of clinical depression according to our measure. Similarly, Table 2 depicts that on average individuals in our sample have about 11.4 years of schooling, and over 80 percent of the sample have mothers and/or fathers with a basic education. Furthermore, the average age for the sample in 2002 is 59 (i.e., the first wave of the GSOEP where mental health indicators were available). About 53 percent of the sample is female, and 43 percent of the respondents live in rural areas.

4 Empirical Framework and Identification Strategy

Our approach to estimating the long–term mental health effect of childhood exposure to warfare is to use a generalized difference–in–differences strategy following Duflo (2001) and Hoynes at al.

(2016).[15] Specifically, we exploit plausibly exogenous city–by–cohort variation in the intensity of early childhood exposure to warfare, where the treatment variable is defined as an interaction between the bombing intensity per square kilometer in a given city and an indicator for being between zero and five years of age during the WWII.[16] This strategy can be formalized by the following empirical equation:

$$Y_{irt} = \alpha + \beta(Bombing_r x WarCohort_{it}) + \delta_r + \theta_t + \sigma_{st} + \omega' X_{irt} + \epsilon_{irt}, \quad (1)$$

where Y_{irt} denotes mental health outcome for individual i, in city r, born in year t. These variables include mental component summary (MCS), its sub-components and clinical depression indicator. $Bombing_r$ denotes the intensity of the aerial attacks in each city r measured by the total number of bombs per square kilometer. $WarCohort_{it}$ is a dummy variable that takes on the value of 1 if individual i was born between 1934 and 1945, and zero otherwise. Note that individuals born between 1934 and 1945 were five or younger at the onset of and during the WWII; therefore they constitute our treatment group. These individuals were between ages 57 and 76 at the time their mental health was assessed. On the other hand, individuals who were older than 5 years of age at the onset of WWII (i.e., the 1923–1933 cohorts) and individuals who were born after the war ended (i.e., the 1950 and 1960 cohorts) form the control group.[17] In equation (1), δ_r represents city-specific fixed effects, accounting for time-invariant differences across cities including pre-war city characteristics; θ_t is the year of birth fixed effects, controlling for the likely secular changes in mental health across cohorts.[18] We further control for several individual and household characteristics in the vector X_{irt}, including indicators for gender and rural residence, years of schooling, parental education, father's occupation, and mother's age at birth. Lastly, we include the linear-state trends in our estimations with σ_{st} to flexibly account for the post-war state specific policies.[19] The error

[15] Recent research has demonstrated that the application of the standard difference–in–differences estimator can produce biased results in the presence of heterogeneous treatment effects (e.g., Goodman–Bacon, 2021; de Chaisemartin and d'Haultfoeuille, 2020). However, this problem does not apply in our context since the timing of treatment does not vary over time.

[16] We note that our generalized difference–in–differences strategy explores within city across cohort variation in exposure to wartime bombing; thereby, it is possible that our point estimates are lower bounds for the aggregate nation-wide effects of WWII exposure on German children's mental health as adults.

[17] We dropped the cohorts born immediately after the war (i.e., the 1946-1949 cohort) from the analysis since they were exposed to the post reconstruction and potential immediate spillover effects of the war. Nonetheless, our results are robust, both in magnitude and statistical significance, to the inclusion of these cohorts to the control group. These results are shown in Appendix Table A1.

[18] Since we use a single cross section, θ_t accounts not only for year of birth, but also for age effects.

[19] We present estimates with and without linear state-trends to demonstrate that our results are robust to different model specifications. We also note that healthcare services are funded and administered by state governments. Therefore, controlling for state-level trends would help account for any state-specific factors in the post-war period that might be correlated with mental health, such as

term, denoted by ϵ_{irt}, is assumed to be possibly correlated across individuals within the same city, and therefore the standard errors are clustered at the city level.

The validity of the difference–in–differences estimate hinges on the parallel trend assumption, which postulates that, had WWII not occurred, the difference in mental health outcomes between the affected and control cohorts would have been the same across cities with varying intensity of bombing. We test this assumption by estimating an event–study version of equation (1), in which we trace out cohort–specific impacts of the aerial attacks on long–term mental health outcomes as follows:

$$Y_{irt} = \alpha + \sigma_{c=1}^{5} Bombing_r x Cohort_{ic} \beta_{1c} + \delta_r + \theta_t + \omega' X_{irt} + \epsilon_{irt}. \quad (2)$$

In equation (2), $Cohort_{ic}$ is a dummy variable that indicates whether individual i was born in cohort c (a cohort dummy). Birth cohorts are divided into five–year groups beginning in 1924 to improve statistical precision. Individuals born between 1956 and 1960 constitute the control group, and this cohort dummy is omitted from the regression. Each coefficient β_{1c} in Equation (2) can be interpreted as the cohort–specific estimate of the warfare on the long–term mental health for a given cohort c compared to the omitted cohort. This exercise aims to demonstrate that there are no systematic trends in mental health across cohorts and cities with different war intensity, except for the cohorts who were five years of age and younger at the onset of WWII and those who were born during the war. This exercise also would inform us on the potential spillover effects of the WWII on long–term mental health.

Table 3 presents the results from the estimation of equation (2), which enables us to trace out cohort-specific effects of the bombing intensity. Each coefficient in the table represents the impact of bombing intensity on a a different birth cohort relative the control group, i.e., individuals born between 1956 and 1960. As shown in the table, the estimates for the birth cohorts born between 1946 and 1955 are all statistically and economically indistinguishable from zero. Note that these cohorts were all born after the war had ended. Therefore, it is no surprise that the bombardment occurred during the WWII has no influence on the mental health of these cohorts any differently than the omitted cohort, also born in the post–war period. Table 3 also illustrates that the

healthcare expenditures and reconstruction efforts of healthcare infrastructure.

estimates for birth cohorts born between 1924 and 1933, who were ages 6–20 at the onset of the WWII are insignificant. Interestingly, war destruction caused by the bombing of cities had no differential effect on the long–term mental health of these earlier cohorts relative to the omitted cohort. According to these estimates, it is really the exposure to war trauma during the intrauterine period or within the first five years of life that is linked to poor mental health experienced in the very long–term in life. These null effects in the pre– and post–war birth cohorts presented in Table 3 also indicate that our results are not confounded by pre– and post–war city–specific trends. Taken together, the results in Table 3 support our identifying assumption and suggest that the estimates from equation (1) would not be confounded by pre- and post-war city specific cohort trends in mental health.

We perform a battery of balancing tests to gain further confidence in our identification strategy. As shown in Table 4, the intensity of the aerial bombing attacks experienced by our treatment cohort is not correlated with a set of parental characteristics, including the mother's age at birth, parental education, father working at a blue collar occupation, or whether the child's father died during the WWII. It is comforting that the bombing intensity in a given city is not statistically associated with an array of parental characteristics providing supporting evidence on the validity of the difference-in-differences estimates.

Next, we test whether our results are confounded by pre-war characteristics that might be correlated with long–term mental health. Specifically, it is possible that the differences in city level characteristics prior to the beginning of the war might have influenced the mental health trajectory of the impact of bombing intensity exposed by children ages 0-5 at the onset of the war. To test this, we explored the relationship between our mental health outcomes and city level pre-war characteristics including the number of children and mental health hospitals in 1938, the population and city area in kilometer squares in 1939, and income per capita in 1937. Note that these variables are presumed to be exogenous to bombing intensity, As shown in Appendix Table A2, the estimates from this analysis are small in magnitude and none are statistically significant. These results are consistent with the notion that our analysis of the impact of bombing intensity exposed by the war cohort is unlikely to capture some unobserved differences across cities after controlling for city fixed effects.

Finally, as summarized in Appendix Table A3, we test whether differential mortality or fertility is of concern for our analysis. In column (1), we first investigate whether the affected cohorts experienced a higher rate of mortality relative to the other cohorts in a way correlated with the bombing intensity.[20] The estimate reported in the table reveals no such evidence, suggesting that exposure to different intensities of bombardment within five years of life did not cause differential mortality later in life in a way to lead to changes in sample composition at the time mental health of affected cohort is assessed in GSOEP 2002-2010. Consistent with this finding, the estimate in column 2 indicates that the size of the affected cohort calculated in 1985 is not affected by bombing intensity relative to other cohorts.

5 Results

Table 5 presents our baseline estimates of the impact of early life exposure to warfare on mental health in adulthood obtained from the estimation of equation (1). The estimates for the standardized mental component scale (MCS) are shown in column 1 and the estimates for the binary indicator for meeting a diagnosis for clinical depression are presented in column 2. All the regressions control for years of schooling, gender, an indicator for living in a rural area, city fixed effects, year of birth fixed effects, and survey year fixed effects. The parameter on interaction term, $BombingxWarCohort$, represents the difference–in–differences estimate, which reveals the long–term mental health impact of bombing intensity experienced by those born between 1934 and 1945 above and beyond any impact experienced by those in the control cohort, i.e., individuals who were older than five years of age at the onset of WWII or those born after the war had ended.[21] The estimate on column 1 of Table 5 indicates that a one–standard deviation increase (82.7 bombs per square kilometer) in bombing intensity results in approximately 10 percent ($82.7 * 0.0012$) decline in the long–term standardized mental health score of an individual who was younger than five years of age at the onset of the WWII or born during the war, relative to someone else in the control cohort. According to the estimate in column 2, this effect translates into a 3.4 percentage

[20] The mortality of the affected cohorts over the period 1984-2017 is measured using the panel structure of GSOEP. This variable refers to a dummy variable, which takes the value of 1 if an individual died between 1984 and 2017, and 0 otherwise. Note that we multiplied the variable by 100 to ease the interpretation of the point estimate.

[21] We also estimated our models redefining the control group to include only those who were born after the war had ended. As we show later in the paper, these results are similar to our main estimates.

point increase in the likelihood of meeting a diagnosis of clinical depression. Calculated at the mean, this is equivalent to a 16.8 percent rise in the likelihood of being clinically depressed. These results provide clear evidence to indicate that increased exposure to bombing intensity as a young child during WWII has a negative mental health effect that manifests itself later in life when an individual is between ages 57 and 76.[22]

The results shown in Table 5 are based on a continuous measure of bombardment intensity defined as the total number of bombs dropped per square kilometer in each city over the course of the WWII. This measure is used to reveal a response–dose relationship, assuming that the marginal effect of bombing intensity on long–term mental health is constant across its distribution. However, it is plausible that this relationship follows a nonlinear pattern, for example, with effects getting stronger as one moves upward along the distribution of bombing intensity. To test this possibility, we estimate our empirical model specified in equation (1) using a dichotomized measure of bombing intensity. Specifically, we created binary indicators, corresponding to cities that fall into the top 10 percent, 20 percent, and 25 percent of the bombing intensity distribution. The results shown in Table 6 confirm that the negative impact of aerial attacks carried out by AAF had the most damaging effects on mental health among children in cities that had been most intensely bombed. For example, children who lived in cities in the top 10 percent of the distribution of bombing intensity (approximately 326.7 tons of bombs per square kilometer on average) during the WWII experience a 40 percent decline in their mental health score in their adult and elderly years in life compared to children who lived in other cities during WWII. As expected, the effect size decreases monotonically as we redefine the binary bombing indicator at the 20^{th} and 25^{th} percentile of the distribution. A similar pattern emerges when we consider the binary outcome signifying the presence of clinical depression. According to the point estimates displayed in the last three columns, children who lived in cities that fell into the top 10, 20, and 25 percent of the bombing intensity distribution had a 10.3, 8.5, and 6.1 percentage point higher likelihood of meeting a diagnosis of clinical depression later in their lives.

In Table 7, we present results from a heterogeneity analysis in which we explore whether the

[22] We also estimated equation (1) with a more comprehensive set of control variables, which includes indicators of maternal and paternal education, the occupation of father and mother's age at birth, linear state trends and the interaction of prewar city characteristics with linear trends. The results presented in Appendix Table A4 are very similar to those presented in Table 5.

level of bombing intensity exposed by our treatment cohort varies by several characteristics. As shown in columns 2 and 3, both male and female children who lived in more intensely bombed cities experience a higher likelihood of poor mental health later in life of similar magnitude, compared to children in less severely bombed cities. When we restrict the analysis to children who had lived in urban areas, our difference–in–differences estimate is again statistically significant pointing to an increased likelihood of poor mental health in later stages of life associated with an increased intensity of bombing exposure. Columns 5–7 of Table 7 present the estimates obtained from samples comprised of children of mothers and fathers with less than a high–school degree and fathers with blue collar occupations, respectively. Again, these estimates are statistically indistinguishable from our baseline estimates obtained from analysis of the full sample of children. To the extent that parental education and father's occupation is a proxy for economic status, this finding suggests that the risk of developing poor mental health associated with exposure to intense bombing is independent of access to economic resources. In the last column of Table 7, we present the estimates from a subsample of 776 children whose father had died during WWII. The results indicate that these children are substantially more likely to have poor mental health later in their lives. According to the point estimates, a one–standard deviation increase in bombing intensity results in approximately 66 percent decrease in the long–term standardized mental health score of an individual in the treatment cohort, relative to a person in the control cohort. The estimate in the bottom panel suggests that these children are also 26 percentage points more likely to meet the criteria for a clinical diagnosis of depression later in life.[23]

There are likely both direct (e.g., physical and psychological trauma, displacement) and indirect mechanisms (inadequate and unsafe living conditions, environmental hazards, caregiver mental health, separation from family, displacement–related health risks, and the destruction of health, public health, education, and economic infrastructure) through which our measure of war exposure, i.e., bombing intensity, might influence long–term mental health. Destruction of physical health infrastructure, death and displacement of healthcare personnel, and loss in economic welfare may compromise access to basic necessities, such as food, health care, and education, increasing the severity and chronicity of the trauma that children endure. Consequently, even

[23] Note that none of the children in the post-war control cohorts had a father could have died during the war. Accordingly, the control group in the analysis with the sub-group of children whose father died during the war is limited to cohorts born before the war.

short–lived experiences of war can have harmful effects on mental health across the life course and through adulthood. Next, we examine the sensitivity of our baseline estimates to several potential mediator factors that might partially account for the relationship between war exposure during childhood and long–term mental health. These factors include variables representing the damage to healthcare infrastructure, the loss of the healthcare personnel due to warfare and displacement, the capacity burden of the healthcare system, loss in wealth, and the size of relief funds transferred to municipalities following the war in 1948.

Table 8 presents the results of this mediator analysis. Specifically, we present estimates for the top third most intensely bombed cities and the rest of the sample in separate columns for each of the mental health outcome measures.[24] As shown in the table, the impact of bombing intensity is stronger among cities that suffered the most damage to their healthcare infrastructure captured by the destruction of hospitals. Similarly, variables that likely proxy the capacity burden of the healthcare system (i.e., the number of child patients and the increase in infant-mortality) imply that the long–term mental health effect of bombing intensity is worse in cities with a more severely overburdened healthcare capacity when the war had ended. The last two columns reveal the potential role of economic wealth in mediating the relationship between bombing intensity and long–term mental health. Specifically, a steeper decline in the amount of funds in savings accounts in banks is associated with a stronger negative impact of bombing intensity on the long–term mental health among the treatment cohort. Finally, the last column shows that the size of the per capita relief payment provided to cities in 1948 had a mitigating effect on the negative effect of bombing intensity on the long–term mental health of affected cohorts.

Next, we further explore the extent to which our results are explained by some of the more tangible consequences of war, such as the physical destruction of healthcare infrastructure and loss of healthcare personnel or the invisible wounds of war such as loss of a parent, psychological trauma, disrupted relationships, and damaged social support also play a role. One way to test this is to assess the sensitivity of our treatment coefficient to controlling for a direct measure of physical destruction caused by the war. To investigate this possibility, we supplement our analysis with a measure of wartime physical destruction defined as the aggregate rubble in cubic meters per

[24] In principle, this analysis could be performed by including triple interaction terms among bombing intensity, treatment cohort indicator, and each of these mediating variables. Instead, we adopt a split sample approach for ease of interpretation.

capita.[25] As shown in Table 9, our difference–in–differences estimates are remarkably robust to controlling for this variable. Moreover, the physical destruction measure is statistically insignificant for both outcome measures. This finding lends further support to the notion that the damage to the long–term mental health caused by war exposure has its origins triggered by bombing intensity not necessarily captured by physical destruction. Unfortunately, we do not have direct measures of psychological trauma in our data. However, we do have a measure on whether the mother or the father died during the war. To test the role of a loss of a parent during WWII in explaining our results, we estimate our regressions controlling for this variable. The estimate on the interaction of bombing intensity and war cohort remained robust to this exercise. In particular, the estimate on the standardized MCS measure is -0.001 and the clinical depression indicator is 0.032, both of which are very close to our main estimates from Table 5. The finding implies that the long–term mental health effect of bombing intensity is independent of whether a parent had died during the war. Therefore, the relationship is unlikely to be explained by a single factor, but rather it is likely the manifestation of psychological trauma that originates from the accumulation of a multifaceted set of factors.

Our treatment cohort is composed of people who were born between 1934 and 1945 and therefore between ages 0-5 at the beginning of WWII or were born during the war. While all of these individuals were exposed to war within the first five years of life, the duration of exposure varies across individuals based on their year of birth. For example, someone who was born in 1939 had a full five years of exposure to war, while another person born in 1944 would only have had only one year of exposure. It is possible that the cumulative psychological trauma caused by war might increase by the duration of exposure to bombing intensity. To test this possibility, we replaced our binary war cohort indicator by a variable defined as the number of years of an individual lived through WWII bombing. As shown in Table 10, a longer exposure to bombing intensity is associated with worse mental health in the long–term. For example, the estimate in the first column indicates that one standard deviation increase in the bombing intensity would result in a 3 percent (82.7 x 0.0003) decrease in mental health during adulthood among those with one year of exposure, while the effect would increase to 15 percent for those with five years of exposure.

[25] Note that Akbulut–Yuksel (2014) and (2017) show that physical destruction had detrimental effects on the human capital formation, health, and labor market outcomes of Germans who were exposed to war in-utero or early in life.

The estimates in the second column reveal a similar story. Specifically, a one–standard deviation increase in bombing intensity translates into an approximately one percentage point increase in the likelihood of suffering from clinical depression in adulthood if the exposure is one year, but this effect increases to five percentage points if the duration of exposure is five years.

A related question is whether our results differ between individuals who were born prior to the war period versus those who were conceived during the war. Those who were born during WWII would have been exposed to war in both intrauterine and extrauterine periods, while the group born earlier would have lived through the war only during the extrauterine period. Prior research indicates that shocks experienced in the fetal period can have life–long consequences for adult health, including mental health (Almond and Currie, 2011; Barker, 1990; Schlotz and Phillips, 2009). One of the motivating factors for this line of inquiry is the concept of fetal programming, which states that insults experienced during sensitive periods of fetal development may have long–lasting effects on the changes in the structure and functioning of organs, which then leads to poor psychical and psychological health later in life. Relatedly, there is an emerging body of evidence linking fetal growth with behavioral and mental health outcomes later in life. Given this literature, a discrepancy in our results between the cohort who were in utero when WWII started and those who were born after the onset of the war may serve as evidence in favor or against the fetal origins hypothesis linking fetal shocks to long–term mental illness. To explore this question, we split our treatment variable into two separate cohorts for those born between 1939–45 and those born between 1934–38. The former cohort includes individuals who were, at a maximum, five years of age when they had been exposed to bombardment. Moreover, these individuals were definitely in utero at the time of the war. In contrast, the latter group is comprised of individuals who were born prior to the onset of the war and were older than age 5 when the war had begun. As shown in Table 11, our results are exclusively driven by the younger cohort, whose in-utero period overlapped with WWII and who were at most five years of age during the war. Interestingly, the impact of bombing intensity on the older cohort, who was between ages 6-10 years of age at the onset of the war, appeared to have been no different than those of the control cohort. This result indicates that disruption to the fetal growth might have indeed played a primary role in the increased risk of mental health problems experienced by this group later in life. This finding is consistent with

Persson and Rossin-Slater (2018), who show that a highly stressful event experienced in utero entails a more harmful effect on mental health than an event experienced shortly after birth and that the adverse mental health impacts of exposure to stress in utero are larger when the stress is more severe.[26]

The results in Table 11 suggest that older children are not any differentially affected than those in the control cohort. Note that our control cohort includes two groups of individuals. First group includes those born between 1923 and 1933. These individuals were older than age 5 at the beginning of the war. The second group includes individuals born between 1950 and 1960 and therefore had no war exposure. We test whether these two groups differ between each other with respect to city level bombing intensity. The results shown in Appendix Table A5 reveals no such evidence. The difference-in-differences estimates are indistinguishable from zero both economically and statistically. This finding is consistent with the pattern obtained in Table 11. The treatment does not have any differentiable impact between individuals who were exposed to WWII bombardment as older children versus those who were born after the war had ended. Taken together, the evidence shown in Table 11 and Appendix Table A5 lend further support to the notion that it is really the in-utero exposure or exposure within the first five years of life that matters with respect to any long–term mental health effect caused by bombing intensity.

As discussed in the Appendix, our MCS index is composed of four subscales including *Vitality*, *Social Functioning*, *Role Emotional*, and *Mental Health*. The questions used to represent these subscales are described in Figure A1. Next, we estimate our equation (1) separately for each of these four components to get a sense of which of them drive our results. As shown in Appendix Table A6, the estimates on the interaction term between bombing intensity and war cohort are negative for all of the four components. However, they are estimated with statistical significance only for the individual components of *Mental Health* and *Social Functioning*. A closer look at the questions used to form these components reveals that these two are also the survey instruments, which are most closely related to mental well-being. Specifically, the *Mental Health* component is comprised of the following two questions: "During the past four weeks have you felt calm and

[26] This finding is consistent with the analysis by van den Broek and Fleischmann (2019), who find that in the cities affected by famine caused by the Dutch Hunger Winter (1944-45), mental health was significantly better for the pre-famine and post-famine cohorts compared to the cohort born during the famine. Similarly, Huang et al. (2013) show that pre- and post-natal exposure to the Great Chinese famine (1959-1961) has increased the risk of mental illness for women, while for men they do not find such effects.

peaceful?" and "During the past four weeks did you have a lot of energy?"; and *Social Functioning* is created by the question: "During the past four weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc)?".[27] We interpret the results in Appendix Table A6 as further support for the notion that long–term mental health effects of bombing intensity are manifested by individual responses that reflect mental well-being most closely.

6 Conclusion

Incidences of armed conflict and warfare constitute a global health problem of the highest order with massive direct and indirect consequences on mortality and morbidity. Recently, there has been a surge in the scale and scope of armed conflicts. Running parallel to this development is the rise in the number of children living in territories or countries in armed-conflict or emerging from war. Accordingly, there have been concerns over the long–term psychological harm to children caused by trauma of war and armed conflicts. Although there is mounting evidence on the relationship between early-life risk factors such as exposure to war trauma and mental health and well-being, questions about causality still remain (Angelini et al., 2021). Furthermore, investigations considering a long–term perspective that extends into the late stages of life are relatively rare, possibly due to the paucity of data sources. This paper examines the long–term mental health consequences of war exposure during early childhood, using the arguably exogenous variation in the intensity of bombardment suffered by the German cities during WWII. Our results demonstrate that children bear the invisible wounds of wars that continue to adversely affect their mental health well into late adulthood. Specifically, we document that increased bombing intensity experienced as a young child during WWII had a significant negative impact on mental health in later stages of life when these individuals are in their 50s to 70s. Our analysis shows that early years in life, particularly the first five years in life including the intrauterine period, are especially important in terms of vulnerability to long–term mental health consequences of war. Our investigation into mechanisms indicate that measures capturing the extent of physical destruction in healthcare infrastructure,

[27] The questions used to construct other two components have to do with energy level and work/accomplishments. See questions 6 and 7 for *Role Emotional* and question 10 for *Vitality*.

the rise in the capacity burden of the healthcare system, and wealth loss during WWII exacerbate the negative impact of bombing exposure on long–term mental health, while the size of war relief funds transferred to municipalities following the war has a mitigating impact. With the mental health impact of childhood exposure to warfare persisting well into the late stages of life, the global burden of mental illness may be aggravated for many years to come.

The results in this paper suggest that it is likely the youngest children who appear to be most vulnerable to poor mental health in the long–run. Extensive research shows that the periods of infancy and early childhood are a critical period for interventions to prevent poor outcomes in the future (Currie and Rossin-Slater, 2015; Garcia et al., 2020; Heckman and Masterov, 2007). There are well-established early intervention strategies targeted at young children that have been demonstrated to ameliorate the effect of traumatic experiences that are antecedents of later mental health problems (Izett et al., 2021; Davis et al., 2010). More recently, the mental health concerns associated with war exposure have been renewed with the developments in Ukraine where millions of Ukrainian children have been suffering months of bombing and shelling by the Russian military forces. The findings in this paper underscore the importance of scaling up services to children by governments and international organizations such as UNICEF. The benefits of these interventions are likely to be substantial because the mental health effects of early–life conditions manifest at young ages and persist throughout the life course, which implies that their costs must be exacerbated with longevity (Angelini et al., 2021). In addition to the importance of prioritizing children, our results imply that a long–term horizon in public health planning and response, including the decades during which populations recover from armed conflicts, are critical to mitigating the adverse mental health consequences of exposure to armed conflict.

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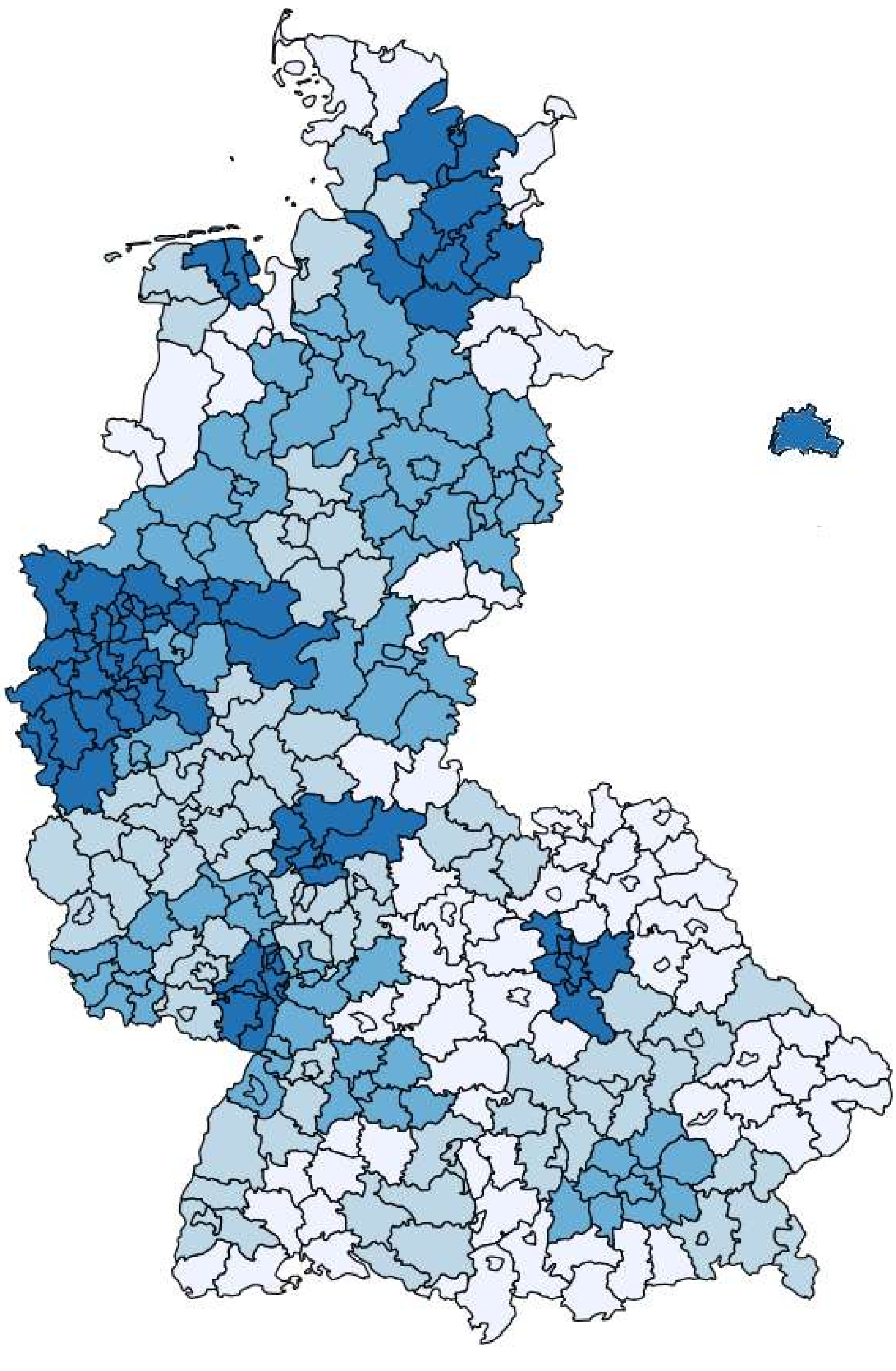
Figure 1: WWII Bombing Intensity Across Raumordnungsregionen (RORs) in West Germany



Notes: Map shows the bombing intensity across 75 Raumordnungsregionen (RORs) in West Germany and Berlin. More detailed borders are associated with the districts (*kreise*) within each ROR.

Table 1: Descriptive Statistics: City Characteristics

	All Cities (1)	Cities with Above Average Bombs (2)	Cities with Below Average Bombs (3)
Total Bombs Dropped (Tons)	24884.440	30301.690	20393.610
	(22305.700)	(20075.500)	(23054.160)
Housing Units Destroyed (%)	36.856	40.000	34.251
	(19.237)	(13.598)	(22.553)
Number of Bombs per Area	114.224	176.422	62.663
	(82.610)	(81.842)	(32.616)
Area in 1938 (km^2)	24.921	21.520	27.740
	(23750.000)	(18052.310)	(27278.380)
Population Density in 1939	1,998	2,282	1,762
	(903,499)	(756,161)	(946,939)
Income per Capita in 1938 (RM)	463,375	481,424	444,957
	(105,685)	(103,564)	(104,659)
Out of Wedlock Children (%)	11.402	11.877	11.023
	(4.200)	(4.403)	(3.991)
Wealth Loss (%)	57.489	59.357	55.338
	(23.897)	(23.036)	(24.680)
War Relief Payment per capita	12,408	13,067	11,865
	(4,848)	(3,648)	(5,591)
Hospital Destruction (%)	34.240	30.236	37.925
	(57.308)	(52.691)	(61.028)
Loss of Healthcare Personnel (%)	0.460	21.029	-17.538
	(54.579)	(25.621)	(65.707)
Increase in Infant Mortality Rate	4.542	4.989	4.184
	(2.234)	(2.249)	(2.157)
Postwar Number of Children Patients	213.273	257.080	174.208
	(230.161)	(301.694)	(125.787)
Prewar Number of Children Hospitals	1.578	1.477	1.669
	(2.019)	(0.979)	(2.617)
Prewar Number of Mental Hospitals	1.339	0.620	2.011
	(2.712)	(0.638)	(3.592)
N	8770	3975	4795

Notes: The sample consists of 75 Regional Policy Regions (Raumordnungsregionen, ROR) in the former territory of West Germany. The sample was divided as above and below average bombing intensity. Standard deviations are in parentheses.

Table 2: Descriptive Statistics: Individual Characteristics

	All Cities (1)	Cities with Above Average Bombs (2)	Cities with Below Average Bombs (3)
Mental Component Summary (MCS)	0.000	0.007	-0.005
	(1.000)	(0.997)	(1.003)
Clinical Depression Indicator	0.203	0.199	0.206
	(0.402)	(0.399)	(0.405)
Years of Schooling	11.374	11.370	11.377
	(2.337)	(2.315)	(2.355)
Mother with Basic Education	0.875	0.880	0.871
	(0.331)	(0.325)	(0.335)
Father with Basic Education	0.830	0.827	0.832
	(0.376)	(0.378)	(0.374)
Age in 1985	41.797	42.294	41.386
	(10.817)	(10.817)	(10.800)
Female	0.532	0.534	0.530
	(0.499)	(0.499)	(0.499)
Rural	0.431	0.416	0.442
	(0.495)	(0.493)	(0.497)
Mother's Age at Birth	41.797	42.293	41.386
	(10.817)	(10.820)	(10.800)
Father died during WWII	0.092	0.092	0.092
	(0.289)	(0.289)	(0.289)
Father fought in WWII	0.020	0.024	0.017
	(0.140)	(0.154)	(0.017)
Father had a blue collar job	0.409	0.410	0.407
	(0.492)	(0.492)	(0.491)
Father had a white collar job	0,126	0.118	0.133
	(0.332)	(0.322)	(0.339)
Father had a civil servant job	0.093	0.106	0.083
	(0.291)	(0.308)	(0.275)
N	8770	3975	4795

Notes: Data are from 2002-2010 GSOEP. The sample consists of individuals born between 1923 and 1960.

Table 3: Effect of WWII Bombing on Mental Health by Cohorts

	Mental Component Summary (1)	Clinical Depression Indicator (2)
Bombing X Born btw. 1924-1928	0.001	-0.014
	(0.001)	(0.032)
Bombing X Born btw. 1929-1933	-0.001	0.006
	(0.001)	(0.036)
Bombing X Born btw. 1934-1945	-0.001**	0.042**
	(0.001)	(0.021)
Bombing X Born btw. 1946-1950	0.000	0.020
	(0.001)	(0.025)
Bombing X Born btw. 1951-1955	-0.001	0.036
	(0.001)	(0.023)
R^2	0.070	0.048
N	9874	9874
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: The control group is individuals born between 1956 and 1960. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 4: Validity Checks by Parental Characteristics and Source of Selection

	Mother's Age at Birth (1)	Parental Education (2)	Father had Blue Collar Job (3)	Father Died During WWII (4)
Bombing X War Cohort	-0.001	0.000	0.027	0.020
	(0.019)	(0.000)	(0.025)	(0.022)
Years of Schooling	0.037	0.036**	-3.245	-1.486
	(0.262)	(0.016)	(2.103)	(1.205)
Female	0.519*	-0.093***	5.341**	-0.820
	(0.270)	(0.016)	(2.501)	(1.447)
Rural	0.249***	0.066***	-4.770***	-0.454*
	(0.061)	(0.004)	(0.537)	(0.245)
R^2	0.082	0.245	0.138	0.123
N	8607	8716	8716	8716
City Fixed Effects	Yes	Yes	Yes	Yes
Birth Year Fixed Effects	Yes	Yes	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes	Yes	Yes

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. The control group is individuals born between 1923-1933 and 1950-1960. Parental education is a dummy variable which takes a value of 1 if either individual's mother or father has a high school degree or more. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 5: Early Life Exposure to Warfare and Mental Health in Adulthood

	Mental Component Summary	Clinical Depression Indicator
	(1)	(2)
Bombing X War Cohort	-0.0012**	0.0336**
	(0.0005)	(0.0143)
Years of Schooling	0.0099	-0.4506
	(0.0087)	(0.3199)
Female	-0.1722***	5.4071***
	(0.0252)	(1.0815)
Rural	-0.0437	2.5684*
	(0.0402)	(1.5219)
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes
R^2	0.087	0.062
Observations	8716	8716
Mean of the Dependent Variable	0.001	20.285
Mean of Bombing per Area	114.396	114.396

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 6: Early Life Exposure to Warfare and Mental Health in Adulthood

	Mental Component Summary			Clinical Depression Indicator		
Bombing Intensity:	Top 10%	Top 20%	Top 25%	Top 10%	Top 20%	Top 25%
	(1)	(2)	(3)	(4)	(5)	(6)
Bombing Quartile X War Cohort	-0.403***	-0.275**	-0.209*	10.291***	8.480***	6.095*
	(0.098)	(0.106)	(0.117)	(3.146)	(2.961)	(3.642)
Years of Schooling	0.010	0.010	0.010	-0.458	-0.460	-0.448
	(0.009)	(0.009)	(0.009)	(0.319)	(0.320)	(0.320)
Female	-0.173***	-0.172***	-0.172***	5.430***	5.390***	5.386***
	(0.025)	(0.025)	(0.025)	(1.075)	(1.088)	(1.089)
Rural	-0.046	-0.043	-0.043	2.622*	2,535	2.558*
	(0.040)	(0.040)	(0.040)	(1.527)	(1.525)	(1.515)
R^2	0.088	0.087	0.086	0.062	0.062	0.062
N	8716	8716	8716	8716	8716	8716
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. The control group is individuals born between 1923-1933 and 1950-1960. Sample is divided according to bombing intensity (i.e. cities that fall into the top 10 percent, 20 percent, and 25 percent of the bombing intensity distribution). Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 7: The Heterogeneity in the Long-term Mental Health Effects of Early Life Exposure to Warfare

	Baseline Results (1)	Female (2)	Male (3)	Urban Only (4)	Mother with Basic Educ. (5)	Father with Basic Educ. (6)	Father had Blue Collar Job (7)	Father Died (8)
				Panel A: Mental Component Summary				
Bombing X War Cohort	-0.001**	-0.002***	-0.001*	-0.002***	-0.001**	-0.001**	-0.002***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)
Years of Schooling	0.010	0.004	0.010	0.002	0.008	0.015	0.013	0.013
	(0.009)	(0.012)	(0.010)	(0.009)	(0.011)	(0.012)	(0.0104)	(0.029)
R^2	0.087	0.095	0.113	0.100	0.092	0.094	0.103	0.382
N	8716	4622	4094	4947	7287	6823	5139	776
				Panel B: Clinical Depression Indicator				
Bombing X War Cohort	0.034**	0.035	0.033**	0.056***	0.037**	0.041**	0.051***	0.260***
	(0.014)	(0.021)	(0.017)	(0.014)	(0.017)	(0.018)	(0.018)	(0.065)
Years of Schooling	-0.451	-0.209	-0.481	-0.289	-0.545	-0.699	-0.346	0.144
	(0.320)	(0.494)	(0.331)	(0.346)	(0.439)	(0.431)	(0.374)	(1.021)
R^2	0.062	0.069	0.094	0.072	0.064	0.069	0.076	0.319
N	8716	4622	4094	4947	7287	6823	5139	776
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 8: Early Life Exposure to Warfare and Mental Health in Adulthood: Channels

	Hospital Destruction		Child Patients		Loss of Healthcare Personnel		Out of Wedlock		Infant Mortality Increase		Wealth Loss		War Relief Payment	
	Top	Mid&Low	Top	Mid&Low	Top	Mid&Low	Top	Mid&Low	Top	Mid&Low	Top	Mid&Low	Top	Mid&Low
	Mental Component Summary													
Bombing X War Cohort	-0.002**	-0.002	-0.003**	-0.001	-0.001	-0.002	-0.002	-0.001	-0.002**	-0.000	-0.007**	-0.002**	0.000	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
Years of Schooling	0.005	0.010	0.028**	0.006	0.023	0.011	0.024	0.002	0.025	0.001	0.012	0.018	0.008	0.007
	(0.018)	(0.012)	(0.013)	(0.011)	(0.021)	(0.013)	(0.018)	(0.010)	(0.016)	(0.010)	(0.018)	(0.013)	(0.017)	(0.011)
Female	-0.188***	-0.161***	-0.120***	-0.172***	-0.089*	-0.172***	-0.075	-0.206***	-0.069	-0.207***	-0.135*	-0.171***	-0.108*	-0.184***
	(0.048)	(0.035)	(0.038)	(0.037)	(0.046)	(0.038)	(0.056)	(0.030)	(0.047)	(0.030)	(0.060)	(0.033)	(0.060)	(0.027)
Rural	-0.061	-0.003	-0.015	-0.021	0.022	0.011	0.033	-0.064	0.063	-0.077	0.050	-0.080	-0.137**	-0.022
	(0.072)	(0.056)	(0.082)	(0.054)	(0.079)	(0.061)	(0.076)	(0.047)	(0.059)	(0.051)	(0.094)	(0.056)	(0.055)	(0.051)
R^2	0.141	0.064	0.106	0.089	0.115	0.092	0.132	0.093	0.135	0.078	0.069	0.108	0.098	0.085
N	2148	4800	2566	5166	1917	4000	2577	6000	2748	5771	1935	3970	2692	5593
	Panel B: Clinical Depression													
Bombs X War Cohort	0.061***	0.036	0.076**	0.026	0.037	0.032	0.042	0.023	0.044*	-0.005	0.161**	0.051**	-0.020	0.051***
	(0.019)	(0.030)	(0.028)	(0.016)	(0.033)	(0.031)	(0.030)	(0.015)	(0.022)	(0.023)	(0.058)	(0.019)	(0.019)	(0.018)
Years of Schooling	-0.827	-0.242	-1.040**	-0.356	-0.886	-0.403	-0.855	-0.180	-0.958**	-0.256	-0.2034	-0.854	-0.189	-0.397
	(0.484)	(0.459)	(0.441)	(0.424)	(0.736)	(0.420)	(0.548)	(0.412)	(0.465)	(0.425)	(0.648)	(0.524)	(0.622)	(0.386)
Female	5.982**	5.654***	3.578*	5.472***	36.678	6.656***	0.882	7.024***	29.712	5.781***	57.251	4.574***	37.894	5.736***
	(2.360)	(1.479)	(1.953)	(1.492)	(2.418)	(1.548)	(2.287)	(1.210)	(1.896)	(1.362)	(3.010)	(1.459)	(2.328)	(1.296)
Rural	18.737	10.873	0.439	30.64	0.904	13.641	0.193	3.482*	-0.866	3.743*	-0.255	30.497	7.008***	10.949
	(2.940)	(2.204)	(2.857)	(2.122)	(3.777)	(1.932)	(2.125)	(1.872)	(1.655	(2.060)	(2.583)	(2.489)	(2.190)	(1.853)
R^2	0.116	0.045	0.086	0.058	0.082	0.065	0.104	0.065	0.109	0.053	0.041	0.076	0.068	0.068
N	2148	4800	2566	5166	1917	4000	2577	6000	2748	5771	1935	3970	2692	5593
City Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Birth Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for years of schooling, gender, an indicator for living in a rural area, city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 9: Early Life Exposure to Warfare and Mental Health in Adulthood: Controlling for Rubble per Capita

	Mental Component Summary (1)	Clinical Depression Indicator (2)
Bombing X War Cohort	-0.001**	0.032**
	(0.001)	(0.016)
Destruction X War Cohort	0.001	-0.093
	(0.006)	(0.175)
Years of Schooling	0.010	-0.427
	(0.009)	(0.328)
Female	-0.167***	5.196***
	(0.025)	(1.091)
Rural	-0.044	2.396
	(0.041)	(1.551)
R^2	0.087	0.063
N	8399	8399
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. The control group is individuals born between 1923-1933 and 1950-1960. War destruction intensity is measured by aggregate rubble in cubic meters per capita. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 10: Length of Early Life Exposure to Warfare and Mental Health in Adulthood

	Mental Component Summary (1)	Clinical Depression Indicator (2)
Bombing X Length of WWII Exposure	-0.0003***	0.0098***
	(0.0001)	(0.0032)
Years of Schooling	0.0114	-0.4723
	(0.0086)	(0.3129)
Female	-0.1698***	5.3982***
	(0.0264)	(1.1307)
Rural	-0.0394	2.403
	(0.0431)	(1.5698)
R^2	0.091	0.064
N	8391	8391
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: Length of WWII Exposure is defined as the total years an individual was affected by the WWII bombing. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table 11: Early Life Exposure to Warfare and Mental Health in Adulthood: Difference between Those Born in 1934-38 and 1939-45

	Mental Component Summary	Clinical Depression Indicator
Bombing X Born btw. 1939-1945	-0.001**	0.032**
	(0.0005)	(0.0157)
Bombing X Born btw. 1934-1938	-0.001	0.036
	(0.001)	(0.025)
Years of Schooling	0.010	-0.449
	(0.009)	(0.318)
Female	-0.172***	5.405***
	(0.0252)	(1.0832)
Rural	-0.043	2.584*
	(0.0397)	(1.5229)
R^2	0.087	0.062
N	8.716	8.716
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

APPENDIX TABLES

Table A1: Early Life Exposure to Warfare and Mental Health in Adulthood: Different Control Groups

Control Group:	Only Postwar Cohort		1946-1949 Cohort Included	
	Mental Component Summary	Clinical Depression Indicator	Mental Component Summary	Clinical Depression Indicator
	(1)	(2)	(3)	(4)
Bombing X War Cohort	-0.001**	0.024*	-0.001**	0.028**
	(0.001)	(0.014)	(0.001)	(0.014)
Years of Schooling	0.008	-0.473	0.008	-0.366
	(0.010)	(0.370)	(0.008)	(0.302)
Female	-0.158***	5.225***	-0.168***	5.384***
	(0.033)	(1.247)	(0.025)	(1.085)
Rural	-0.046	2.558	-0.024	2.134
	(0.046)	(1.687)	(0.038)	(1.377)
R^2	0.095	0.064	0.078	0.053
N	6481	6481	9916	9916
City Fixed Effects	Yes	Yes	Yes	Yes
Birth Year Fixed Effects	Yes	Yes	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes	Yes	Yes

Notes: War Cohort is defined as individuals who were either ages 0-5 at the onset of WWII or born during the war. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effect. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table A2: The Role of Prewar City Characteristics

	Mental Component Summary (1)	Clinical Depression Indicator (2)
Prewar Number of Children Hospitals X War Cohort	0.033	-0.719
	(0.048)	(1.477)
Prewar Number of Mental Hospitals X War Cohort	0.029	-1.054
	(0.029)	(0.901)
Prewar Population X War Cohort	0.000	0.000
	(0.000)	(0.000)
Prewar Area in km^2 X War Cohort	-0.001	0.015
	(0.001)	(0.017)
Prewar Income per Capita X War Cohort	0.000	-0.000
	(0.0000)	(0.000)
R^2	0.077	0.056
N	6634	6634
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: War Cohort is defined as individuals who were 5 and younger during WWII. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for years of schooling, gender, an indicator for living in a rural area, city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table A3: The Roles of Differential Mortality and Cohort Size

	Mortality (1)	Cohort Size (2)
Bombing X War Cohort	0.001	0.006
	(0.004)	(0.004)
Years of Schooling	-0.004	-0.040
	(0.089)	(0.054)
Female	-0.978**	-0.412**
	(0.384)	(0.193)
Rural	-0.424	0.077
	(0.416)	(0.292)
R^2	0.073	0.384
N	8716	8716
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: War Cohort is defined as individuals who were 5 and younger during WWII. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression with city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table A4: Early Life Exposure to Warfare and Mental Health in Adulthood: Parental Controls

	Mental Component Summary (1)	Clinical Depression Indicator (2)
Bombing X War Cohort	-0.001***	0.044***
	(0.000)	(0.015)
Years of Schooling	0.013	-0.688
	(0.012)	(0.426)
Mother has more than Basic Education	0.071	0.533
	(0.065)	(2.673)
Father has more than Basic Education	-0.080	3.470
	(0.079)	(2.619)
Father had a blue collar job	-0.062	2.779
	(0.047)	(2.005)
Father had a white collar job	0.054	-2.764
	(0.066)	(2.506)
Father had a civil servant job	0.032	-4.249*
	(0.069)	(2.341)
Mother's age at birth	0.002	0.023
	(0.003)	(0.138)
R^2	0.094	0.068
N	6354	6354
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: War Cohort is defined as individuals who were 5 and younger during WWII. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression with city and birth year fixed effects and survey year fixed effects. Each column also controls for gender and rural dummies, linear state trends and the interaction of the prewar city characteristics such as prewar population density and income per capita with individual's birth year. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table A5: Falsification Test

	Mental Component Summary (1)	Clinical Depression Indicator (2)
Bombing X Placebo War Cohort	-0.0002	-0.0099
	(0.0006)	(0.0250)
Years of Schooling	0.0077	-0.5019
	(0.0092)	(0.3686)
Female	-0.1495***	4.0317**
	(0.0339)	(1.5314)
Rural	-0.0379	2.5004
	(0.0553)	(2.2181)
R^2	0.091	0.069
N	5268	5268
City Fixed Effects	Yes	Yes
Birth Year Fixed Effects	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes

Notes: The control group is individuals born between 1950 and 1960. "Placebo" War Cohort is individuals born between 1923 and 1933. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

Table A6: Early Life Exposure to Warfare and Mental Health in Adulthood: Sub-components

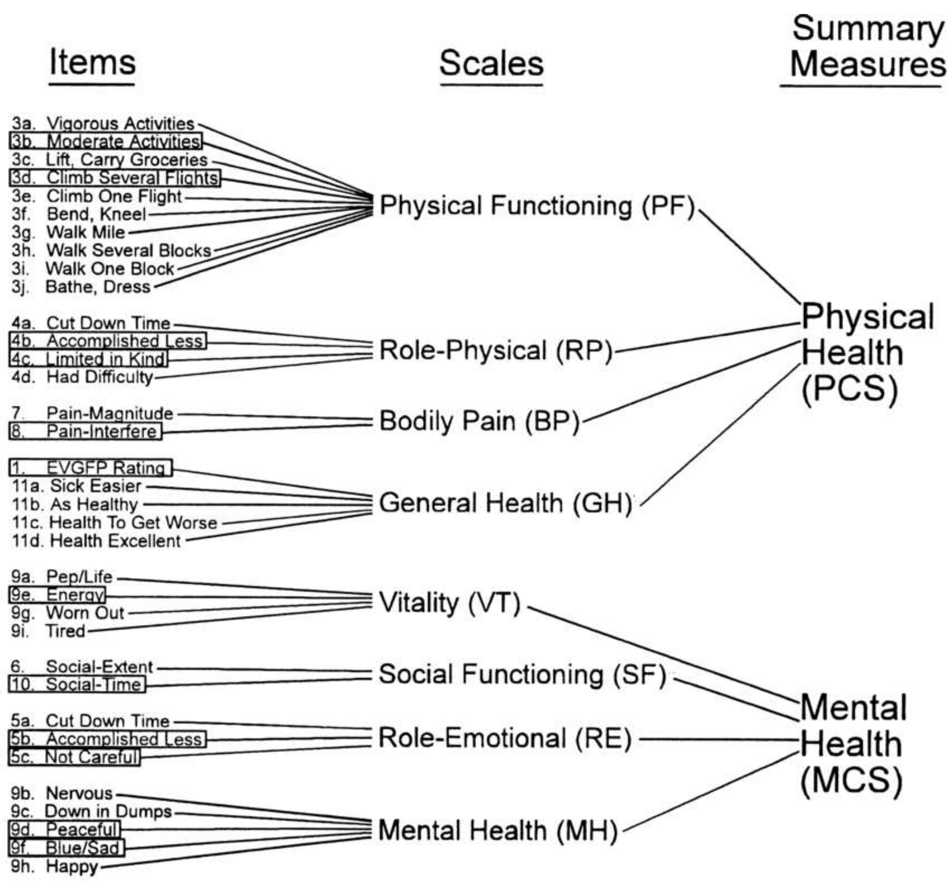
	Mental Health (1)	Vitality (2)	Social Functioning (3)	Role Emotional (4)
Bombing X War Cohort	-0.007*	-0.004	-0.014***	-0.007
	(0.004)	(0.004)	(0.005)	(0.005)
Years of Schooling	0.256***	0.346***	0.238**	0.198**
	(0.077)	(0.080)	(0.092)	(0.083)
Female	-2.013***	-0.778***	-1.069***	-1.862***
	(0.249)	(0.268)	(0.289)	(0.287)
Rural	-0.342	-0.449	-0.235	-0.493
	(0.419)	(0.357)	(0.389)	(0.422)
R^2	0.097	0.107	0.084	0.100
N	8716	8716	8716	8716
Mean of the Dependent Variable	50.281	48.136	47.639	47.597
Mean of Bombing per Area	114.396	114.396	114.396	114.396
City Fixed Effects	Yes	Yes	Yes	Yes
Birth Year Fixed Effects	Yes	Yes	Yes	Yes
Survey Wave Fixed Effects	Yes	Yes	Yes	Yes

Notes: War Cohort is defined as individuals who were 5 and younger during WWII. The control group is individuals born between 1923-1933 and 1950-1960. Each column is from a separate regression including controls for city and birth year fixed effects and survey year fixed effects. Standard errors clustered at the city level are shown in parentheses. Asterisks denote significance levels (*=.10, **=.05, ***=.01).

APPENDIX

SF-12 questionnaire is a simplified version of SF-36 questionnaire on health-related quality of life. (Ware et al., 2001). While SF-36 consists of 36 questions, 8 subscales and 2 superordinate dimensions of physical and mental health, SF-12 contains only 12 of the original 36 questions, which are again grouped into 8 subscales and two final dimensions of physical and mental health. Figure A1 represents the health measurement model of SF-36 and SF-12 surveys:

Figure A1: Health Measurement Model



Notes: Items in boxes are selected for SF-12. Source: Ware, Kosinski and Keller (1996).

The SF-12 survey contains categorical questions (yes/no), Likert response formats on a three-point scale (limited a lot, limited a little, or not limited at all) and five-point scale (not at all, a little bit, moderately, quite a bit, and extremely). In the measuring procedure, first, all items are scored so that a high score reflects a more favorable health state between 0 and 100. Next, using these questions sub-scales consist of one or two questions (boxed items in Figure A1) are constructed. For each subscale a mean value is computed and transformed to a 0–100 scale (z-transformation). Sub-scales with one question are directly transformed to 0–100 scale, and for sub-scales with two questions each, the mean value of the two items is computed (arithmetic mean). Then, these subscale scores were transformed to two 0–100 scale (physical and mental) with the higher score indicating less dysfunction or impairment.

Mental Component Summary (MCS) consists of four subscales —Vitality, Social Functioning, Role Emotional and Mental Health as depicted in Figure A1. The questions in the SF-12 Health Survey are listed below. In constructing these four Mental Health Subscales, question 10 is used for *Vitality*, question 12 is used for *Social Functioning*, questions 6 and 7 are used for *Role Emotional*, and questions 9 and 11 are used for *Mental Health*.

SF-12 Survey Questions:

1. In general, would you say your health is? (Excellent/ Very Good/ Good/ Fair / Poor)

   The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

2. Moderate activities, such as moving a table, pushing a vacuum cleaner, bowling, or playing golf? (Yes, limited a lot / Yes, limited a little / No, not limited at all)

3. Climbing several flights of stairs? (Yes, limited a lot / Yes, limited a little / No, not limited at all)

   During the past four weeks have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

4. Accomplished less than you would like (Yes/No)

5. Didn't do work or other activities as carefully as usual (Yes/No)

During the past four weeks have you had any of the following problems with your work or other regular daily activities as a result of any emotional problems (such as feeling depressed or anxious)?

6. Accomplished less than you would like (Yes/No)
7. Didn't do work or other activities as carefully as usual (Yes/No)
8. During the past four weeks, how much did pain interfere with your normal work (including both work outside the home and housework)
9. During the past four weeks have you felt calm and peaceful?(All of the time/ Most of the time/ A good bit of the time/ Some of the time/ A little of the time/ None of the time)
10. During the past four weeks did you have a lot of energy? (All of the time/ Most of the time/ A good bit of the time/ Some of the time/ A little of the time/ None of the time)
11. During the past four weeks have you felt downhearted and blue? (All of the time/ Most of the time/ A good bit of the time/ Some of the time/ A little of the time/ None of the time)
12. During the past four weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting friends, relatives, etc)? (All of the time/ Most of the time/ A good bit of the time/ Some of the time/ A little of the time/ None of the time)