

Pandemic Exposure and Infant Mortality: Evidence from Early Twentieth-Century Taiwan

Introduction

Infant mortality has long been regarded as one of the most sensitive indicators of population health and social welfare. Because infants are biologically vulnerable and highly dependent on caregivers, their survival reflects not only biological conditions but also family organization, social inequality, and exposure to environmental shocks. Epidemic diseases represent one of the most dramatic forms of such shocks, simultaneously disrupting public health conditions, household stability, and caregiving environments.

The global influenza pandemic of 1918-1920, commonly referred to as the Spanish influenza, infected approximately one-third of the world's population and caused tens of millions of deaths worldwide. Taiwan, then under Japanese colonial rule, experienced three waves of the pandemic, with the second wave in late 1918 proving particularly devastating. While the demographic consequences of this pandemic for adult mortality have been widely documented, its effects on infant survival remain less well understood, particularly in historical Asian societies. This study examines infant mortality in early twentieth-century Taiwan during the Spanish influenza period and asks two related questions: (1) whether exposure to the influenza pandemic increased infant mortality risks in Taiwan, and (2) whether the effects of the pandemic varied according to infants' demographic characteristics and household contexts, especially family structure and kin composition. By addressing these questions, the study contributes to broader debates in historical demography concerning how epidemic shocks interact with family institutions and household resource allocation to shape early-life survival. By examining a historical East Asian population with detailed household records, the study also contributes to comparative research on how pandemics affect early-life survival across different family systems and institutional contexts.

Historical and Theoretical Backgrounds

Understanding infant mortality requires integrating perspectives from epidemiology, family demography, and evolutionary approaches to kin relations. Epidemics may affect infant survival through both direct and indirect mechanisms. Direct effects arise when infants themselves are exposed to infectious disease environments, while indirect effects occur when epidemics affect caregivers, particularly pregnant women and

nursing mothers, thereby compromising fetal development, breastfeeding, or household care.

A growing body of research emphasizes the importance of prenatal conditions in shaping later-life health outcomes. The fetal origins hypothesis suggests that adverse conditions during gestation, including maternal illness, nutritional stress, and environmental shocks, can have lasting physiological consequences. Under this perspective, children conceived during epidemic periods may face elevated mortality risks even if they themselves are not directly infected.

At the same time, infant survival is shaped by family organization and intra-household resource allocation. Resource allocation theory suggests that parents distribute limited time and resources among children in ways that reflect both biological needs and social priorities. Variables such as birth order, sibling competition, and household size may therefore influence infant mortality risks. In traditional Chinese family systems, patrilineal kinship norms and hierarchical family structures may further shape caregiving patterns and the distribution of resources within households. Extended-family arrangements may provide additional caregiving support, but they may also introduce competition for household resources.

Evolutionary perspectives provide additional insights into how kin relationships influence childcare. Concepts such as kin investment asymmetry and paternity uncertainty suggest that different relatives may invest unequally in child survival. The grandmother hypothesis, for example, proposes that grandmothers may enhance child survival by contributing childcare labor and household knowledge. Taken together, these perspectives suggest that infant mortality risks are shaped by the interaction of epidemic shocks, prenatal health conditions, and the structure of family support systems.

Taken together, these perspectives suggest that infant mortality risks during epidemic periods may be shaped by two interacting mechanisms: biological vulnerability arising from prenatal exposure to epidemic environments and household-level resource allocation shaped by kinship structures. This study therefore examines how pandemic exposure and family composition jointly influenced infant survival in early twentieth-century Taiwan.

Data and Research Setting

This study uses data from the Taiwan Historical Household Registration Database (1906-1945), derived from Japanese colonial household registers. These records provide detailed longitudinal demographic information, including births, deaths, kin

relationships, and residential histories. Because they track individuals and households over time, they allow researchers to reconstruct family structures and life events with exceptional precision.

The present analysis focuses on four communities in the Hsinchu region, where the household registration records are particularly complete and have been extensively validated in previous research. These communities provide a valuable empirical setting for examining demographic processes in rural Taiwan during the early twentieth century.

The dataset includes 42,235 children born between 1906 and 1945, making it one of the largest micro-level studies of infant mortality in historical Taiwan. For each child, the dataset records the exact dates of birth and death (if applicable), sex, birth order, and the presence or absence of specific household members at the time of birth. The household registers also allow the identification of broader family contexts, including sibling composition and the presence of grandparents, which are crucial for evaluating how kin networks influence infant survival.

Methods

The empirical analysis relies on event-history techniques to estimate mortality risks during early childhood. To capture survival patterns across different cohorts, Kaplan-Meier survival curves were employed, enabling comparison of survival probabilities across birth cohorts. In addition, Cox proportional hazards models were used to evaluate how demographic characteristics, household composition, and exposure to the influenza pandemic influenced the likelihood of infant death. These models incorporated variables such as the sex of the child, the birth cohort to which the child belonged, the number of older siblings present at the time of birth, and the presence of grandparents in the household. To measure the impact of the pandemic more precisely, the analysis distinguished between children who were born during the influenza years and those who were conceived during that period. This distinction made it possible to assess whether the pandemic's influence operated primarily through postnatal infection risks or through prenatal mechanisms that affected fetal development.

Findings

The analysis reveals several key patterns in infant survival. Mortality in the Hsinchu communities was high, with roughly one-fifth of children dying before the age of three. Survival differed across cohorts, and children born around the time of the Spanish influenza pandemic faced particularly elevated risks. The effect was most pronounced

among those conceived during the pandemic, which suggests that prenatal exposure to epidemic conditions had a significant impact on early-life health outcomes.

Gender also played a role in shaping survival chances. Male infants consistently experienced higher mortality than females, a finding that aligns with biological vulnerabilities observed in many historical populations. Household structure further influenced outcomes. The presence of grandparents altered survival probabilities, with grandmothers were associated with lower mortality risks, whereas the presence of grandfathers showed weaker or occasionally negative associations with infant survival. Sibling composition mattered as well. Infants with older siblings, especially older sisters, tended to have lower mortality risks, which points to the possibility that sibling support contributed to childcare and improved survival prospects.

Together, these findings demonstrate that infant mortality in early twentieth-century Taiwan was shaped not only by the devastating shock of the influenza pandemic but also by the micro-level dynamics of family organization and caregiving. The elevated risks among pandemic-conceived cohorts highlight the importance of prenatal health conditions, while the protective roles of grandmothers and sisters underscore the significance of kinship networks in buffering households against crisis.

Discussion

Taken together, these findings highlight the importance of considering both macro-level shocks and micro-level family contexts when analyzing infant mortality. The Spanish influenza pandemic influenced infant survival in Taiwan not only through direct disease exposure but also through prenatal conditions and household-level mechanisms. The elevated mortality risks observed among cohorts conceived during the pandemic are consistent with the fetal origins hypothesis, emphasizing the importance of maternal health and prenatal environments in shaping early-life outcomes.

At the same time, the role of household structure suggests that extended-family arrangements and kin networks mediated the impact of epidemic shocks by influencing caregiving practices and resource allocation within families. The protective role of grandmothers and older sisters underscores the importance of intergenerational and sibling support in child survival.

Comparative evidence from England, the United States, and other contexts reinforces these conclusions. Reid's (2005) study of England found that infants born during the pandemic faced a 76% higher risk of death from prematurity and malnutrition. Barker's fetal origins hypothesis has been applied to diverse populations, linking prenatal

exposure to influenza with later-life health deficits such as cardiovascular disease and diabetes. Studies in Taiwan and the U.S. (Lin & Liu, Acquah et al.) similarly demonstrate long-term consequences of pandemic exposure.

Conclusion

This study demonstrates how historical demographic data can illuminate the complex interactions between epidemic crises, family institutions, and early-life survival. By analyzing household registration records from colonial Taiwan, it provides systematic evidence of the Spanish influenza's impact on infant mortality. The findings underscore the dual importance of epidemic exposure and family context, showing that survival was shaped not only by disease environments but also by kinship structures and caregiving practices.

Future research should incorporate time-varying household characteristics and additional demographic variables, such as maternal age and birth spacing, to better identify mechanisms linking epidemic environments and infant mortality. Comparative studies across regions and countries would further enrich understanding of how pandemics shape demographic outcomes.

Ultimately, this study contributes to historical demography by demonstrating how pandemic shocks interacted with prenatal health conditions and household organization to shape infant survival. By linking epidemic exposure to family-level caregiving structures, it highlights the importance of integrating epidemiological and household perspectives in the study of early-life mortality.