



LUND UNIVERSITY

Disease, Death, and Displacement

The long-term effects of early-life conditions on income, education, and health in Sweden, 1937-2011

Serratos-Sotelo, Luis

2021

Document Version:

Publisher's PDF, also known as Version of record

[Link to publication](#)

Citation for published version (APA):

Serratos-Sotelo, L. (2021). *Disease, Death, and Displacement: The long-term effects of early-life conditions on income, education, and health in Sweden, 1937-2011*. [Doctoral Thesis (compilation), Lund University School of Economics and Management, LUSEM]. Lund University (Media-Tryck).

Total number of authors:

1

Creative Commons License:

Unspecified

General rights

Unless other specific re-use rights are stated the following general rights apply:

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Read more about Creative commons licenses: <https://creativecommons.org/licenses/>

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

LUND UNIVERSITY

PO Box 117
221 00 Lund
+46 46-222 00 00



Disease, Death, and Displacement

The long-term effects of early-life conditions on
income, education, and health in Sweden, 1937-2011

LUIS SERRATOS-SOTELO

LUND STUDIES IN ECONOMIC HISTORY 98 | LUND UNIVERSITY



Disease, Death, and Displacement

How are people's lives shaped by what they experience during infancy, childhood, and adolescence? How are their adult lives impacted by a sudden improvement or worsening in their early-life conditions?

This dissertation aims at providing some insights about how specific changes in early-life conditions can affect individuals' lives in the long-term. It focuses on three very different shocks to early-life conditions:

- (1) exposure to disease and vaccination, studied through the case of polio and the vaccine against it,
- (2) experiencing forced migration, studied through the case of Yugoslavian refugees in Sweden, and
- (3) losing a parent during the childhood years.

Since they alter the environment in which children develop, these experiences can also have long-term repercussions in their adult outcomes. Using high-quality, individual-level data from the Swedish administrative registers, as well as methods of causal inference, the four studies in this thesis attempt at understanding how these shocks can affect the educational attainment, adult health, and adult income of the children who lived through them.

For the case of disease and vaccination, the results show that there was no evidence that exposure during early life to either a polio outbreak, or to introduction of the vaccine against the disease, had long-term impacts on adult income, education, or health. Through the study of the case of polio, this thesis contributes to our understanding of scarring effects of disease exposure, particularly by showing that not all shocks and diseases have repercussions felt across the years, even if those effects are theoretically plausible, a case that had not really been discussed in the literature so far.

For the case of forced migration, the results show that asylum-seeking children who arrived in Sweden as a consequence of the mid-90's war in Yugoslavia had lower educational outcomes, compared to non-displaced children, measured almost a decade after the exposure occurred. Finally, for the case of parental death, the results provide evidence that there is an association between parental loss during childhood and lower adult income, educational attainment, and worse health. This analysis also suggests that children's grief and emotional trauma related to losing a parent is a relevant mechanism for the observed effects.

Disease, Death, and Displacement

The long-term effects of early-life conditions on income, education, and health in
Sweden, 1937-2011

Disease, Death, and Displacement

The long-term effects of early-life conditions on income,
education, and health in Sweden, 1937-2011

Luis Serratos-Sotelo



LUND
UNIVERSITY

DOCTORAL DISSERTATION

by due permission of the School of Economics and Management, Lund University, Sweden.

To be defended at EC3:211 on Thursday, the 29th of April 2021 at 10:15.

Faculty opponent:
Mikael Rostilla

| | | |
|--|--|--|
| Organization LUND UNIVERSITY | | Document name DOCTORAL DISSERTATION |
| Department of Economic History Box 7083 SE-220 07 LUND Sweden | | Date of disputation 2021-04-29 |
| Author(s) Luis Serratos-Sotelo | | Sponsoring organization |
| Title and subtitle Disease, Death, and Displacement: The long-term effects of early-life conditions on income, education, and health in Sweden, 1937-2011 | | |
| Abstract How are people's lives shaped by what they experience during infancy, childhood, and adolescence? How are their adult lives impacted by a sudden improvement or worsening in their early-life conditions? This dissertation aims at providing some insights about how specific changes in early-life conditions can affect individuals' lives in the long-term. It focuses on three very different shocks to early-life conditions: (1) exposure to disease and vaccination, studied through the case of polio and the vaccine against it, (2) experiencing forced migration, studied through the case of Yugoslavian refugees in Sweden, and (3) losing a parent during the childhood years. Since they alter the environment in which children develop, these experiences can also have long-term repercussions in their adult outcomes. Using high-quality, individual-level data from the Swedish administrative registers, as well as methods of causal inference, the four studies in this thesis attempt at understanding how these shocks can affect the educational attainment, adult health, and adult income of the children who lived through them. For the case of disease and vaccination, the results show that there was no evidence that exposure during early life to either a polio outbreak, or to introduction of the vaccine against the disease, had long-term impacts on adult income, education, or health. Through the study of the case of polio, this thesis contributes to our understanding of scarring effects of disease exposure, particularly by showing that not all shocks and diseases have repercussions felt across the years, even if those effects are theoretically plausible, a case that had not really been discussed in the literature so far. For the case of forced migration, the results show that asylum-seeking children who arrived in Sweden as a consequence of the mid-90's war in Yugoslavia had lower educational outcomes, compared to non-displaced children, measured almost a decade after the exposure occurred. Finally, for the case of parental death, the results provide evidence that there is an association between parental loss during childhood and lower adult income, educational attainment, and worse health. This analysis also suggests that children's grief and emotional trauma related to losing a parent is a relevant mechanism for the observed effects. | | |
| Key words vaccine, polio, migration, forced migration, Yugoslavia, refugees, parental death, early-life, income, education, health, Sweden | | |
| Classification system and/or index terms (if any) | | |
| Supplementary bibliographical information | | Language English |
| ISSN and key title 1400-4860 Lund Studies in Economic History | | ISBN 978-91-87793-70-7 (print) 978-91-87793-71-4 (pdf) |
| Recipient's notes | | Number of pages 179 |
| | | Price |
| | | Security classification |

I, the undersigned, being the copyright owner of the abstract of the above-mentioned dissertation, hereby grant to all reference sources the permission to publish and disseminate the abstract of the above-mentioned dissertation.

Signature 

Date 2021-03-22

Disease, Death, and Displacement

The long-term effects of early-life conditions on income,
education, and health in Sweden, 1937-2011

Luis Serratos-Sotelo



LUND
UNIVERSITY

Lund Studies in Economic History is a series of doctoral dissertations and edited volumes of high scholarly quality in subjects related to the Department of Economic History at the School of Economics and Management, Lund University. All volumes have been reviewed and approved prior to publication.

Cover photo: Petersens, L. (1957). *Tjärhovsgatan 32. Gårdsbild med barn* [Photograph]. Stockholms stadsmuseum. Fotonummer F 56416. <https://stockholmskallan.stockholm.se/post/13665>

Funding information: This work was financially supported by the Department of Economic History at Lund University, the Max Planck Institute for Demographic Research, and the Foundation for the Promotion of Economic Research at Lund University (*Stiftelsen för främjande av ekonomisk forskning vid Lunds universitet*).

© Luis Serratos-Sotelo 2021

School of Economics and Management
Department of Economic History

ISBN: 978-91-87793-70-7 (print)

ISBN: 978-91-87793-71-4 (pdf)

ISSN: 1400-4860 Lund Studies in Economic History

Printed in Sweden by Media-Tryck, Lund University, Lund 2021



*To my parents
Sergio & Yolanda*

Contents

| | |
|--|------------|
| Acknowledgements | iii |
| List of papers | vii |
| Introduction | I |
| 1 Rationale and aim of the thesis | 1 |
| 2 Context | 5 |
| 2.1 Healthcare and Vaccination in Sweden | 5 |
| 2.2 Migration in Sweden | 7 |
| 2.3 Families in Sweden | 10 |
| 3 Theory and Previous Research | 13 |
| 3.1 Early-life shocks: Cohort and Period Effects | 13 |
| 3.2 Medical/Epidemiological Evidence | 14 |
| 3.3 Economic Evidence | 16 |
| 3.4 Psychological Evidence | 21 |
| 3.5 Early-life shocks explored in this thesis | 22 |
| 4 Methods and Data | 25 |
| 4.1 Quasi-experimental methodologies | 25 |
| 4.2 Methods used in this thesis | 26 |
| 4.3 The Swedish Interdisciplinary Panel | 28 |
| 4.4 The Swedish Longitudinal Immigrant Database | 28 |
| 4.5 Limitations | 29 |
| 5 Results | 31 |
| 5.1 Summary of the papers included in this thesis | 31 |
| 6 Discussion and Conclusions | 37 |
| 7 References | 39 |
| Paper I: The long-term economic effects of polio: Evidence from the introduction of the polio vaccine to Sweden in 1957. | 49 |
| Paper II: Were there long-term economic effects of exposure to Polio Vaccination?: An analysis of migrants to Sweden 1946-2003. | 89 |
| Paper III: The long-term effects of forced migration: An early-life approach with evidence from Yugoslavian refugees in Sweden | 101 |
| Paper IV: The lasting economic effects of parental loss during childhood: Evidence from Sweden | 123 |

Acknowledgements

This dissertation could simply not have been possible without the support and encouragement of my supervisors, colleagues, friends, and family. Through these lines, therefore, I would like to express my heartfelt gratitude to all those who accompanied or helped me during the past years.

Isaac Newton once wrote that "*If I have seen further it is by standing on the shoulders of giants*"¹, a sentiment that resonates so powerfully to me in this moment that I'd like to begin by acknowledging my four giants. I would like to thank my main supervisor, Tommy Bengtsson, for always being incredibly generous with his time, wisdom, and advice, and for giving me the chance to pursue my dream of doctoral education at Lund University. I am extremely grateful to my assistant supervisors: Mikko Myrskylä, for welcoming me into the Max Planck Institute for Demographic Research and making sure that my time in Rostock was always productive and enriching; Anton Nilsson, for always pushing me to the highest standards of methodological rigor in everything I write; and Peter Eibich, for his intellectual generosity, kindness, and approachability. I will be forever thankful to have had the opportunity to learn first-hand from you all, during the past few years, how to be a better mentor, leader, researcher, and collaborator.

I also feel incredibly thankful for being allowed to work in two amazing places during my time as a Ph.D. student. The Department of Economic History in Lund University was my harbor and my safe-space all through my studies. Working here has always felt to me like being part of a huge family, particularly during seminars, Friday's *fika*, and kick-off meetings. I would like to thank Mats Olsson who, as head of department, has not only protected and nurtured the working environment for everyone, but whose door is always open to listen, counsel, and support. Patrick Svensson, Astrid Kander, and Ellen Hillbom acted as Director of Ph.D. studies during my time here, and to all three I thank their support and understanding during the many difficulties of doctoral studies. I'll be forever thankful to Fay Lundh Nilsson, Tobias Axelsson, Kirk Scott, and Martin Dribe for giving me the chance to develop my pedagogical skills by allowing me to collaborate in the teaching of graduate-level courses at Lund University. I'd like to especially thank Anneli Nilsson Ahlm, Tina Wueggertz, Kristin Fransson, Madeleine Jarl, and Christina Rothman who, with what can only be described as superhuman levels of patience and kindness, have helped me navigate all the administrative procedures that studying, working, teaching, and living in Sweden has entailed during the past years.

Within the Department, the Centre for Economic Demography has always provided me with a research and learning environment that has been at once welcoming, challenging, and nurturing in the multidisciplinary use of quantitative methodologies for cutting-edge

¹Newton, I. (1675). Letter from Isaac Newton to Robert Brooke. Historical Society of Pennsylvania.

social science research. I'd like to thank Martin Dribe, Director of the Centre, not only for coordinating the many research seminars at the Centre, but also for his words of encouragement, his openness and frankness, and for his invitations throughout my studies to collaborate with him in teaching and lecturing. I'm indebted to both Martin and Volha Lazuka, for their wonderful comments and suggestions during my final seminar. To all my colleagues at the Centre, I am grateful for your insights, your wisdom, and your willingness to collaborate and offer advice.

I would also like to thank everyone at my second workplace, the Max Planck Institute for Demographic Research, for giving me the opportunity to spend some of my time as a student among the many talented researchers who truly embody both appetite for knowledge and multidisciplinary collaboration. I would like to particularly thank Jo Hale, Timothy Riffe, Kieron Barclay, Angela Carollo, Angelo Lorenti, Chia Liu, Mine Kühn, and Christian Dudel for making my time in Rostock not only productive, but also enjoyable and fun; and to Anja Ewald and Birgit Möller for their kind-hearted support in dealing with all the German paperwork.

Nothing strengthens bonds like going through challenges together, and so I must thank all my fellow Ph.D. students at the Department of Economic History for their company, solidarity, and friendship in this greatest of our academic endeavors so far. I was extremely lucky to share an office during four years with Martin Önnersfors, whose sense of humor, openness, and god-level coding skills filled the office every day not only with intellectually challenging discussions and awesome maps, but also with laughter and *joie de vivre*. Even after the pandemic forced everyone into home-office, we managed to virtually continue our time-honored tradition of bouncing ideas off each other over *fika*, and I cannot overstate how helpful your support and advice has been, especially during the last year. I am also thankful for the patience, support, and friendship of Enrico Debiasi, who never fails to have an encouraging word, a witty joke, a clever insight, or a restaurant recommendation whenever I need it the most. Elien van Dongen's frankness and intelligence made her one of my favorite people to discuss anything with, research included, and I am indebted to her for all her advice during the past few years. To Volha Lazuka, Annika Elwert, Jeff Nilsson, Anna Tegunimataka, Finn Hedefalk, Siddartha Aradhya, Kathryn Gary, and all those Ph.D. students who graduated before me, who have managed to be at the same time colleagues and approachable mentors, I thank you for all the support and encouragement.

Throughout my doctoral studies, I was fortunate enough to actively participate in Lund's Doctoral Student Union (LDK) as Board Representative for the Economics and Management Doctoral Student Council. LDK gave me the opportunity to be involved with university-wide questions looking to improve the conditions for all Ph.D. students at Lund University, but also to meet and work with wonderful people from other faculties. For all the amazing times serving the doctoral student community, and for all the battles fought together, the fun meetings (both in-person and virtual), chats, and *fika*, I'd like to thank

Tanya Kolyaka, Brian Thorsbro, Shelby Shrigley, Katherine Burlingame, Nicolai Baumert, and Ranita Yusran.

Having friends who have a little distance from your work is a true blessing that has helped me to keep going during the past years. Whether we bonded over philosophy, cooking, video games, or disappointing TV plot twists, I'd like you all to know that without your friendship I simply would not have been able to make it through the grueling process of doing a Ph.D. So big, big thanks to Elsy-May Manninen, Joel Holmdahl, Cristina Mendoza, Stephen Nicola, Sandra López, Kamil Chojnowski, Jessica Muñoz, Zofia Polakiewicz, Max Meza, Mattias Andersson, Julia Ogne, Marco Andersson, Max Hertrich, Linus Hall, Sofie Kindholm, and Alexandre Martins.

I have to acknowledge that everything I've been able to achieve was only possible due to the support and love from my family. As stated a few pages back, this book is especially dedicated to my parents, Sergio and Yolanda, in recognition that it is only because of their hard work and sacrifices that I have been able to pursue my goals and dreams. You are the best role models life could've set in my path, and I'm thankful everyday to have you always cheering and supporting me in everything I do. My brother, Sergio, can always manage to make me smile when I'm feeling overwhelmed and has been there for me through thick and thin, for which I'm immensely grateful. I'd also like to thank my sister-in-law, Heidi, as well as my nephew and godson, Matías, for the incommensurable amount of joy they bring into my life. And speaking of family, a special thank you to the Hylén family for welcoming me with open arms and providing the light and warmth that are so often in short supply when you're an academic expatriate.

Last, but in no way least, I would like to express my gratitude to my partner, Christian. You have been my rock and my happiness, walking every step of the way next to me. Thank you for listening to my ceaseless talking about academic stuff, for encouraging me during the long writing times, but also for worrying about me and keeping me sane and grounded in something larger than work. Whether we were travelling the world or social distancing at home for a year, know that you have been my biggest joy all along.

List of papers

This thesis is based on the following papers, referred to by their Roman numerals:

- I **The long-term economic effects of polio: Evidence from the introduction of the polio vaccine to Sweden in 1957.**
Serratos-Sotelo, L., Bengtsson, T. & Nilsson, A.
Economics and Human Biology, 35(2019) pp. 32–41
- II **Were there long-term economic effects of exposure to Polio Vaccination?: An analysis of migrants to Sweden 1946-2003.**
Serratos-Sotelo, L.
SSM Population Health, 11(Aug. 2020) 100589
- III **The long-term effects of forced migration: An early-life approach with evidence from Yugoslavian refugees in Sweden**
Serratos-Sotelo, L.
Unpublished Manuscript
- IV **The lasting economic effects of parental loss during childhood: Evidence from Sweden**
Serratos-Sotelo, L., Eibich, P.
Unpublished Manuscript

Papers I and II are reproduced here by permission of Elsevier. The copyright for Papers III and IV is owned by the authors and they are reproduced here with their permission.

Introduction

I Rationale and aim of the thesis

As the whole world is still attempting to get through the worst global pandemic in a century, it would be hard to argue against the importance that the conditions in which we live our lives have on the actions we take, or how successful we are at achieving our goals. Almost everyone reading this is sure to have experienced some sort of alteration to their life as a consequence of the COVID-19 pandemic. After many months of isolation, social distance, and virtual-everything, people are beginning to wonder if this changed environment will have consequences that will continue to affect our lives way after the pandemic is over. For instance, there are reasonable worries that isolation and loneliness will negatively impact the mental health of the population (Kumar and Nayar, 2020; Moreno et al., 2020), which could have economic and health repercussions for years to come.

Of particular importance, however, is how this pandemic will impact the future of today's children, who are not only exposed to the same isolation and mental-health risks as adults (Liu et al., 2020), but who are also missing crucial opportunities during extended periods of their educational development. Online and distance learning efficiency is greatly affected by economic resources and parental engagement, and the pandemic is likely to widen the achievement gap between rich and poor children (Bacher-Hicks et al., 2020). Given how important education is upon entering the labour market, worse educational environments today may as well affect the future economic prospects of today's children.

Long-term effects of early-life conditions, the subject of this dissertation, can be better visualized through a simple analogy: imagine life as a marathon, where the first years of life correspond to the start of the race. A rough start in the race, say by tripping and falling due to not wearing the right shoes, will leave that person with a disadvantage *vis-à-vis* everyone who had a better start. Conversely, having improved conditions at the beginning of the race will probably increase your chances of running a smooth race, other things being equal. While childhood experiences are not deterministic of later-life outcomes (one might end up catching up with the pack after falling in the race, for example), the analogy hopefully

serves to illustrate why a change in early-life conditions can be an important study subject, and one whose relevance has been suddenly amplified by our current context.

While some of the characteristics of the current global pandemic are new to us all, others bear a striking resemblance to past events.² Therefore, the study of historical events and of how societies and individuals have responded to, and been affected by them can be of great help in replicating what successes we've had, avoiding past mistakes, and correcting or adjusting for the known and expected consequences of circumstances such as this. Furthermore, it is of particular importance for research to also explore the ways in which children are affected by sudden changes in their early-life conditions, and how these can have repercussions throughout their lives.

Consequently, this dissertation aims at providing some insights about how specific changes in early-life conditions have impacted individuals' lives in the long-term. These changes (also referred to hereafter as *exposures* or *shocks*) had the potential to improve or worsen the conditions in which individuals developed during the beginning years of their lives. By altering the environment in which children develop, these shocks can also have long-term repercussions in their adult health, educational attainment, and labour market outcomes.

While there is ample evidence in the literature that shocks that alter early-life conditions can have lasting consequences (Almond et al., 2018; Almond and Currie, 2011; Kuh and Ben-Shlomo, 2004), these effects tend to vary dramatically depending on the nature of the shock studied and the context in which the shocks take place and are studied. Thus, it becomes relevant to provide an insight into how certain shocks have played out in the Swedish context, which is renowned not only for political and economic environments aimed at ensuring the welfare of the population, but also for the existence of administrative registers that provide unique opportunities for research interested in long-term effects.

Composed of four self-standing research papers, this dissertation focuses on three very different shocks to early-life conditions, all of which could have plausibly affected the later-life outcomes of the children who experienced them. As stated in the title of the dissertation, the shocks relate to either the disease environment and vaccination, displacement (also known as forced migration), or the death of a family member. In general, the research articles share the same goal of finding out whether living through any of these events during early life substantially alters adult life, measured through different later-life outcomes.

An important definition, before going any further, is what is meant by referring to *early life*. There are several, well differentiated periods of development in human life, for instance, the fetal development stage ends at birth, infancy usually refers to the first year of life,³

²One needs only to watch the images advocating for and against the use of face masks during the 1918 influenza pandemic to recognize today's struggles in past experiences.

³For example, the *infant* mortality rate (IMR), a measure widely used, considers only deaths that happen under the age of 1 (Wachter, 2014).

while early-childhood often refers to the pre-schooling years. However, the papers in this dissertation focus on individuals of different ages and at different stages of development, be it infancy or the first few years of life. In that sense, and to enhance the consistency of terms across all the chapters, I use *early life* as a umbrella term in which infants, toddlers, and older children can be included.⁴ The decision of which specific age range is considered in each study obeys theoretical and/or methodological considerations explained carefully in each paper, as well as in section 3.5 of this introductory chapter.

In the first paper, we look at early-life exposures to disease and medical innovations in order to explore if these had any long-term impact on adult income, education, and health among native Swedes. Epidemic or pandemic outbreaks of disease can threaten the present and future health of exposed children, while new medical innovations can potentially improve the chances of healthy child development. In this paper, we study the case of polio, an infectious epidemic disease, and the introduction of the vaccine against it, which took place in Sweden during 1957. Specifically, in this paper our aim is to answer the questions:

Were there long-term negative effects of early-life exposure to polio epidemic outbreaks? Were there long-term benefits of early-life exposure to the introduction of the vaccine against polio?

In the second paper, I further the study of polio and vaccination, by exploring whether country of origin (and therefore, of exposure to the disease and vaccine) plays any role in how the disease and the inoculation affected the adult outcomes (income, educational attainment, health) of the children who lived through them. I focus this study on a sample of individuals born in a variety of countries, where they were exposed to the introduction of the vaccine against polio, and who then moved to Sweden at some point during their lives.

Leaving the disease environment aside, the third paper of this thesis explores the impact of early-life displacement, or forced migration, on educational outcomes. Displacement alters dramatically both the cultural environment in which child development takes place, and the family resources available for it. The paper analyses one specific bout of displacement that was caused by the war in Yugoslavia during the 1990's, when a large number of displaced individuals sought asylum in Sweden. Focusing on the experiences of young children, this study aims to answer the following question:

Is there any impact of forced migration on the educational outcomes of children who were displaced as a direct consequence of war?

⁴On the use of the term, Heim (2013) notes that it is a malleable term with no generally agreed upon definition, but which many researchers employ flexibly to group individuals from age 0 and up to a certain age, usually setting the upper limit around 12-18 years.

Finally, the fourth paper looks at parental death. Losing a parent during childhood is a shock to early-life conditions which not only implies that children will go through a traumatic experience that will burden them with grief and emotional stress, but it will also forever alter the family structure and the parental resources available to them during their developmental years. This paper follows 14 full cohorts of Swedish-born children up to adulthood, and observes if/when the death of a parent occurred. Specifically, this study aims to answer the question:

How does parental bereavement during early life affect a child's adult income, educational attainment, and health?

Where effects are found, the papers in this dissertation aim at explaining not only the mechanisms that drive them, but also if there are particular periods in early-life where they might become larger or smaller. Where effects are not found, the studies aim at providing a possible explanation of why this might be the case, according to previous literature and the methodological tools at hand. In order to conduct the four articles included in this thesis, I make use of high-quality administrative Swedish data that allows the follow-up of the individual-level experiences of people through an extended period of time. This means that in most cases it is feasible to follow individuals from birth and childhood into adulthood. The administrative records are complemented, whenever needed, with data on each specific shock collected explicitly for that purpose. The research in this dissertation favours the use of methodologies that allow causal inferences to be drawn from the results obtained, and exploits quasi-experimental settings, whenever possible, to identify and isolate the effects of interest.

This dissertation is structured as follows: the rest of the current introductory chapter will provide the essential background and context information in which the papers are set. It will also provide the theoretical framework and relevant empirical evidence on how events experienced in early life can affect later-life outcomes. After reviewing the methods and data used in the papers, it will present a brief summary of the results obtained in each one of them. The introductory chapter ends with a brief discussion on how the results from the studies can be related to the general knowledge in the field. Afterwards, the main body of the dissertation is comprised of four independent research papers, described above and presented in full in Chapters 2-5.

2 Context

As it was mentioned before, the research in this dissertation aims at understanding how different shocks in early life can impact the long-term outcomes of children who live through them. While the shocks studied might be quite different from one another, they all share the common characteristics of (1) being a sudden change in early-life conditions and (2) being studied in a Swedish context. Sweden is, in a manner of speaking, used as a laboratory in which the shocks are studied, the individuals followed, and the outcomes analysed.

Given that the studies in this dissertation deal with shocks and people in the time-frame 1937-2011, this section will present the Swedish context during the years of the 20th and 21st century, focusing on the three particular areas that are most relevant for the studies in this dissertation. It will first present how healthcare provision, including vaccination, developed in the country; it will then describe the migration flows and characteristics that Sweden experienced during the last century, and it finalizes by presenting how the families in Sweden formed and changed in the same period.

2.1 Healthcare and Vaccination in Sweden

At the beginning of the 20th century, Sweden found itself in a rather prosperous position thanks to the years of economic growth that followed the industrialization process. This prosperity brought along higher incomes which allowed further improvements in the dietary access of the population, while continued government expenditures provided more and better housing and access to clean water (Axelsson, 2000). Public health provision in the country had an early start, with the first hospital opening in 1752, and by 1900 both somatic and isolation hospitals were a common sight in most towns in Sweden (Hjortsberg et al., 2001; Lazuka et al., 2016), with most health care being provided in one of these hospitals, as opposed to private practices (Axelsson, 2000). With the exception caused by the 1918 influenza pandemic, health, heights, and life expectancy continued to rise during the first half of the century (Sandberg and Steckel, 1997).

The years between 1920 and 1950 saw an expansion of the welfare state that meant that there was some degree of social security for those who became sick or unemployed, and healthcare was becoming increasingly available and reliable (Sundin and Willner, 2007). The Hospital Act in 1927 gave the regional governments the responsibility to provide inpatient care for all their residents, and over the years they expanded the system to provide also non-hospital medical services such as maternity and paediatric health care. After World War II, the government increased the access to health care by introducing the National Health Insurance Act in 1946. The act allowed the population to get partial reimbursements from physician consultations, inpatient care, and prescription drugs, effectively lowering the cost of health

care provision, substantially increasing coverage, and allowing people with lower incomes to overcome financial constraints in the access to better health (Hjortsberg et al., 2001). The integration into the hospital system of maternity and child health services allowed the country to improve maternal health and significantly reduce infant mortality, which already in 1950 was around 20 deaths per 1000 live births, when at the beginning of the century the rate was over 5 times higher (Burström, 2003). In addition, public health initiatives and the introduction of new treatments, like the sulphonamide (1930's) and penicillin (1940's) antibiotics reduced overall mortality of common and widespread illnesses like pneumonia (Lazuka, 2020).

Vaccines, a particular interest for two studies in this dissertation, came to boost the efficiency of the public health efforts to prevent disease. Between 1940 and 1970, vaccination campaigns against tuberculosis, diphtheria, tetanus, whooping cough, polio, and measles were launched in the country. Epidemics that regularly affected the population were curbed, and diseases like polio were completely eradicated from the country, in this case in less than 10 years after the introduction of the vaccine against it in 1957 (Fagraeus and Böttiger, 1980). A complete list of the vaccination campaigns undertaken in Sweden up to the present can be seen in Table 1.

Table 1: Vaccination Campaigns in Sweden

| Year | Vaccine against: |
|--------------|------------------------------------|
| Early 1800's | Smallpox |
| 1940's | Tuberculosis |
| 1940's | Diphtheria and Tetanus |
| 1950's | Whooping Cough |
| 1957 | Polio |
| 1971 | Measles |
| 1974 | Rubella |
| 1982 | MMR: Measles, Mumps, Rubella |
| 1993 | H1B: Haemophilus Influenzae Type B |
| 1996 | Hepatitis B |
| 2009 | Pneumococcal Disease |
| 2010 | HPV: Human Papillomavirus |
| 2019 | Rotavirus |
| 2021 | COVID-19 |

Source: Data from *Folkhälsomyndigheten*, The Public Health Agency of Sweden.

Note: The year of introduction denotes only when the vaccine was first applied in the country. Some, like smallpox, are no longer in use due to eradication while others, like that against COVID-19, are currently being rolled out to at-risk populations.

In the 1980's, further reforms expanded access to health care to its current universal status. The Health and Medical Services Act (*Hälsa- och sjukvårdslag*) of 1982 states the objective of providing “good health care on equal terms for the entire population”, giving eligible

migrants and refugees access in the same conditions as citizens. The Social Services Act (*Socialtjänstlag*) in 1980 had also determined that the local (*kommuner*) governments would be responsible to provide care of older and disabled people, who had the right to receive public services and help at all stages of life (Burström and Sagan, 2018).

Life expectancy rose throughout the second half of the 20th century, increasing by almost a decade between 1950 and the turn of the millennium, when it passed the 80-years threshold (Human Mortality Database, 2020). This increase in life expectancy was derived from a continuous rise in the living standards, coupled with advances in both medical sciences and public health care infrastructure (Sandberg and Steckel, 1997). In 2014, the Public Health Agency of Sweden (*Folkhälsomyndigheten*) was formed to consolidate all the public health responsibilities at the national level, by merging the Swedish National Institute of Public Health (*Folkhälsoinstitutet*) and the Swedish Institute for Communicable Disease Control (*Smittskyddsinstitutet*). The agency is also in charge of producing environment and public health reports that were once published by the National Board of Health and Welfare (*Socialstyrelsen*) (Burström and Sagan, 2018). The Public Health Agency's main national public health initiatives in recent years are focused on modification of individual lifestyles in order to avoid disease (exercise, obesity, alcohol and tobacco consumption, etc.), as well as increasing attention paid to mental health and to the health-impact of work environments (stress, social networks, etc) (Sundin and Willner, 2007). These strategies aim at diminishing the health disparities across socioeconomic groups and achieving equality in health care provision and availability (Johannisson, 1994). As of 2021, the Public Health Agency in Sweden is in charge of coordinating the national response to the COVID-19 pandemic, both in terms of issuing prevention guidelines and recommendations, and organising, in consultation with other relevant authorities, the vaccination campaign to immunize the population against the disease.

2.2 Migration in Sweden

Sweden's migration flows during the last 120 years can be neatly summarized in three main periods: (1) a period of net emigration lasting until the 1930's, (2) a period of net immigration, mainly of labour migrants, with relaxed immigration laws, that lasted between the end of the 1930's and the end of the 1960's and (3) a period of net immigration, mainly of asylum seekers, with restrictively regulated immigration covering from the end of the 1960's until today. The emigration and immigration flows that occurred in Sweden during 1900-2019 can be seen in Figure 1.

Since around the middle of the 19th century, Sweden became a country with net emigration, with more people leaving than arriving in an annual basis. Hard conditions in the country forced over a million Swedes to leave for greener pastures and try their lucks mainly in the United States, but also in Canada, Australia, or even South America. This *great emigration*

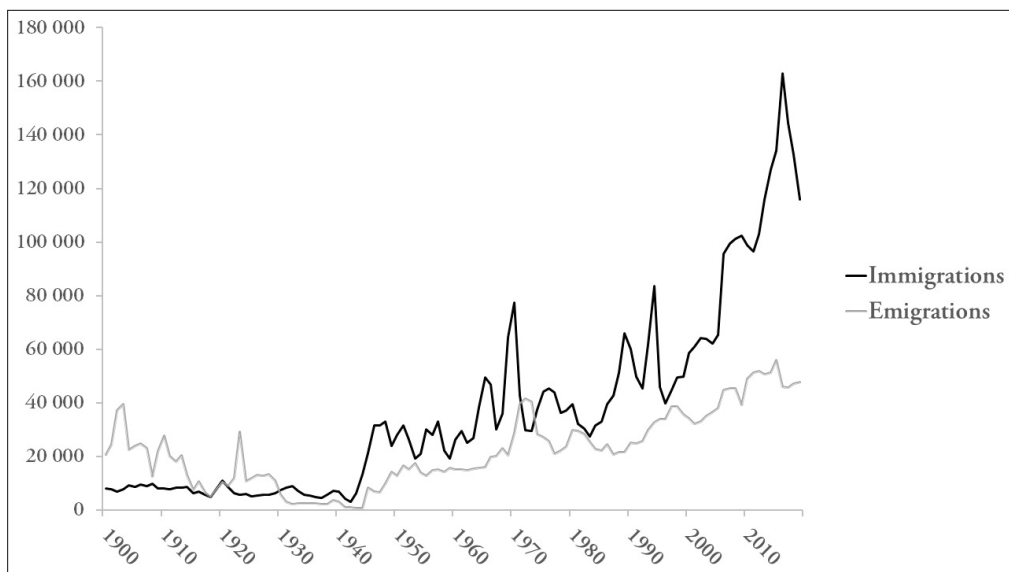


Figure 1: Migration flows in Sweden 1900-2019
 Note: Author's elaboration with data from Statistics Sweden

had tangible and sizeable effects in the Swedish society and, perhaps more importantly, the labour market and the industrialization of the country. With trans-Atlantic emigration effectively draining the supply of labour, wages rose in Sweden. Along with industrialization, this incentivized structural economic change, since traditional low-productivity sectors could not afford to pay higher wages while newly emerged, high-productivity branches of industry could. The great emigration of Swedes is at least partly responsible for kick-starting the industrialization process in Sweden, and the higher salaries caused by the shrinking labour supply may have helped raise the living standards for those who remained in the country (Ljungberg, 1997). The World Wars, jointly with more restrictive immigration laws in the United States, slowly stopped the flow of migration out of Sweden, and by the end of World War II, immigrants into the country outnumbered those who emigrated.

The second period, which can roughly cover since the end of the 1930's until 1967, saw Sweden become a net immigration country. Early in the period refugees from other European countries sought asylum in Sweden either during or after World War II. Given Sweden's neutrality position, the country emerged from the war years in better shape than most European countries and, particularly advantageous, with an intact industrial complex. The post-war years were ones where the booming Swedish industry required hands a plenty, and so friendly immigration policies were put in place. For instance, the Common Nordic Labour Market agreement made it easier, beginning in 1954, for citizens of other Scandinavian countries to move to Sweden to work, without a pre-arranged job offer or other usual requirements. After this inflow of workers proved insufficient to meet the demand, the visa

and requisite exemptions were expanded to include nationals from other European countries, issuing in large scale immigration from Austria, Germany, Italy, Yugoslavia, Turkey, and Greece (Bengtsson et al., 2005).

The third period, beginning in 1968 and extending until the present, is one in which the immigration laws were tightened, in order to reduce the flows of labour migrants. Labour unions in the 1960's argued that employers were deliberately employing immigrant labourers in order to depress the salaries paid to all workers, native and foreign alike. As a result, they pressed for more restrictive immigration laws, and in 1968 the new regulations all but halted the labour-migrant flows into the country, by requiring that work-migrants arrange employment, housing, and the work permit before travelling to Sweden. Furthermore, employers seeking to hire migrants instead of Swedes needed to provide motivation to justify their choice, and labour unions were empowered to evaluate and decide upon the adequacy (or lack thereof) of these motivations. When in 1972, the Swedish Trade Union Confederation recommended that trade unions rejected all the work applications of non-Nordic citizens, labour migration outside this group became almost impossible (Bengtsson et al., 2005). During this period, labour migration steadily gave way to asylum-seeking and family reunification migration the main reasons for immigration into the country.

Waves of immigration into Sweden since in the last 50 years have roughly corresponded to bouts of conflict, disaster, or war somewhere else in the globe, with Sweden being sought after as a safe haven for the affected populations. In the 1970's, asylum seekers entering the country came primarily from Chile, where they were escaping a recent military coup and the subsequent military regime of Augusto Pinochet, and from El Salvador, where they were attempting to escape civil war. During the 1980's conflicts in Ethiopia, Iran, and Iraq were the main reasons for people to flee their homes and immigrate to Sweden. Of particular interest to one of the latter chapters of this dissertation, immigration during the 1990's was decidedly marked the conflict in Yugoslavia, as the federation disintegrated through a civil war that would end up displacing over 2.2 million people, of which Sweden ended up granting asylum to over 100,000 individuals (Migrationsverket, 2020). While the first years of the new millennium were characterized by family-reunification immigration, this scene rapidly changed in the mid-2010's when conflicts broke out in several Muslim-majority countries, among them Afghanistan, Iraq, Somalia, and most notably Syria. This multi-origin wave of asylum seekers attempting to find refuge in European countries pushed the continent's humanitarian response to a breaking point in 2015, with over 1.3 million asylum seekers applying to reside in different countries in the continent. During this year, Sweden received more refugees than any other country in the European Union, with almost 163,000 displaced individuals applying for settlement in the country on humanitarian grounds (Migrationsverket, 2020).

In order to deal with the growing number of refugee migrants, beginning in 1985 the Swedish Migration Agency was given responsibility to randomly assign refugees to live in

municipalities all across Sweden (Vogiazides and Mondani, 2020).⁵ This strategy, known as “Whole Sweden strategy” (*Hela Sverige strategin*) was aimed at avoiding large concentrations of refugees in the large metropolitan areas, and to help spread the cost of supporting refugees (especially housing and language courses) across all the municipalities in Sweden. While this policy was also targeted at increasing integration of refugees into Swedish society, there is evidence it might have achieved just the opposite. The placing of refugees across Sweden was guided mostly by housing availability, and had little regard for labour market conditions at the destination. This may have actually made it harder for refugees to find a job, and the consequential idleness of migrants placed according to the strategy remained elevated even after almost a decade of residence in Sweden (Bengtsson et al., 2005; Ekberg and Hammarstedt, 2002). The placement strategy was strictly enforced until 1991, and as the unusually large refugee wave from the Yugoslavian war entered the country in 1993-1994, the Migration Agency reverted to allowing asylum-seekers to select their own residence municipality, a freedom that remains to this day.

The shift in immigration policy during the 20th century fomented, at least to a certain degree, a rebalance away from labour migration and into asylum-seeking and family reunification migration that has been also partly corresponded with a worsening in the perception of foreign-born individuals in the country.⁶ As the share of immigrants in need of asylum and humanitarian help grew over time, so did the perception of foreigners as a net burden to Swedish society among native Swedes. In recent years, there has been a rise in right-wing political movements that have made restricting refugee migration, particularly from non-Western and Muslim-majority countries their main driving ethos. Furthermore, this phenomenon is not exclusive to Sweden, but is observable in many European countries such as Austria, France, or Germany (Lucassen and Lubbers, 2012; Steinmayr, 2017). As a global pandemic disrupts the continent’s economic and social life at the beginning of the 2020’s, it remains to be seen how European (and Swedish) migration systems will deal with the pressure caused by the sudden lack of seasonal immigrant workers, and whether or not the legal framework to immigrate are changed accordingly.

2.3 Families in Sweden

The last 120 years have been of profound transformation for Swedish families, as the country has moved away from the traditional process of family formation and into a more diverse and modern one, where marriage is not a prerequisite to childbearing and family dissolution

⁵At the peak of the short-lived policy, 277 out of 284 municipalities in Sweden participated in it.

⁶Structural change in the economy, with the service sector rising in importance over agriculture and industry, was also responsible for the change. Since the new jobs available raised the importance of country-specific skills, such as language and cultural proficiency, the demand for foreign labour decreased (Rosholm et al., 2006).

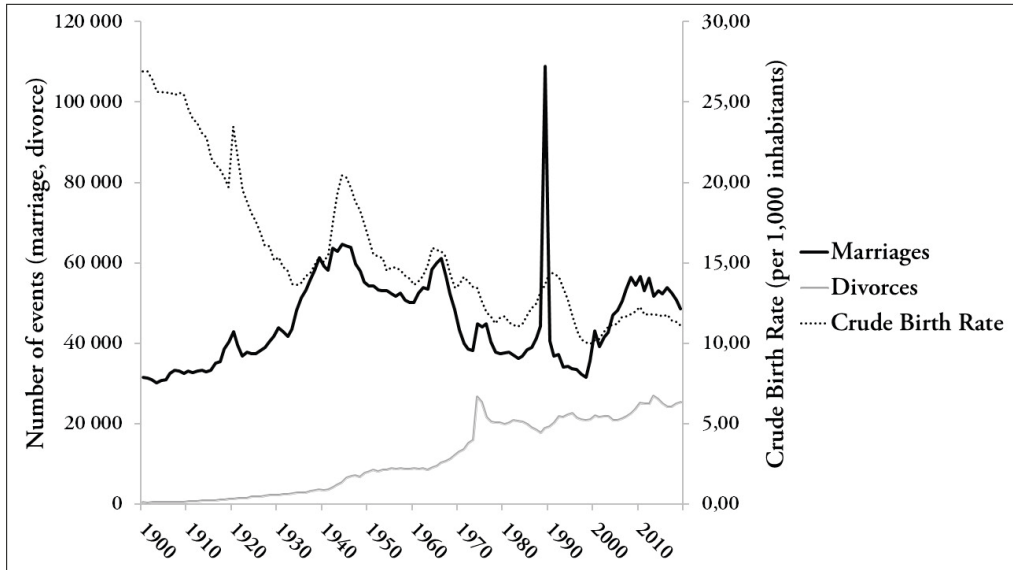


Figure 2: Marriages, Divorces, and Fertility in Sweden: 1900-2019
 Note: Author's elaboration with data from Statistics Sweden

is commonplace. The long-term changes in marriages, divorce, and fertility in Sweden can be seen in Figure 2.

At the beginning of the 1900's, as previously mentioned, Sweden was losing people to emigration, so policies in the country aimed at encouraging childbearing and maintain the population. For instance, a law passed in 1910 made it illegal to sell, or even provide information about, contraceptives (Wells and Bergnehr, 2014). During the first years of the century, a rise in the price of milk and butter, relative to that of grain, raised the opportunity cost of childbearing, since dairy and milk processing were traditionally women's work in the agricultural setting of the time. Fertility in the country declined as a consequence of this price change (Schultz, 1985).

During the 1930's fertility fell to unprecedented levels, with Sweden having the lowest birth rate in the world and also one of the lowest net reproduction rates (Kälvmemark and others, 1980). To try to offset this decrease in population and fertility, during the 30's and 40's the public authorities implemented a series of reforms intended to facilitate the process of childbearing and of family formation. In 1934, prominent politicians, through a book called "Crisis in the Population Question" (*Kris i befolkningsfrågan*) called for the abolition of the contraceptive law of 1910, which was finally repealed in 1938 (Kälvmemark and others, 1980). Other policies during the 1940's allowed combining paid work with child care, and granted parents a general child allowance (Wells and Bergnehr, 2014). During these decades, the authorities assumed greater responsibility for providing childcare and education.

Nurseries and playschools (*leksskolor*) became widespread in this period, and free school meals were also introduced to promote better child health (Skolverket, 2000; Wells and Bergnehr, 2014).

During the period covering 1950-1970, fertility remained generally low, and family dynamics changed, with the decreasing rates of family formation and rising rates of divorce in the country. Non-marital cohabitation, non-marital childbearing, union dissolution, and step-family formation all became widespread phenomena in Swedish society (Ohlsson-Wijk et al., 2020). Female labour was in high demand in the post-war years and policies were introduced to facilitate infant and childcare. For example, in 1955 Sweden guaranteed three months of paid maternity leave for all mothers (Wells and Bergnehr, 2014), while in the 60's the government appointed the National Commission on Child Care (*Barnstugeutredningen*) in order to improve child care provision and raise the standard of the social, educational, and supervisory services provided to Swedish children (Skolverket, 2000).

Marriage rates continued to drop in Sweden during the 1970's, and fertility rates remained around replacement level in the period. Laws in this period granted women the right to abortion (up until the 18th week of gestation), facilitated marriage dissolution by permitting divorce without a particular reason (1974) and granted fathers the same rights to parental leave as mother's had enjoyed since the 1950's. The 1980's saw a marked increase in fertility all over the country, and also marriage rates increased during the decade, mostly as new rules regarding the access to widow's pension were introduced in 1989 (Hoem, 1991). By the end of the decade, high-quality child care facilities, both nurseries and preschools, became more and more available and affordable to working parents (Skolverket, 2000; Wells and Bergnehr, 2014). In recent years, there was a period of increased fertility among Swedish families that lasted between 1997 and 2010. Marriage now generally occurs at a later stage of people's lives, as they take into consideration economic and relationship stability before marrying, which usually means that childbearing in Sweden precedes marriage itself, a trend that is observable across the Nordic countries (Holland, 2013). Policies on parental leave and childcare provision have changed the gender relations in Swedish families, and gender equality remains a top policy priority. The government has aimed at adapting the laws to the demographic change that the Swedish families have undergone recently, with non-marital cohabitations being a more common family configuration. In 2009, same-sex marriages were recognized in the country, and Swedish policy has aimed at providing equal rights and access to child care for all different types of families (Wells and Bergnehr, 2014). The high rates of divorce and family dissolution have been accompanied by an increase in the shared custody of children, since all parents are more involved in family- and care-oriented activities, and as children's right to equal access to both parents has been recognized (Ohlsson-Wijk et al., 2020). The change in family policies during the last few decades have allowed the Swedish family to be more varied and more gender-equal than almost anywhere in the world.

3 Theory and Previous Research

As previously mentioned, the main aim of the studies in this dissertation is to look at events that occurred during early life and find out whether they had any long-term effects on adult outcomes. The literature that has explored similar questions in the past is quite extensive and, as it often happens, the answers come from different areas of scientific research. While the phenomenon studied is the same, the approach varies as different sciences conceptualize the way in which early-life conditions affect individuals throughout their lives. In this section, consequently, I present the argument in support of the hypothesis that early-life shocks can, through different pathways, impact later-life outcomes. In order to fully appreciate how different areas visualise and operationalise this relationship, I present the evidence separately for (1) medical/epidemiological research, which focuses on health and bodily adaptations to shocks, (2) economic research, which emphasizes on how the process of human capital formation is affected, and (3) the psychological research, which highlights the importance of stress and grief as the main mechanism through which effects can be found. But before that discussion, I present a brief overview on how research from all areas has changed their focus through time, from favouring cohort-oriented to period-oriented approaches to the question of early-life shocks.

3.1 Early-life shocks: Cohort and Period Effects

There are two basic ways to conceptualize the study of long-term effects of events that happen in early life, that is, they can be thought of as period or cohort effects. A period effect is generally some change that affects everyone alive at some point in time, regardless of age, for example, everyone alive during 1918 was exposed to the influenza pandemic of that year. In this scenario, the research simply chooses to focus on people who were in early life at the time and follows them through time. If we think instead of cohort effects, we are referring to shocks that affect a particular subset of the population that shares a temporal experience (e.g. a birth cohort). For example, babies whose gestational development happened during the Dutch famine of 1944-1945 were all exposed to worsened foetal nutrition, and the health effects can thus be followed as the cohort ages.

If we look at the ultimate long-term effect, that is, the study of mortality, we find that across time, research has focused on either period or cohort factors as a way to explain why it mortality has changed, say, for everyone at different points in time, or between different cohorts. For instance, the decline in mortality that happened in Western countries between the 18th and 20th centuries has been attributed (partly, or jointly) to period effects associated with improvements in public health, like better sanitation or medical breakthroughs (Easterlin, 2004; Preston, 1975, 1976), better living standards and improved diets (Floud et al., 2011; Fogel, 2004; McKeown, 1976). Research has also identified cohort effects that

contributed to the mortality decline, such as improvements in the disease environments in childhood (Fridlitzius, 1989; Kermack et al., 1934) or the foetal development consequence of better maternal nutrition (Fogel, 2004).

Studies of early-life shocks employ either a cohort or a period perspective depending on the nature of the shock, the mechanism hypothesized, and the data available to conduct the research. To get a better understanding of how different shocks have been studied in the past, and to gain an insight into the different approaches across disciplines, the following sections discuss evidence from medical, economic, and psychological research.

3.2 Medical/Epidemiological Evidence

The notion that early-life environments, through protective or risk factors, may have an effect on later-life health has been formally around since the early 20th century, when Kermack et al. (1934) proposed that improvements in early-life conditions contributed to the great mortality decline, through their effect on children. They tested their hypothesis using data for England, Wales, Scotland, and Sweden, and calculated a cohort's relative mortality level. They found that, after surviving the first years of life, which have specific mortality risks, each generation carried with them their relative mortality all the way to adulthood and old age. This, in their view, is consistent with the hypothesis that the early-life environment (up to age 15) is an important factor in determining later-life health and mortality. They mention that environmental changes after early life seem to have little direct effects on later-life mortality.

In the years since, substantial research studies have employed life-course approaches to understand the long-term impact of early-life environments on adult health, especially focusing on the epidemiology of chronic illnesses that are nowadays common in the developed world (Kuh and Ben-Shlomo, 2004). It has produced two main theoretical models of how these mechanisms are at work in the human body, the *critical periods hypothesis* and the *accumulation of risk hypothesis*. In the first of these, early-life events and environments have an impact on later-life health because of the existence of certain time periods where the human body is more vulnerable. For example, most organs' development process during the first years of life is not a constant one, but experiences periods of increased growth at some points and slows down at others, a rhythm that is mirrored by other physiological processes like height increases (Tanner, 1989). Damage done or avoided during these so-called critical periods can increase the risk of suffering disease in later life. Any period or stage during development in which there is an increased sensitivity to environmental risks can be labelled as a critical period (Hallqvist et al., 2004). This theory is closely related to the studies in this thesis, since they all examine periods of early life to determine whether they are periods of vulnerability to different shocks.

Most influentially perhaps, the research of Barker (1990, 1994, 1995) and Barker and Osmond (1986) has identified *in utero* and neonatal development as critical periods in which adverse environmental changes can program or predispose the onset of disease in adulthood and later-life. Barker and Osmond (1986) looked into the incidence of ischaemic heart disease in England and Wales in 1969-1978 and concluded that the early-life environments faced by the cohorts studied, as captured by the infant mortality rates in 1921-1925, were highly correlated with disease incidence. The relationship between neo- and postnatal mortality and ischaemic heart disease, which is more prevalent in rich countries, suggests that poor early-life environments increases the susceptibility to the effects of an “affluent diet” (Barker and Osmond, 1986). Barker (1994) presented evidence that there is an existing link in developed countries between (1) weight at birth, infant weight and cardiovascular mortality, and (2) between weight at birth, blood pressure, and glucose tolerance (diabetes type II). The causal mechanism postulated by Barker and colleagues is related to inadequate development in the uterine environment due to poor or insufficient maternal nutrition. This inadequate development then triggers a disproportional retardation in foetal growth (Barker, 1995) in a down regulation process that results in low weights at birth, a mechanism that is also implicit in the body size adaptation process described by Fogel (1994) and Fogel and Costa (1997).⁷ Research on the foetal origins of adult disease hypothesis (also known as the Barker hypothesis) has found and demonstrated links between poor environments in early-life and the onset of a range of diseases that go from ischaemic heart disease to hypertension, diabetes type II, obesity, chronic thyroiditis, and even breast cancer (Barker, 2012).

The accumulation of risk hypothesis, on the other hand, postulates that early-life health insults affect later-life because each exposure increases the risk of suffering disease in adulthood, and this risk accumulates throughout the life cycle (Hallqvist et al., 2004; Mann et al., 1992). Mann et al. (1992) studied this hypothesis by focusing on the respiratory health of a 1946 birth cohort in England, Scotland, and Wales. They find the accumulated risks from childhood exposures to atmospheric pollution, poor social circumstances, and particularly childhood illness all predict the incidence of adult lower respiratory problems, concluding that these determinants of adult disease have independent effects, but interact when experienced together, accumulating the risk of disease over time. Further studies have corroborated that, indeed, hardship in early-life, either economically or health defined, increases the risk, through accumulation, of suffering hardship and disease in later-life. For instance, Lynch et al. (1997), using a sample of individuals from the U.S. who were around retirement age in 1994, found that those who had experienced economic hardship, and particularly so those with repeated episodes of hardship in earlier years had increased risks for suffering depression and needing assisted living conditions in later-life, pointing to the conclusion that economic hardship, through risk accumulation, leads to poorer physical,

⁷This process of physiological changes in response to environmental factors is also known as developmental plasticity in the field of human evolutionary biology (Ellison, 2005).

psychological, and cognitive functions in later-life (Lynch et al., 1997). In a study following a British cohort of individuals born between 1937 and 1939, Holland et al. (2000) found that health disadvantages during childhood (lower height, chronic diseases, inadequate nutrition) exacerbated the effects of health-damaging environments experienced in adulthood (air pollution, smoking, residential damp). They also found substantial differences in the way these risks accumulate according to gender and social class. Of the studies in this thesis, paper III relates somewhat closely to this hypothesis, since it examines an early-life experience of hardship brought about by armed conflict.

One mechanism through which childhood diseases increase the risk of later-life ailments is known as the *inflammation hypothesis*. It is thought that diseases and infections that cause inflammation during childhood affect the immune system and predispose individuals to suffer during later-life chronic illnesses with inflammatory components. While this hypothesis was first discussed during the early 19th century, it has re-emerged since the 1970's as an explanation for the onset of diseases such as atherosclerosis (Benditt and Benditt, 1973; Mattila et al., 1998; Nieto, 1998) cardiovascular diseases, and strokes (Finch, 2010; Mattila et al., 1998). For instance, in a study using macro-level data for Swedish cohorts between 1751 and 1940, Finch and Crimmins (2004) find that later-life mortality is related to exposures to inflammatory disease in early-life, which implies there is an "imprint of early exposures" on the cohort's morbidity and mortality. They relate their findings to the secular mortality decline, claiming that it was brought about by improved childhood health and survival, reduced exposures to chronic inflammatory diseases, and improved medical and economic environments (Finch and Crimmins, 2004). In this thesis, papers I and II study the case of avoiding an infectious disease that caused inflammation.

3.3 Economic Evidence

In the field of economics, research has focused on how the process of human capital accumulation responds to changes in the early-life environment. Since health is a vital part of both human capital levels and the accumulation potential for the future, most analyses focus on the role of an early-life health shock on later life human capital. There has been in the last two decades a renewed interest in exploring the process of human capital accumulation with relation to early-life investments.⁸ In this section, I present briefly the theoretical model through which economists study early-life investments or shocks that alter human and health capital formation, and discuss some notable studies that are related to later chapters of this thesis.

The main driver behind human capital theory is the notion that economies, countries, and societies can derive economic benefits from investing in its people. Expenditure in human

⁸For systematic reviews of this literature, see Almond and Currie (2011) and Almond et al. (2018).

capital is thus considered a form of investment, which is clearly differentiated by its returns from other forms of expenditures, like consumption, that while necessary provide little to none added benefits. Originally, the term human capital, perhaps influenced by the Solow-Swan model (Solow, 1956; Swan, 1956), focused exclusively on the role of education (Becker, 1964), through its most easily quantifiable aspect: formal schooling. However, this definition quickly broadened to include formalized education in different levels (Cohn and Geske, 1990), informal education acquired both at home and at work (Schultz, 1981), formal on-the-job training, job experience, and apprenticeships (Mincer, 1974), and vocational education in secondary and post-secondary levels (Corazzini, 1967). Furthermore, the health and nutritional status of individuals was also rapidly considered not only an active component of human capital (Schultz, 1981), but also as an input to the generation of other forms of human capital, since unhealthy individuals are not only less productive but at the same time they are less likely to make substantial investments in their own skills or education (Bleakley, 2010a). The relation between the health and education components of human capital is also acknowledged bidirectional, since educational investments usually have a positive impact on health status as well (Schultz, 1963).

Shocks to a person's human capital, particularly focusing on the health status of a person, usually follow the model proposed by Grossman (1972), in which the future health of a person is determined by present health stock (which depreciates over time) and by health investments made in the present. If the critical periods hypothesis is assumed to be true, one can also characterize health investments made during early life to have higher returns than those made at older ages. Consequently, shocks in early life can affect adult outcomes in two ways: (1) via its effect on the total investment level in early and later life, and (2) via the effect on the period where it happens, which might be a critical period where investments are not so easily substituted or compensated later (Currie and Almond, 2011).

Empirically, studies have tested this model and explored the effect of a wide variety of early-life shocks on adult outcomes. Here I discuss some of the ways in which studies have looked at early-life shocks similar to those included in the studies that make up the remainder of this thesis, namely disease outbreaks, new drug or treatment introductions, war or armed conflict, displacement, and parental loss.

For the case of diseases, research has looked at the effects that exposures to particular outbreaks of disease can have on later-life outcomes ranging from economic, and cognitive, to health and mortality. A usual way of measuring exposure to particularly bad disease environments in early-life is to look at outbreaks of disease (natural experiment) and, when those are not available, at the infant and child mortality rates in the first years of life. In this last case, researchers look instead at deviations from the trends in infant and child mortality that children were exposed to in their particular region of birth to determine if they faced a worse-than-average disease environment in early-life. Case and Paxson (2009) look at such exposures using data from the United States. They measure early-life disease environments

by looking at infant mortality rates and also at mortality rates by disease (typhoid, malaria, influenza, measles, and diarrhoea). They find that the disease environment in early-life is associated with poorer performance on cognitive tests in old age (ages 50-90), like word recalling or counting backwards. Chay et al. (2009) look at the achievement gap among black and white applicants to the U.S. military. They find that the gap in test performance is partly attributable to different disease environments in early-life, measured through post-neonatal mortality rates. Almond (2006) studies the 1918 outbreak of influenza using U.S. census data to analyse how cohorts *in utero* during the pandemic were affected. He finds that this prenatal exposure resulted in lower educational attainments, incomes, and socioeconomic status, as well as higher rates of disability and transfer payments compared to non-exposed birth cohorts. Similarly, Myrskylä et al. (2013) found that cohorts born in the U.S. during the peaks of the pandemic saw an increase in their old-age non-cancer mortality rates (which includes respiratory and cardiovascular disease mortality), which they hypothesize might be related to inflammatory or apoptosis effects. Bengtsson and Lindström (2003) look at exposures in the year of birth to airborne infectious diseases in later-life mortality, using historical data for Southern Sweden. They find that being born in a year with a worse-than-usual disease environment led to an increase in old-age mortality (ages 55-80). Using similar data and with a focus on infant mortality rates, Bengtsson and Broström (2009) find that the disease environment in early-life directly limits the ability of individuals to accumulate wealth throughout their lives. Also for the case of Southern Sweden, Quaranta (2013) finds that, for Swedish women, being born in a year with a high disease load (including diseases such as measles, scarlet fever and whooping cough) lowered their probabilities of attaining a high socioeconomic status in adulthood, and their offspring's sex-ratio and neonatal mortality rates.

Avoiding disease, or improving one's fighting chances against it, has been considered a positive shock to the process of human capital formation. Bleakley (2007), looked at a medical intervention that successfully eradicated the hookworm parasite among around 400,000 individuals living in the U.S. South circa 1910. Taking advantage of differences in incidence rate of the parasite across diverse areas of the South, Bleakley estimates that children from areas with higher incidence of the disease benefited in a greater measure from the eradication, finding that the treatment led to increased school enrolments, attendance, and literacy after the intervention. Since learning and school attendance were severely affected by the parasite, Bleakley argues that the intervention also increased the returns to schooling in the area. Later, Bleakley (2010b) analysed the role played by malaria eradication in the U.S., Brazil, Colombia, and Mexico, at the beginning of the 20th century. He finds that, relative to areas where malaria incidence was low, children born after the eradication took place went on to earn higher incomes as adults than those cohorts born before eradication. The effect is quite large, ranging from a 12% increase for the U.S. cohorts, to a 40% increase for those in Latin American countries. Interventions such as this, the author argues, can help to partially explain regional and international income differentials.

For the case of Sweden, two recent studies have looked at the long-term effects of medical innovations during early-life. Lazuka (2018) studied the long-term impact of being born with the assistance of a qualified midwife on the health outcomes of individuals born 1881-1930. Following the individuals until age 80, Lazuka found that, in the short-term, having a qualified midwife reduced neonatal mortality, and in the long-term, it reduced CVD and diabetes mortality at ages 40-80, as well as reduced morbidity and improved the skills for males at ages 19-21. In another study, Lazuka (2020) looked at the effect of the introduction of a new medical treatment, sulpha antibiotics, against pneumonia during the 1930's. Using a similar methodology to that of Bleakley (2007), she finds that cohorts exposed to sulpha antibiotics in early-life went on to earn labour income in late adulthood that was between 2.8% and 5.1% higher than that of their non-exposed counterparts.

On the topic of war, armed conflict, and forced migration, infants and children are known to suffer immediate and short-term consequences from living through an armed conflict, these include a higher mortality rate and higher chances of being underweight (Guha-Sapir and van Panhuis, 2004; O'hare and Southall, 2007). Looking at long-term effects of exposures, however, Bundervoet and Franssen (2018) studied the impact of the Rwandan genocide of 1994 on the outcomes of children who were exposed to it during gestation, and found that this *in utero* exposure affected educational attainments. According to this study, children who were exposed to the genocide during their first or second trimester of gestation completed 0.3 fewer years of education, and were 8% less likely to finish elementary education, than children who were born just a couple months later. The authors argue that while armed and violent conflict is known to affect school-aged children, their results show that even those exposed *in utero* to the violent outbreaks might benefit from public policies aiming at compensating for this exposure.

Studying the case of exposure to the Angolan civil war (1975-2002), Avogo and Agadjanian (2010) compared the short- and long-term mortality of (1) children who were forced to relocate because of the conflict, (2) children whose families also migrated but not directly because of the conflict, and (3) non-movers. They found that, indeed, exposure to forced migration in childhood increased the mortality hazards in the short-term (immediately after displacement) and even in those children born after relocation (through worse parental medical care and child's neonatal care). Verwimp and Van Bavel (2005) analysed the fertility differences across refugees forced out of their place of origin by armed conflicts in Rwanda between 1960 and 1990. They found that refugee women exhibited higher fertility after relocation, but their children had lower chances of survival, with newborn females facing worse odds than their male counterparts, which suggest that sex ratios change as consequence of forced migration. Saarela and Elo (2016) studied the case of the Finnish ceded Karelia, a region of Finland that was relinquished to Soviet control during World War II. Residents of the region were forced to leave and relocate in other regions of Finland, providing a natural experiment to study the long-term health effects of experiencing

forced migration during early-life. They found no evidence of long-term effects from the sudden migration shock on the adult health (ages 43-65) or mortality (ages 43-84) of those who experienced displacement during early-life. Saarela and Elo actually found that forced child migrants went on to have lower odds ($\approx 6\%$) of requiring sickness benefits than other Finns, and equal or lower chances of requiring disability pension than people born outside of Karelia (equal odds for men, women 16% lower odds). They hypothesize that this lack of negative effects from displacement might be related to how the forced migrants adapted into their new homes somewhere new in Finland. People in places that received Karelians were said to be generally supportive of their displaced compatriots, providing assistance and integration efforts that benefited the forced migrants. Saarela and Elo argue that this points towards the importance of the receiving environment on the outcomes of those who experience forced migration in early-life.

In the same direction, Nakamura et al. (2016) studied a volcanic eruption in Iceland during 1973 that forced the entire population ($\approx 5,000$ inhabitants) of a small island to move away to a safe location either temporarily, during the 5 months that the eruption took place, or in some cases permanently. They found that those who experienced the forced relocation when they were younger than 25 years of age saw a considerable improvement on their lifetime earnings of around 60% and in their educational attainment by around 3.5 extra years of schooling, with these effects not being present in those who experienced the eruption and displacement after the age of 25. They interpret this *gift of moving* as being related to comparative advantages of educated people who got to relocate to a place where their education was better suited to the market's need. The affected island's economy was heavily based on fishing and fish processing, which meant that educated people living on the island were not fully exploiting their human capital, a situation they were able to correct after moving away to places like Reykjavik. Young people and children, who had yet to finish their studies, thus benefited from a more diverse economy and labour market elsewhere, as compared to their prospects on the island, which also helps explain why the older cohorts did not see any benefits from moving, given that their education was fixed and adaptation was harder.

Finally, on the topic of parental loss during childhood, Rostila and Saarela (2011), using data from Sweden, found that losing a parent in early-life is associated with an increased risk of mortality in later years. Berg et al. (2014) found that parental loss in early-life is reflected in lower grades and higher chances of school failure by age 16. Similarly, Amato and Anthony (2014) found that the increased stress created by the loss of a parent in childhood is associated with worse school-age outcomes such as reading ability and interpersonal skills. Furthermore, Black et al. (2016) found that parental loss grief can affect multiple generations, by measuring outcomes of children who were *in utero* when their mothers lost a relative, finding this shock can contribute to reduced birth weight.

3.4 Psychological Evidence

The psychological literature has long held that stress plays an important role in the development of psychological disturbances and is considered an important risk factor for mental health and cognitive development (Hawkes, 1857; Hinkle, 1974; Rees, 1976; Rosen, 1959). The main framework in which this phenomenon has been studied since the 1970's is called the *diathesis-stress model*. Based upon the works of Rosenthal (1963, 1971), this model conceptualizes stress and stressful events as triggers or tipping points that can contribute to how our bodies express biological and genetic vulnerabilities (diathesis) through, for instance, the onset of disease (Monroe and Simons, 1991). In this context, for example, while people have different degrees of genetic predisposition to suffer from mental illness, experiencing stressful or traumatic events in early-life, such as abuse or the loss of a parent, can largely contribute to how this predisposition is expressed in the onset of, for instance depressive symptoms, with children exposed to higher levels of stress or trauma also displaying higher levels of mental illness morbidity (Robins and Block, 1988). It is important to differentiate, however, between what is general and what is disease specific. While the diathesis relates to predispositions to specific diseases, like a particular gene or hormone, the environmental stressors can facilitate the expression or onset of one or more diseases depending on the individual.

Rosenthal (1963) proposed that certain diseases, like schizophrenia, have a pathological process that obeys mainly two components. Genetic inheritance will make one more or less predisposed to suffer from the disease in later-life, but the environment one lives in can determine and alter the timing of the onset, and even whether or not the genetic predisposition is clinically manifested. Rosen (1959) argued that this environmental role is due to the fact that mental health and illness have a markedly social aspect. In his study of social stress and mental disease, he notes that for humans to achieve and maintain mental health, they must live in an environment that provides them with opportunities for self-expression and social usefulness, and that a failure of the social environment to provide these can lead to mental illness. Rees (1976) stressed the role of early life as a critical period by claiming that stressors and environmental factors experienced in childhood can influence one's ability to deal with and respond to psychological stress later in life, which he argues constitutes the precursor of mental and other illnesses like asthma, allergies, and ulcers. Monroe and Simons (1991) found that stressors and shocks across the lifetime could interact with personal predispositions in the onset of depressive symptoms, while Brodsky (2016) recently found that the environment in early-life could increase the diathesis for behaviours such as non-suicidal self-injury (NSSI) and suicidal injuries, not only through psychological processes, but also through the alteration of biological neurotransmitter systems. Brodsky's study is particularly relevant for this thesis, since one of the early-life stressors in her research is low levels of parental care, which can be a consequence of parental loss as studied in paper IV. Brodsky found that low parental care had a great impact of NSSI and suicidal behaviour

among a sample of depressed adults, with low maternal care associated with higher incidence of suicidal attempts and low paternal care associated with higher incidence of NSSI. The onset of depression has also been shown to interact with and alter cognitive processes and functions years after exposures to environmental stress (Robins and Block, 1988). In this sense, stressful events in early life have potential long-lasting effects on outcomes beyond the direct links studied in the mental health literature, given that early-life stressors have been found to impair cognition processes (Kovacs and Goldston, 1991), which could result in spillovers through educational attainment differentials.

3.5 Early-life shocks explored in this thesis

Three distinct shocks in early-life are studied throughout the remaining chapters of this thesis. These range from medical innovations that meant general improvements in public health, to displacement or forced migration caused by war environments, to family ruptures that forever alter the parental investments during the childhood years. Below is a detailed description of each of the shocks, some background information, definition of early-life years comprised, and the way in which they are included and studied in this dissertation.

The introduction of the vaccine against polio

Acute Poliomyelitis, commonly known as *polio* for short, is an extremely infectious disease caused by exposure to any of the three versions of the enterovirus known as poliovirus. Transmitted by contact with human waste via the oral-faecal route, infection with poliovirus begins in the digestive tract and can have two main outcomes: either (1) the individual experiences mild to moderate flu-like symptoms followed by a complete recovery (known as inapparent infections) or (2) the infection progresses out of the digestive system and begins attacking nerve tissue, particularly by causing inflammation in the grey matter tissue of the spinal cord (Nathanson and Martin, 1979). While the second scenario is considered a rare outcome, with less than 1% of total infections progressing to that stage, it is also the most well-known, since the irreversible damage done to the nerve tissue means individuals will be left with some degree of permanent loss in muscle strength, which can range from leg weakness to full body paralysis. Mortality among paralytic polio patients is highest for those whose paralysis reached the diaphragm muscles, compromising autonomous breathing, and is an extremely rare outcome of infection with mortality rates of around 0.02-0.05%. No cure is known for the infections, once it occurs, and prevention through vaccination is the main strategy around the world to fight the spread of the disease (Paul, 1971).

Papers I and II focus on how a medical innovation, the vaccine against polio, affected the adult income, education, and health of those exposed to its introduction. Salk (1955) was the first to succeed in manufacturing an effective vaccine, based on the ground-breaking

research of Enders et al. (1949) who had found, just a few years previously, how to grow cultures of the virus without using live human nerve tissue (people). The Salk vaccine contained killed copies of the virus and was injected subcutaneous or intramuscularly. A few years later, in 1961, Albert Sabin would succeed in creating a vaccine with live, weakened virus that could be administered orally (Sabin, 1962), which was crucial for mass vaccination in developing nations where sterile needles were limited or not readily available. Both vaccines provide immunity against the disease and prevent any degree of paralysis, with the Sabin vaccine also protecting against the initial gastrointestinal infection (Gotheffors, 2008; Paul, 1971).

For paper I, we look specifically at the introduction of the vaccine against polio in Sweden, which occurred during 1957. After recurring epidemics all during the early 20th century, the Swedish government managed to procure enough vaccines to start a mass immunization campaign in 1957, using both imported American and nationally produced ones from the Bacteriological Laboratory in Stockholm (Fagraeus and Böttiger, 1980; Wesslén et al., 1957). The successful vaccination campaign, which was described as having almost universal outreach, put the country in the path of eradication, which it would achieve in under a decade (Fagraeus and Böttiger, 1980). For the case of Sweden during the years of the vaccine introduction, detailed and historical research of the disease indicates that the bulk of infections happened before the age of 10 (Axelsson, 2004b,a) which constitutes the population most-at-risk and therefore our definition of early-life years most relevant for this paper (ages 0-10).

For paper II, the introduction of the same vaccine is analysed, but on a multi-country setting. The countries included in the study, apart from Sweden, are the United States, Denmark, Finland, Norway, Yugoslavia, Chile, West Germany, Greece, and Italy. The main focus of the paper is on the first mass vaccination campaign to immunize the populations against polio, as opposed to small town or regional trials that some countries adopted first. Detailed description of the vaccine introduction in each country, which would be too long to include here, can be found in Section 2.2 of paper II. In this study, data limitations and methodological considerations meant that only the year of birth (age 0) could be analysed in a conclusive manner, therefore constituting the definition of early-life for paper II.

Forced migration caused by war

Paper III studies the lasting effects of stress caused by exposure to war and displacement (also known as forced migration) during childhood years. Specifically, it looks at children aged 0-5 who came to Sweden during the height of the Yugoslav Wars (1993-1994), which was an immediate consequence of the disintegration of the former Socialist Federal Republic of Yugoslavia (SFRY, henceforth referred to simply as Yugoslavia). While the war lasted longer than the period analysed, it is generally accepted that the biggest push in

outward displacement, both internally, to other Yugoslavian regions, and internationally as asylum-seekers, came during the 1993-1994 conflict between Serbia, Croatia, and Bosnia.⁹ The initial stress shock of displacement, followed by stress stemming from adapting to the new environment, has been found to affect forced migrants' mental health (Porter and Haslam, 2001) and labour market outcomes (Kondylis, 2010). Studies of the effects of displacement during childhood, when the increased stress leads to certain health and social hazards (James, 1997), are very limited in number. Since this paper focuses on educational outcomes (grades at the end of compulsory education, grade 9 \approx age 15), and in order to have a cleaner definition of exposure, I choose to follow only children who were displaced because of the conflict and came to Sweden before they started compulsory education (ages 0-5) in either country. Having all the children in the sample (Yugoslavian or not) exposed only to the Swedish school system provides a cleaner identification. It is therefore that, for paper III, the years of early-life examined are those between ages 0 and 5.

Loss of a parent

Paper IV, finally, looks at the loss of a parent during the childhood years. Parental bereavement can be considered a shock to both a child's emotional stress levels (Amato and Anthony, 2014; Berg et al., 2014; Black et al., 2016; Rostila and Saarela, 2011) and to the resources available to them during their developmental years (Barclay and Hällsten, 2019; Brodsky, 2016; Corak, 2001; Gertler et al., 2004). We include all children born in Sweden between 1968 and 1981, and follow them until 2011, observing whether they, at any point and for any cause, lost a mother or a father. We then focus specifically on those who lost him or her during the years of early-life. We define early-life years in this study as ages 0 to 15, when most children in modern Sweden are still living at the parental home and not yet done with their formal compulsory education (grade 9, as described above). This allows us not only to have a bigger sample, given that parental death (especially maternal death) is still a rare occurrence, but also to split the analysis into subgroups according to age, and to differentiate the effect of paternal, maternal or any parental loss during different age periods in the childhood years.

⁹Hostilities began as early as 1991 and lasted until 2001, since many of the involved republics were at different times in conflict with one another.

4 Methods and Data

4.1 Quasi-experimental methodologies

In economics in general, and economic history in particular, there has been a general trend of moving methodologically past the area of associations and correlations into favouring methods and estimations that can allow the researchers to address causal effects and the mechanisms driving them. Whenever the research questions and the data allow it, these causal approaches can be of great use for public policy evaluation and recommendation, as well as for providing a better understanding of causes and effects in the real world.

In the natural sciences, randomized control trials (RCT) are the gold standard to study causal relationships because their design, which randomly assigns participants into either control or treatment groups, allows for reduction and elimination of certain forms of biases in the estimation of the treatment effect, such as selection or allocation bias. In the social sciences however, particularly in the cases of economics and economic history, RCT's are the exception rather than the rule, mostly because they can require rather large financial resources, ethical considerations might not allow it, or simply because (as is the case in economic history) the subjects and interventions we focus on are studied in a retrospective way, which means that no conditions, exposures, or participants can be altered anymore.¹⁰

In this case, researchers try to identify natural experiments, which provide plausibly exogenous variations in exposures of interest. A natural experiment is a situation in which individuals are exposed to a certain phenomenon in a plausibly random or exogenous way that resembles the manner in which an RCT assigns people between treatment and control, without relation or interference from either researcher or subject. Bias from selection into treatment/control groups can be, thus discounted in an appropriate natural experiment setting. Natural disasters, new laws coming into effect, and disease outbreaks have all been used in the past as natural experiments. In the economic sciences, a rather popular way of calculating the effect of a natural experiment on a certain outcome of interest is through a differences-in-differences (DD, also referred to as Diff-in-Diff or DiD) estimation. In a DiD estimation, the researcher identifies a particular intervention or exposure that could be considered a natural experiment, then they compute the difference in an outcome before and after the intervention in the group exposed to it, comparing it later to the same difference in outcome for the control or unaffected group (Bertrand et al., 2004). Its simplicity and ability to deal with many of the endogeneity issues associated with observational-study comparison of heterogeneous groups and individuals help explain the DiD popularity and appeal in economics (Bertrand et al., 2004; Meyer, 1995).

¹⁰For more on experimental approaches to economic issues, the reader could consult the research of the 2019 Nobel Laureates in Economic Sciences, Esther Duflo, Abhijit Banerjee, and Michael Kremer, who have developed extraordinary approaches to experimental economic research aimed at alleviating poverty.

Natural experiments are often combined with different control methodologies to attempt at diminishing sources of well-known bias and confounding, and to enhance a causal inference approach. One of these control strategies is the inclusion of fixed effects (FE), which can help with omitted variable bias. In a fixed effects model, some of the parameters are allowed to vary at the group level, as opposed to individually or randomly, for example, by including a family (or mother) fixed effect, the researcher can control for all the variation that happens at that group level (across siblings in this case), like family environment or parental abilities and attitudes, that might otherwise be unobservable to the researcher while still potentially related to the subject studied. Among the most common levels at which fixed effects are defined includes the family (commonly referred to as sibling fixed effects), the year of birth, country of birth, or region of birth.

4.2 Methods used in this thesis

The studies included in this thesis attempt at using natural experiments and control strategies in order to estimate the effects of early-life exposures on later-life outcomes. All four papers make methodological choices aimed at permitting a causal interpretation of the results. Limitations and shortcomings in this aspect are discussed both in a later section and in each of the papers.

In paper I, we exploit a natural experiment that affected everyone in the country in an arguable simultaneous way. The introduction of the vaccine against poliomyelitis was introduced in 1957 and has been described as having near-universal reach. The study relies also on differences in incidence rates of the disease across the country to set up a modified version of the classical DiD methodology. In our setting, individuals are compared based on the incidence of the disease in their region of birth (high/low) and on whether they were exposed to the vaccine in early-life (ages 0-10) or not (before/after). This model was introduced in Bleakley (2007) and has also been more recently employed by Bleakley (2010b) and Lazuka (2020). Fixed effects are included for the year of birth and county (region) of birth within Sweden. Estimation of the model is done through ordinary least squares (OLS) regression.

Paper II, while focusing on the same vaccine against polio, exploits differences in the timing of the introduction of the vaccine in the countries of origin of the individuals included in the sample. This study looks at how being exposed to the vaccine in the year of birth and in the country of origin affected later-life outcomes, among a sample of individuals from 10 countries who at some point of their lives relocated to Sweden. In this case, a more classical version of the DiD methodology was chosen, comparing the outcomes of the individuals according to country of origin and whether they were born before or after the vaccine was introduced in that country.

However, unlike the classic DiD, and more in line with paper I, fixed effects are included for the year of birth and country of birth. Estimation of the model is done through OLS regression.

Paper III uses another natural experiment, this time brought about by armed conflict, and sets up a quasi-experimental design to study the effect of forced migration during early-life (ages 0-5) on the educational outcomes (around age 15) of children who were displaced of their country of origin, Yugoslavia, during the critical period of the wars that followed the disintegration of the country during 1993-1994. Using a sharp increase in the migration levels from Yugoslavia that occurred exclusively under the period studied, I identify Yugoslavian forced-migrant children in Sweden and follow them until age 15, when I observe their grades in Math, Swedish, English, and their merit rating scores. The control groups are comprised of (1) native Swedes of similar ages, who did not experience forced migration in early-life, and (2) other non-forced migrants, who share the migration experience but not under the same dire circumstances. Estimation of the model for merit rating score is done through OLS regression while the estimation for Math, Swedish, and English grades is done through an ordered logit model. A secondary analysis is performed using standardized grades (Z-scores). Fixed effects are included for the year of birth and the school of attendance.

Paper IV studies the effect of experiencing parental death during early-life (ages 0-15) on adult income, educational attainment, and health among Swedish-born children. We use three different methods to estimate the impact of this exposure on the outcomes. First, we model the impact of parental loss through OLS estimation with controls for covariates such as the individual's sex and the education level of the parent lost, the comparison group in this model is comprised of those who did not experience parental death in early-life. Fixed effects are included for the year of birth and county (region) of birth within Sweden. Since parental death might not be entirely a random event, and in order to avoid the selection that arises from comparing those who experienced a parental death with those who did not, in the second methodology, we restrict the sample to only those who we can observe in our data ended up losing a parent. If there is selection into parental death in the period we observe, this model should circumvent that issue. Fixed effects are included for the year of birth and county (region) of birth within Sweden. This model estimates the effect of parental death in early-life relative to losing a parent after age 15. However, unobservable family characteristics might also be correlated with both parental death and the outcomes (risk-aversion preferences for instance). In order to avoid this omitted variable bias, we set up a third model in which we include a family-level (mother) fixed effect, to capture all the omitted variation that siblings have in common. In this model, again all siblings included ended up losing a parent, so the model gives us the effect of losing a parent on the outcomes, relative to a sibling who lost that parent at a different age. This model also allows us to identify if there are critical periods within the early-life years (0-15 for this paper) in

which losing a parent affects a specific outcome particularly hard. Since we cannot rule out the possibility that our estimates are confounded by some unobserved characteristic of the families in which early-death takes place, we are also unable to attribute causality to our estimates, interpreting them as correlations instead.

4.3 The Swedish Interdisciplinary Panel

The dataset more extensively used throughout this thesis is the Swedish Interdisciplinary Panel (SIP). The SIP is a collection of Swedish administrative registers, hosted at the Centre for Economic Demography, which provide detailed individual information on a variety of areas such as demographic events (birth, death, family links), work, education, in- and outpatient hospitalizations, pensions, and sickness absences.

The SIP contains two different versions or datasets, each focused on particular research questions and possibilities. The first one, SIP-EXIT, contains the total population of Sweden for cohorts born between 1930 and 1980, as well as allowing linkages to parents and siblings. Individuals born before 1930 are observable in the dataset only if they had a child born after 1930. This dataset is ideal to look at life-course responses to different phenomena, since some of the cohorts included may be followed entirely through their work lives and into retirement (Centre for Economic Demography, 2019). This dataset also allows to follow individuals yearly in diverse registers since their establishment beginning in 1968 (although some registers, like the in- and outpatient hospital care one began later) and all the way up to 2011-2012, depending on the register.

The second dataset in the SIP is focused on more recent cohorts (1973-1995), their family linkages, and their administrative data. The SIP-ENTRY, as it is named, is ideal for studying early career and life transitions, educational performance, and related subjects (Centre for Economic Demography, 2019). In this thesis, papers I and IV rely heavily on data from SIP-EXIT, while paper III uses the data contained in the SIP-ENTRY. In all papers, the data from the SIP registers was complemented with other relevant sources at the regional, national, or international level, like statistical yearbooks, and then merged with the main individual-level dataset.

4.4 The Swedish Longitudinal Immigrant Database

Paper II uses data from the Swedish Longitudinal Immigrant Database (SLI). While it still consists of a collection of administrative register data, the SLI differs from the SIP in that it does not contain the full population of the country for any given cohort, but instead is comprised of a sample of 109,699 individuals from sixteen different countries of origin, and a group of native Swedes of the same size as a control group (Centre for Economic Demo-

graphy, 2017). The individuals in the SLI can be followed from their arrival in Sweden or 1968 (whatever happened before), a peculiarity that dictated the methodological adaptations needed to conduct the analysis done for paper ii. However, the detail of the SLI with regards to country of origin meant that it suited this analysis better than the SIP. The SLI also has an important characteristic that makes it unique (even though it was not used for any of the papers in this thesis), that is, for a subsample of about 22,000 individuals it provides detailed information on pre-migration education, working experience, and language abilities, as well as the specific type of visa with which they entered the country (Centre for Economic Demography, 2017).

4.5 Limitations

The studies in this thesis use data of the highest quality available anywhere in the world, as well as solid methods for statistical analysis and causal inference that have been recently and consistently used in state-of-the-art research in economics and economic history. However, a choice of data and methodology brings with it an inherent set of limitations. While the specific limitations of each study are dealt with in detail in every paper, and robustness checks are routinely performed on statistical results, I will present here a summary of the most relevant limitations derived from the data and methods chosen and employed in each of the papers that form part of this dissertation.

In papers I and II, we are limited by the data (and so is reflected in our choice of method) insofar as we are unable to observe actual vaccination uptake or infection status. While Swedish doctors were required by law to report the number of cases of paralytic polio they attended to, these reports were only aggregated cases, not linked to personal identifiers. While other studies for Nordic countries, particularly Denmark, have access to infection status at the individual level (Gensowski et al., 2019), our data imposes a limitation for our studies in that sense.

The choice of method and the interpretation of the results for paper II is limited by the fact that data on arrival to Sweden is not available for those who migrated prior to the establishment of the registers in 1968. It would have been ideal, in terms of how comparable are the results from papers I and II, to use the same definition of exposure. However, since we could not observe when exactly most of the cohorts in paper II migrated to Sweden, the definition of exposure had to accommodate this data limitation, redefining it to only those during the year of birth, when it is certain that every individual was in their country of origin.

One final limitation of the analyses performed in papers I and II is the time period to which they are constrained. Long-term scarring analysis of exposures to disease usually aim to take a full-life approach to study a wide range of outcomes, including mortality. Given

that the epidemic outbreaks studied in these papers occurred relatively recently (1950's), the exposed cohorts are for the most part still alive and, in some cases, even in working ages. While we find no effect of exposure to the epidemics on outcomes measured in early adulthood, there may exist an effect when looking at old(er)-age outcomes, such as disability, or mortality, which these papers are unable to observe¹¹. Future research might aim at completing the picture we started here, when enough time has passed and the cohorts involved have complete mortality data.

Paper III faced a similar limitation that was data-driven. While studying forced migrants seeking asylum in Sweden because of war in their country of origin, it would have been ideal to identify them by their migration status and visa type. Asylum seekers (later refugees, if asylum is granted) enter the country with a specific visa type. Privacy considerations mean that this data is, for the most part and in any case for this particular study, not easily available, since even anonymized data could allow identification due to small numbers in combination with other personal characteristics. Since we could not clearly determine who had and didn't have an asylum seeker visa for the whole duration of the Yugoslavian War (1991-2001), I instead chose to identify forced migrants as those belonging to one particular peak of migration from Yugoslavia that occurred only during, and directly because, the most critical and violent period (1993-1994) of the armed conflict. While this is an identifying assumption that seems to be reasonable to make, as visual inspection shows (see the figure in Section 2.2 of paper III), it remains nevertheless a solution derived from a data limitation.

Finally, for the case of paper IV, and as has been mentioned before, the main limitation is that the exposure to parental death during early-life, in itself a rare outcome, cannot really be assumed to be randomly/as good as randomly assigned, nor could we, through methodological considerations, ensure that selection mechanisms into the exposed group was completely ruled out. While our methodological choices were driven to avoid or exclude as many sources of selection and bias as possible, addressing true causality and circumventing the selection issues associated with parental death remain challenges (and opportunities) for further research.

¹¹However, a simple visual inspection of the mortality of cohorts born during an earlier epidemic outbreak of polio (1911-12) comparable to the one in the 1950's shows no indication of increased mortality (Human Mortality Database, 2020)

5 Results

5.1 Summary of the papers included in this thesis

With the exception of the current introductory chapter, the remainder of this thesis is comprised of four self-standing studies, each related to a particular early-life exposure as described previously in Section 3.5. In this section, a brief overview of each of these papers is presented, so as to give a clearer picture of how they were conducted and the results obtained in each of them.

Paper 1: Serratos-Sotelo, L., Bengtsson, T. Nilsson, A. (2019) The long-term economic effects of polio: Evidence from the introduction of the polio vaccine to Sweden in 1957. Published in *Economics and Human Biology*, 35(2019) pp.32–41.

This paper was co-authored with two supervisors, Tommy Bengtsson (Main Supervisor) and Anton Nilsson (Assistant Supervisor). Luis Serratos-Sotelo was the main author, both in the production of the paper (all stages and components) and during its publishing process.

The aim of paper 1 is to explore whether or not there was any long-term beneficial impact from exposure to a medical innovation such as the vaccine against polio. The reasoning behind this is that, as we have seen before with examples like clean water introduction, innovations that improve health by preventing disease can have lasting positive impact on people's outcomes because of the diseases they prevent. In the case of polio it is clear that the vaccine provided protection and immunity against the disease, so it is plausible to hypothesize that there might've been long-term benefits of avoiding the disease altogether. We use data from public health and population statistical reports to calculate the incidence rate of polio for every county in Sweden between 1910 and 1970. We also use detailed administrative data from the Swedish Interdisciplinary Panel to both link individuals to their county of birth, in order to capture the disease environment in early life, and to follow them up until adulthood, in order to observe their income, educational attainment, and health, years after the vaccine was introduced in the country in 1957.

Given that the vaccine against polio was introduced quite rapidly and uniformly around the country, we rely on variations in incidence rate of the disease in the pre-vaccine years to set up a variation on the classical differences-in-differences model. In this setup, we assume that individuals that were born in counties where the disease hit harder in the pre-vaccine years stood more to gain from immunization than those who were born in relatively low incidence regions of the country.

The results, however, suggest that this assumption did not hold in reality, and we find no statistically significant differences in years of schooling, and differences in income and health that were so small that they have very little to none economic significance.¹²

After finding the vaccine against polio does not appear to have benefited more those in high incidence counties, we ask ourselves why this might be the case. We assumed, as has been the case with other diseases, that exposures to outbreaks of polio would cause the long lasting effects known as scarring in exposed individuals, even when actual infection status is unknown or unrecorded.¹³ If this assumption does not hold, and exposure to polio epidemics did not scar individuals the way other illnesses did, then it might explain why the vaccine, while very effective in eradicating the disease, did not seem, on average, to have any long term impact on adult economic outcomes of those who were exposed to its introduction.

By performing a test on this assumption, we find that indeed it seems to be the case that polio did not scar individuals as influenza or whooping cough did in the past. We find no statistical differences in the outcomes of those individuals who were born, as is common practice to compare, immediately before and after a major outbreak of polio, which suggests the existence of no scarring effects from exposure to the outbreak.¹⁴ Our conclusion is, therefore, that while it is undeniable that the vaccine had very large short-term benefits for both society and individuals who received it, the lack of long-term economic benefits associated with its introduction is not related to its effectiveness to prevent disease, but to the characteristics of the disease itself, which infected many, but scarred only those who suffered the most recognizable paralytic symptoms and allowed everyone else to make a full and lasting recovery.

Paper II: Serratos-Sotelo, L. (2020) Were there long-term economic effects of exposure to Polio Vaccination?: An analysis of migrants to Sweden 1946-2003. Published in *SSM Population Health*, 11(Aug.2020) 100589.

Stemming from the results of paper II, the same questions kept showing up repeatedly: Do these results hold only for native Swedes? What about everyone else? Given the dataset and methodology we used for paper I we could only really look at native Swedes, which allowed

¹²These results are very robust and did not change with different specifications of our treatment variable, different definitions of income or hospitalizations, nor to the inclusion or exclusion of certain specific birth cohorts or counties of birth.

¹³For instance, influenza (Helgertz and Bengtsson, 2019; Myrskylä et al., 2013), measles, and whooping cough (Quaranta, 2013) have all been found to scar individuals exposed to their outbreaks, regardless of actual infection status.

¹⁴While technically the lack of differences in outcomes could be caused by similar-sized selection and scarring effects happening simultaneously, we do not think this is the case since polio does not exhibit signs of selective mortality, leaving only the scarring effect to account for the differences or lack thereof.

us to say very little about the generalizability of the results. Therefore, the next logical step was to address this question, which was the main aim of paper ii. In this paper, I look at the same basic relationship between the introduction of polio vaccination and later life income, education and health as we did in paper i, but this time I make data and methodological adaptations that allow me to conduct the study from a multiple country-of-origin point of view. For the study, I use data from the Swedish Longitudinal Immigrant Database (SLI), a unique database that contains economic and demographic register data for a randomly selected representative sample of individuals from both Sweden and other 16 countries of origin. I then collected information on when and how the vaccine against polio was first introduced in each of these countries. Since some countries represented in the SLI did not have information on the vaccine introduction that was readily available, reliable, and in a language available to the research team, the final sample for this paper included individuals born between 1946 and 1971 from 10 different countries, in chronological order according to when they introduced the vaccine against polio these are: the United States, Denmark, Finland, Sweden, Norway, Yugoslavia, Chile, West Germany, Greece, and Italy.

While the data provided excellent opportunities to increase the diversity of the sample, it also meant adding some limitations to the analysis. Because of the structure of the administrative data from which the SLI sample was taken, it is not possible to observe the date of arrival or migration into Sweden before the registers were established in 1968. This means that for all but three of our sample birth cohorts, data on when migration happened is not available. Consequently, exposure had to be redefined in a way that suited this study; in paper i we looked at exposure to the vaccine up to the age of 10, which historical studies identify as the ages (0-10) most at risk of infection from polio; in the case of paper ii, since we couldn't observe in which country (origin or Sweden) was each child living during their childhood years, I instead focused on whether or not the vaccine against polio was available in the country of origin during the year of birth. Given that it is possible to observe a child's country of birth, it seems reasonable to assume that children spend at least part of their year of birth in that country before migrating to Sweden.

The time difference in the introduction of the vaccine across the countries in the sample provided the key aspect of the identification strategy, which employed a more classical version of the differences in-differences model to estimate the long-term impact of exposure to the vaccine on adult income, educational attainment, and hospitalizations. The results were in line with those of paper i, in showing that there are no statistically significant effects on adult income, education, or health from exposure to the vaccine against polio, regardless of national origin. Furthermore, as we did in paper i and for the same reasons, a scarring analysis was performed to test whether exposure to polio outbreaks had any negative impacts on the adult outcomes. Comparing individuals born immediately before and after the last epidemic polio outbreak in their countries of origin, I conclude that no scarring effects are present, reinforcing the hypothesis we set forth in paper i that polio did not scar

individuals in the same way as other contemporary epidemic diseases did, and that the lack of scarring is a good candidate to explain the absence of long-term impact from vaccine exposure. The general conclusion of both papers I and II is that, while there is ample evidence that some diseases caused scarring, and that lots of medical innovations and public health advancements had positive long term impacts, this should not be thought of as a universal rule, applying to every epidemic and new medicine, but that it should be carefully considered and analysed in each case, accounting for differences in disease pathology and epidemiology, to know if lasting benefits and/or scarring effects would be present.

Paper III: Serratos-Sotelo, L. The long-term effects of forced migration: An early-life approach with evidence from Yugoslavian refugees in Sweden. *Unpublished Manuscript*.

Taking a step away from the two-paper analysis of polio vaccination, paper III focuses on another early-life shock: forced migration. Also referred to as displacement, forced migration comes about as a direct consequence of armed conflict, persecution, or natural disasters. It is often related to enormous and repeated shocks of stress, as one is first forced to uproot oneself and then as one adapts to the new and safer environment (Porter and Haslam, 2001). A shock of stress of this magnitude is hypothesized to have some lasting effects on children who experience it, but the literature gives us no *a priori* consensus on the direction of the effect. This paper is therefore focused on the early-life conditions experienced by children (ages 0-5) who lived through the critical period of the Yugoslav Wars (1993-1994) and whose families were forced to relocate and seek asylum in Sweden, in order to avoid the hardship and violence caused by the war. It then follows the individuals for around a decade until they finish the compulsory education in Sweden around age 15, and compares their educational performance to children who were not exposed to forced migration.

The data for the study comes from the Swedish Interdisciplinary Panel, which provides information on the grades obtained by students finishing the ninth year of formal and mandatory education in Sweden. Yugoslavian children exposed to the war, as well as a Swedish children control group, form the sample. Four measures of educational performance are included in the analysis, the grades obtained in mathematics, Swedish, and English, and the merit rating score or *meritvärde*. While the subject grades are given in the regular Swedish scale of not approved/ approved/ well approved/ very well approved, the merit rating score is a composite measure of academic achievement during the years of *högstadium* (grades 7-9). The merit rating score is calculated by taking a student's 16 best grades from grades 7-9 and assign numerical values to the grades received. While it is sometimes referred to as GPA, for simplicity and in reference to the American-system Grade Point Average, it differs substantially in its calculation, since the GPA takes credit-hours into consideration and includes all taken courses while the Swedish merit rating score does not. To avoid confusion in international comparisons I keep the original Swedish name instead of the American-style term.

In order to identify those children who were exposed to the height of the war in Yugoslavia and who were therefore forced to relocate to Sweden, I use variation in migration to Sweden from Yugoslavia that coincide temporally with the conflict. Since no data on the visa type for each person was available (refugee visas would be identified that way), I follow Kondylis (2010) in identifying forced migrants by deviations from the usual migration trends that happened during the height of the conflict. As can be seen in Figure 2 of paper III, migration into Sweden from countries that were part of the former Yugoslavia was pretty stable and low both before and after the height of the conflict. The spike in migration that happened in 1993-1994, is reasonable to say, was a direct consequence of the escalating levels of violence during the conflict, and is not a result of a sudden rise in economic or voluntary migration. Therefore, all children who migrated to Sweden from Yugoslavia during the 1993-1994 time period are identified as forced migrants. Using linear regression and ordered logit models with fixed effects for year of birth and school of attendance, I estimate the impact that being exposed to forced migration during childhood had on educational performance of children from the former Yugoslavia. The results show that children who experienced forced migration between ages 0-5 performed worse in school, as measured by their Math and Swedish grades, and Merit Rating scores, with forced migrants achieving grades that were on average 5% (Merit Rating), 7% (Swedish), and 22% (Math) of a standard deviation lower than those of native Swedes. The results of this study are in line with other research that has found that the stress shock related to being displaced from the home country because of armed countries can have negative consequences for children who live through them (Guha-Sapir and van Panhuis, 2004; James, 1997; O'hare and Southall, 2007).

Paper IV: Serratos-Sotelo, L. Eibich, P. Lasting economic effects of parental loss during childhood: Evidence from Sweden. *Unpublished Manuscript*.

This paper was co-authored with a supervisor, Peter Eibich (Assistant Supervisor, Max Planck Institute for Demographic Research). Luis Serratos-Sotelo was the main author during the production process of the manuscript.

In the last chapter of this dissertation, we look at the long-term effects of parental death experienced during the childhood years. Beyond the emotional grief and stress it generates, bereavement can also have lasting implications to the family organization and to the resources available to the children during their development years.

This negative shock can affect children's future outcomes for two main reasons, (1) it increases the amount of stress experienced during the childhood developmental period, which can have health, cognitive and educational repercussions (Amato and Anthony, 2014; Berg et al., 2014; Rostila and Saarela, 2011); it can also (2) alter the amount of resources devoted by the remaining parent or family members to each child, parental investments being crucial

for human capital formation, this goes on to impact all sorts of adult outcomes like income, education, and occupational choice (Barclay and Hällsten, 2019; Corak, 2001; Gertler et al., 2004; Kailaheimo and Erola, 2016).

In this study, we use data from the Swedish Interdisciplinary Panel in order to identify children who were born in Sweden between 1968 and 1981 who lost a parent at some point during their life. We then follow them to adulthood in order to observe their later-life outcomes (income, educational attainment and hospitalizations).¹⁵ The data allows us to observe individuals until 2011, which means that we are able to observe all our selected cohorts at least until the age of 30. The main exposure in this analysis is losing a parent (we differentiate the effects of paternal and maternal loss) during early life, which we define here as ages 0 to 15, when most children in modern Sweden are still living at the parental home and are not done with their formal education. Using several methodological strategies we estimate three main models which capture (1) the general effect of parental loss in childhood (which may be biased because of selection issues described in the paper), the (2) relative effect of losing a parent in early-life vs. losing them in later life, and (3) the relative effect of parental loss during childhood using older siblings as a control group.

Comparing individuals who lost a parent in childhood to those who did not experience parental loss, the results show a strong and highly significant negative association for adult income, education and health. When we compared individuals who lost a parent during childhood to individuals who experienced parental loss later in life, the results show negative and significant effects of paternal loss for all five outcomes. This analysis also suggests that there are critical periods in which losing a parent, in this case a father, has a greater impact on certain outcomes. Finally, our comparison of siblings who lost their parent at different ages during childhood found only a marginally statistically significant increase in hospitalizations. This, we argue, cannot be interpreted as evidence against a negative impact of parental loss, because all estimates are relative to siblings who lost a parent during young adulthood. Instead, it could be interpreted as evidence that younger and older children as well as young adults are equally affected by the loss of a parent. By focusing only on the effect on hospitalizations related to mental health, we find suggestive evidence that grief and emotional trauma are relevant mechanisms behind these observed effects. We conclude that, while the analysis yields some interesting results, further research is needed to attempt to disentangle the persistent selection issues and address the true causality of the estimates.

¹⁵For hospitalizations, we distinguish between total number of hospitalizations, total days of hospitalization, and number of hospitalizations related only to mental health.

6 Discussion and Conclusions

Taken together, the findings from the four research papers in this dissertation have painted a somewhat less universal and yet more realistic picture of how early-life shocks can, in some conditions, affect children's long-term outcomes. In paper I, we started up with the expectation, backed by previous literature, that a new vaccine would prove pivotal and very significantly impact the adult outcomes of children who were, for the first time, exposed to such treatment. On finding effects that were either not economically or statistically significant, our secondary and complementary analyses showed that the tools used to assess whether exposure to epidemics produce long-term scarring did not really show that was the case for polio. This suggests that epidemics of polio did not behave the same way as other diseases studied such as measles, scarlet fever, whooping cough (Quaranta, 2013) or influenza (Almond, 2006; Helgertz and Bengtsson, 2019; Myrskylä et al., 2013) did. While polio is known for the damages it causes, through the inflammation of the spinal cord and other nerve tissue, the disease and its epidemics in general did not seem to conform to the inflammation hypothesis set forth by Finch and Crimmins (2004) and Finch (2010). This being the case, our best hypothesis is that there must be factors relating to either the pathology or the epidemiology of the disease that causes the lack of scarring, allowing those who are exposed to the outbreaks but who avoid the paralytic symptoms to make a full recovery in respect to both their short- and long-term outcomes.

The results from paper II expanded on those of paper I by showing that the lack of scarring, and consequently of benefit from exposure to the vaccine, was not an isolated case that represented only the experience of native Swedes. Using a multi-country approach with migrants to Sweden who were exposed to the vaccine in their country of origin during their year of birth, the results once again failed to detect any long-term differences in income, educational attainment or hospitalizations directly attributable to the exposure itself. The diverse sample, in terms of national origin, ruled out the possibilities that (1) native Swedes enjoyed some sort of natural protection against the disease outbreaks or (2) that the vaccination campaign in Sweden was at fault for the results previously obtained. The results also showed that across 10 different countries, each with a specific vaccination introduction date and roll-out strategy, there were no discernible effects of exposure to a polio epidemic outbreak, reinforcing our conclusions from paper I, related to the specific nature of the disease. However, as was very accurately pointed out by one of the anonymous reviewers of the paper, the only scenario this research has been unable to rule out is that one where the Swedish context somehow neutralized the scarring effects of the disease. Given that both samples in papers I and II are both exposed to the Swedish context (health care system, education, labour market, etc), the only way of addressing this issue would be to conduct a multi-country, multi-register study which, because of the scope of this dissertation, remains an open question for further research.

If anything, the results from papers I and II indicate that analyses that relate to scarring from epidemic outbreaks, and to the possible long-term effects of treatments against them, need to be carefully evaluated and considered in a case-by-case scenario. We have found that not all inflammatory infectious diseases (without selective mortality) exhibit scarring effects in populations exposed to their outbreaks, a case that had not really been discussed in the literature so far. Opportunities for further research arise from these results, in evaluating and determining the scarring nature of diverse diseases and epidemics, in order to assess the long-term benefits that could be derived from new, innovative treatments and vaccines.

In paper III, the study of children exposed to war and displacement revealed that asylum-seeking children aged 0-5 who arrived in Sweden as a consequence of the mid-90's war in Yugoslavia had lower educational outcomes, compared to non-displaced children, measured almost a decade after the exposure occurred. Exhibiting grades that were on average 5% (Merit Rating), 7% (Swedish), and 22% (Math) of a standard deviation lower than those of their counterparts, this paper speaks of the consequences of war and forced migration on the process of human capital formation. While this may in future lead to depressed health and labour market outcomes, as described in previous studies (Kondylis, 2010; Porter and Haslam, 2001), the children exposed to this particular armed conflict and bout of forced migration are yet too young to have fully left the educational system and entered the labour market. If confirmed, these long-term effects might provide incentives and directives for government interventions. Further research could, in time, explore the role of this particular exposure on the transition into the labour market (age, first job characteristics, etc.), on the total educational attainment (in years) of the exposed children, and on their adult income and health, as the other studies in this dissertation did.

Finally, paper IV provided evidence that there is an association between parental loss during childhood and lower adult income, educational attainment, and worse health. The analysis that focused on the timing of the loss, comparing those who lost a parent in early life to those who lost them after age 16, revealed that there might be some critical periods, as defined by Hallqvist et al. (2004), in which parental bereavement hits particularly hard. This was the case, for instance, with children who lost a father during the school ages of 6-15 and who saw their educational attainment more heavily impacted than other age groups exposed to similar shocks. A further analysis restricting the sample only to siblings yielded virtually no statistically significant differences in outcomes across age groups, suggesting that all siblings are equally affected by the loss of a parent, regardless of their age. While these results cannot be addressed or interpreted in a causal manner, they do point towards methodological or quasi-experimental opportunities for further research, which could in that way help to disentangle the selection-into-mortality issue that was persistent across our analysis.

The papers in this dissertation have all looked for long-term effects of exposures that occurred during early-life. In doing so, it has contributed to our understanding that not all shocks and diseases have repercussions felt across the years, even if those effects are theoretically plausible. Where they did not find long-term impacts of exposure, the studies aimed at explaining why that was the case and ruling out possible alternative explanations, and they showed that the results were not driven by one country or nationality alone. Where they did find effects of exposure, the studies contributed to our understanding of the lasting consequences of forced migration and parental loss experienced during the years of early life.

The papers have also set the scope for further research, where increased follow-ups, better natural experiments, or improved data availability will determine the questions that can be answered through it. While the exposures and shocks studied in this thesis are all set in the past century, the results from them provide knowledge that is not restricted by their socioeconomic Swedish context or by their temporal frame, and that could very well be applicable, reasoned, and interpreted through a contemporary lens, as parental death, armed conflict, forced migration, and pandemics in desperate need of a vaccine remain pressing issues up to this very day.

7 References

- Almond, D. (2006). Is the 1918 influenza pandemic over? Long-term effects of in utero influenza exposure in the post-1940 US population. *Journal of political Economy*, 114(4):672–712.
- Almond, D. and Currie, J. (2011). Killing me softly: The fetal origins hypothesis. *Journal of economic perspectives*, 25(3):153–72.
- Almond, D., Currie, J., and Duque, V. (2018). Childhood Circumstances and Adult Outcomes: Act II. *Journal of Economic Literature*, 56(4):1360–1446.
- Amato, P. R. and Anthony, C. J. (2014). Estimating the effects of parental divorce and death with fixed effects models. *Journal of Marriage and Family*, 76(2):370–386.
- Avogo, W. A. and Agadjanian, V. (2010). Forced migration and child health and mortality in Angola. *Social Science & Medicine*, 70(1):53–60.
- Axelsson, P. (2004a). Historien om polio i Sverige: från barnförlamning till poliovaccin. *Svensk Medicinhistorisk Tidskrift, Supplement*, 8(1):57–66.
- Axelsson, P. (2004b). *Höstens spöke: de svenska polioepidemiernas historia*. PhD thesis, Umeå University, Faculty of Arts, Historical Studies.

- Axelsson, R. (2000). The organizational pendulum: healthcare management in Sweden 1865-1998. *Scandinavian Journal of Public Health*, 28(1):47–53. Publisher: Sage Publications Sage CA: Thousand Oaks, CA.
- Bacher-Hicks, A., Goodman, J., and Mulhern, C. (2020). Inequality in household adaptation to schooling shocks: Covid-induced online learning engagement in real time. *Journal of Public Economics*, 193:104345. Publisher: Elsevier.
- Barclay, K. J. and Hällsten, M. (2019). Socioeconomic variation in child educational and socioeconomic attainment after parental death in Sweden. Technical report, Max Planck Institute for Demographic Research, Rostock, Germany.
- Barker, D. J. P. (1990). Fetal and infant origins of adult disease. *British Medical Journal*, 301(6761):1111.
- Barker, D. J. P. (1994). *Mothers, babies and disease in later life*. BMJ Publishing Group, London.
- Barker, D. J. P. (1995). Fetal origins of coronary heart disease. *British Medical Journal*, 311(6998):171–174.
- Barker, D. J. P. (2012). Developmental origins of chronic disease. *Public health*, 126(3):185–189.
- Barker, D. J. P. and Osmond, C. (1986). Infant mortality, childhood nutrition, and ischaemic heart disease in England and Wales. *The Lancet*, 327(8489):1077–1081.
- Becker, G. S. (1964). *Human capital: A theoretical and empirical analysis, with special preferences to education*. National bureau of economic research.
- Benditt, E. P. and Benditt, J. M. (1973). Evidence for a monoclonal origin of human atherosclerotic plaques. *Proceedings of the National Academy of Sciences*, 70(6):1753–1756.
- Bengtsson, T. and Broström, G. (2009). Do conditions in early life affect old-age mortality directly and indirectly? Evidence from 19th-century rural Sweden. *Social Science and Medicine*, 68(9 - Online 13 March 2009):1583–1590.
- Bengtsson, T. and Lindström, M. (2003). Airborne infectious diseases during infancy and mortality in later life in southern Sweden, 1766–1894. *International Journal of Epidemiology*, 32(2):286–294.
- Bengtsson, T., Lundh, C., and Scott, K. (2005). From boom to bust. The economic integration of immigrants in post war Sweden. In Zimmermann, K., editor, *European migration: What do we know?*, pages 15–58. Oxford University Press, Oxford.

- Berg, L., Rostila, M., Saarela, J., and Hjern, A. (2014). Parental death during childhood and subsequent school performance. *Pediatrics*, 133(4):682–689.
- Bertrand, M., Duflo, E., and Mullainathan, S. (2004). How Much Should We Trust Differences-In-Differences Estimates?*. *The Quarterly Journal of Economics*, 119(1):249.
- Black, S. E., Devereux, P. J., and Salvanes, K. G. (2016). Does grief transfer across generations? Bereavements during pregnancy and child outcomes. *American Economic Journal: Applied Economics*, 8(1):193–223.
- Bleakley, H. (2007). Disease and Development: Evidence from Hookworm Eradication in the American South*. *The Quarterly Journal of Economics*, 122(1):73–117.
- Bleakley, H. (2010a). Health, human capital, and development. *Annu. Rev. Econ.*, 2(1):283–310.
- Bleakley, H. (2010b). Malaria eradication in the Americas: A retrospective analysis of childhood exposure. *American Economic Journal: Applied Economics*, 2(2):1–45.
- Brodsky, B. S. (2016). Early childhood environment and genetic interactions: the diathesis for suicidal behavior. *Current psychiatry reports*, 18(9):86.
- Bundervoet, T. and Fransen, S. (2018). The educational impact of shocks in utero: Evidence from Rwanda. *Economics & Human Biology*, 29:88–101.
- Burström, B. (2003). Social differentials in the decline of infant mortality in Sweden in the twentieth century: the impact of politics and policy. *International journal of health services*, 33(4):723–741. Publisher: SAGE Publications Sage CA: Los Angeles, CA.
- Burström, B. and Sagan, A. (2018). Sweden. In Rechel, B., Maresso, A., Sagan, A., Hernández-Quevedo, C., Williams, G., Richardson, E., Jakubowski, E., and Nolte, E., editors, *Organization and financing of public health services in Europe: country reports*, number 49 in Health Policy. European Observatory on Health Systems and Policies, Copenhagen. Publisher: World Health Organization.
- Case, A. and Paxson, C. (2009). Early life health and cognitive function in old age. *The American economic review*, 99(2):104.
- Centre for Economic Demography (2017). The Swedish Longitudinal Immigrant Database (SLI).
- Centre for Economic Demography (2019). The Swedish Interdisciplinary Panel (SIP).
- Chay, K. Y., Guryan, J., and Mazumder, B. (2009). Birth Cohort and the Black-White Achievement Gap: The Roles of Access and Health Soon After Birth. Working Paper 15078, National Bureau of Economic Research.

- Cohn, E. and Geske, T. (1990). *The economics of education*. Pergamon Press, New York, 3rd edition.
- Corak, M. (2001). Death and divorce: The long-term consequences of parental loss on adolescents. *Journal of Labor Economics*, 19(3):682–715.
- Corazzini, A. J. (1967). When should vocational education begin? *Journal of Human Resources*, pages 41–50.
- Currie, J. and Almond, D. (2011). Chapter 15 - Human capital development before age five. volume 4 of *Handbook of Labor Economics*, pages 1315 – 1486. Elsevier.
- Easterlin, R. A. (2004). *The reluctant economist: Perspectives on economics, economic history, and demography*. Cambridge University Press.
- Ekberg, J. and Hammarstedt, M. (2002). 20 år med allt sämre arbetsmarknadsintegrering för invandrare. *Ekonomisk debatt*, 30(4):343–353.
- Ellison, P. T. (2005). Evolutionary perspectives on the fetal origins hypothesis. *American Journal of Human Biology*, 17(1):113–118.
- Enders, J. F., Weller, T. H., and Robbins, F. C. (1949). Cultivation of the Lansing strain of poliomyelitis virus in cultures of various human embryonic tissues. *Science*, 109(2822):85–87.
- Fagraeus, A. and Böttiger, M. (1980). Polio Vaccination in Sweden. *Reviews of Infectious Diseases*, 2(2):274–276.
- Finch, C. E. (2010). Evolution of the human lifespan and diseases of aging: roles of infection, inflammation, and nutrition. *Proceedings of the National Academy of Sciences*, 107(suppl 1):1718–1724.
- Finch, C. E. and Crimmins, E. M. (2004). Inflammatory exposure and historical changes in human life-spans. *Science*, 305(5691):1736–1739.
- Floud, R., Fogel, R. W., Harris, B., and Hong, S. C. (2011). *The changing body: Health, nutrition, and human development in the western world since 1700*. Cambridge University Press, Cambridge.
- Fogel, R. W. (1994). Economic Growth, Population Theory, and Physiology: The Bearing of Long-Term Processes on the Making of Economic Policy. *The American Economic Review*, 84(3):369–395.
- Fogel, R. W. (2004). *The escape from hunger and premature death, 1700-2100: Europe, America, and the Third World*. Cambridge University Press, Cambridge.

- Fogel, R. W. and Costa, D. L. (1997). A theory of technophysio evolution, with some implications for forecasting population, health care costs, and pension costs. *Demography*, 34(1):49–66.
- Fridlitzius, G. (1989). The deformation of cohorts: Nineteenth century mortality decline in a generational perspective. *Scandinavian Economic History Review*, 37(3):3–17.
- Gensowski, M., Nielsen, T. H., Nielsen, N. M., Rossin-Slater, M., and Wüst, M. (2019). Childhood Health Shocks, Comparative Advantage, and Long-Term Outcomes: Evidence from the Last Danish Polio Epidemic. *Journal of Health Economics*, 66:27–36.
- Gertler, P., Levine, D. I., and Ames, M. (2004). Schooling and parental death. *Review of Economics and Statistics*, 86(1):211–225.
- Gothefors, L. (2008). The impact of vaccines in low-and high-income countries. *Annales Nestlé (English ed.)*, 66(2):55–69.
- Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political economy*, 80(2):223–255.
- Guha-Sapir, D. and van Panhuis, W. G. (2004). Conflict-related mortality: an analysis of 37 datasets. *Disasters*, 28(4):418–428.
- Hallqvist, J., Lynch, J., Bartley, M., Lang, T., and Blane, D. (2004). Can we disentangle life course processes of accumulation, critical period and social mobility? An analysis of disadvantaged socio-economic positions and myocardial infarction in the Stockholm Heart Epidemiology Program. *Social Science & Medicine*, 58(8):1555 – 1562.
- Hawkes, J. (1857). On the increase of insanity. *Journal of Psychological Medicine and Mental Pathology (London, England: 1848)*, 10(7):508.
- Heim, C. (2013). Stress, Early Life. In Gellman, M. D. and Turner, J. R., editors, *Encyclopedia of Behavioral Medicine*, pages 1903–1906. Springer New York, New York, NY.
- Helgertz, J. and Bengtsson, T. (2019). The Long-Lasting Influenza: The Impact of Fetal Stress During the 1918 Influenza Pandemic on Socioeconomic Attainment and Health in Sweden, 1968–2012. *Demography*, 56(4):1389–1425.
- Hinkle, Jr., L. E. (1974). The concept of “stress” in the biological and social sciences. *The International Journal of Psychiatry in Medicine*, 5(4):335–357.
- Hjortsberg, C., Ghatnekar, O., Rico, A., Wisbaum, W., Cetani, T., and World Health Organization (2001). Health care systems in transition: Sweden. Technical report, Copenhagen: WHO Regional Office for Europe.

- Hoem, J. M. (1991). To marry, just in case...: the Swedish widow's-pension reform and the peak in marriages in December 1989. *Acta Sociologica*, 34(2):127–135. Publisher: Sage Publications Sage CA: Thousand Oaks, CA.
- Holland, J. A. (2013). Love, marriage, then the baby carriage? Marriage timing and child-bearing in Sweden. *Demographic research*, 29:275–306. Publisher: JSTOR.
- Holland, P., Berney, L., Blane, D., Smith, G. D., Gunnell, D. J., and Montgomery, S. M. (2000). Life course accumulation of disadvantage: childhood health and hazard exposure during adulthood. *Social Science & Medicine*, 50(9):1285–1295.
- Human Mortality Database (2020). Human Mortality Database. *University of California, Berkeley (US), and Max Planck Institute for Demographic Research (Germany)*, page Available at www.mortality.org or www.humanmortality.de (data downloaded on June 2020).
- James, D. C. (1997). Coping with a new society: The unique psychosocial problems of immigrant youth. *Journal of school health*, 67(3):98–102.
- Johannisson, K. (1994). 4. The People's Health: Public Health Policies in Sweden. *Clio medica*, 26:165–182.
- Kailaheimo, S. and Erola, J. (2016). The effect of early parental death on children's university education. *Working Papers on Social and Economic Issues*, 12:2016.
- Kermack, W. O., McKendrick, A. G., and McKinlay, P. L. (1934). Death-rates in Great Britain and Sweden some general regularities and their significance. *The Lancet*, 223(5770):698–703.
- Kondylis, F. (2010). Conflict displacement and labor market outcomes in post-war Bosnia and Herzegovina. *Journal of Development Economics*, 93(2):235–248.
- Kovacs, M. and Goldston, D. (1991). Cognitive and social cognitive development of depressed children and adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry*, 30(3):388–392.
- Kuh, D. and Ben-Shlomo, Y. (2004). *A life course approach to chronic disease epidemiology*. Number 2. Oxford University Press.
- Kumar, A. and Nayar, K. R. (2020). COVID 19 and its mental health consequences. *Journal of Mental Health*, pages 1–2. Publisher: Routledge.
- Källemark, A.-S. and others (1980). Sweden in the 1930's: population development, population debate and policy implications. Publisher: Almqvist & Wiksell.

- Lazuka, V. (2018). The long-term health benefits of receiving treatment from qualified midwives at birth. *Journal of Development Economics*, 133:415–433.
- Lazuka, V. (2020). Infant health and later-life labour market outcomes: Evidence from the introduction of sulfa antibiotics in Sweden. *Journal of Human Resources*, 55(2):660–698.
- Lazuka, V., Quaranta, L., and Bengtsson, T. (2016). Fighting infectious disease: Evidence from Sweden 1870–1940. *Population and Development Review*, 42(1):27–52.
- Liu, J. J., Bao, Y., Huang, X., Shi, J., and Lu, L. (2020). Mental health considerations for children quarantined because of COVID-19. *The Lancet Child & Adolescent Health*, 4(5):347–349. Publisher: Elsevier.
- Ljungberg, J. (1997). The impact of the great emigration on the Swedish economy. *Scandinavian Economic History Review*, 45(2):159–189. Publisher: Taylor & Francis.
- Lucassen, G. and Lubbers, M. (2012). Who fears what? Explaining far-right-wing preference in Europe by distinguishing perceived cultural and economic ethnic threats. *Comparative Political Studies*, 45(5):547–574. Publisher: SAGE Publications Sage CA: Los Angeles, CA.
- Lynch, J. W., Kaplan, G. A., and Shema, S. J. (1997). Cumulative impact of sustained economic hardship on physical, cognitive, psychological, and social functioning. *New England Journal of Medicine*, 337(26):1889–1895.
- Mann, S. L., Wadsworth, M. E., and Colley, J. R. (1992). Accumulation of factors influencing respiratory illness in members of a national birth cohort and their offspring. *Journal of Epidemiology & Community Health*, 46(3):286–292.
- Mattila, K., Valtonen, V., Nieminen, M. S., and Asikainen, S. (1998). Role of infection as a risk factor for atherosclerosis, myocardial infarction, and stroke. *Clinical Infectious Diseases*, 26(3):719–734.
- McKeown, T. (1976). *The Modern Rise of Population*. Arnold, London.
- Meyer, B. D. (1995). Natural and quasi-experiments in economics. *Journal of business & economic statistics*, 13(2):151–161.
- Migrationsverket (2020). Migration to Sweden: History.
- Mincer, J. (1974). *Schooling, Experience, and Earnings*. National Bureau of Economic Research, Massachusetts, USA.
- Monroe, S. M. and Simons, A. D. (1991). Diathesis-stress theories in the context of life stress research: Implications for the depressive disorders. *Psychological Bulletin*, 110(3):406–425.

- Moreno, C., Wykes, T., Galderisi, S., Nordentoft, M., Crossley, N., Jones, N., Cannon, M., Correll, C. U., Byrne, L., Carr, S., and others (2020). How mental health care should change as a consequence of the COVID-19 pandemic. *The Lancet Psychiatry*. Publisher: Elsevier.
- Myrskylä, M., Mehta, N. K., and Chang, V. W. (2013). Early life exposure to the 1918 influenza pandemic and old-age mortality by cause of death. *American journal of public health*, 103(7):e83–e90.
- Nakamura, E., Sigurdsson, J., and Steinsson, J. (2016). The gift of moving: Intergenerational consequences of a mobility shock. Technical report, National Bureau of Economic Research.
- Nathanson, N. and Martin, J. R. (1979). The epidemiology of poliomyelitis: enigmas surrounding its appearance, epidemicity, and disappearance. *American Journal of Epidemiology*, 110(6):672–692.
- Nieto, F. J. (1998). Infections and atherosclerosis: new clues from an old hypothesis? *American Journal of Epidemiology*, 148(10):937–948.
- O’hare, B. A. and Southall, D. P. (2007). First do no harm: the impact of recent armed conflict on maternal and child health in Sub-Saharan Africa. *Journal of the Royal Society of Medicine*, 100(12):564–570.
- Ohlsson-Wijk, S., Turunen, J., and Andersson, G. (2020). Family forerunners? An overview of family demographic change in Sweden. *International Handbook on the Demography of Marriage and the Family*, pages 65–77. Publisher: Springer.
- Paul, J. R. (1971). *A History of Poliomyelitis*. Yale University Press, New Haven, CT.
- Porter, M. and Haslam, N. (2001). Forced displacement in Yugoslavia: a meta-analysis of psychological consequences and their moderators. *Journal of traumatic stress*, 14(4):817–834.
- Preston, S. H. (1975). The changing relation between mortality and level of economic development. *Population studies*, 29(2):231–248.
- Preston, S. H. (1976). *Mortality patterns in national populations: with special reference to recorded causes of death*. Academic Press, New York.
- Quaranta, L. (2013). *Scarred for Life. How conditions in early life affect socioeconomic status, reproduction and mortality in Southern Sweden, 1813-1968*. PhD thesis, Lund University (Media-Tryck).
- Rees, W. L. (1976). Stress, distress and disease. *The British Journal of Psychiatry*, 128(1):3–18.

- Robins, C. J. and Block, P. (1988). Personal vulnerability, life events, and depressive symptoms: A test of a specific interactional model. *Journal of personality and social psychology*, 54(5):847.
- Rosen, G. (1959). Social stress and mental disease from the eighteenth century to the present: some origins of social psychiatry. *The Milbank Memorial Fund Quarterly*, 37(1):5–32.
- Rosenthal, D. (1963). A suggested conceptual framework. In *The Genain Quadruplets: A Case Study and Theoretical Analysis of Heredity and Environment in Schizophrenia*, pages 505–516. Basic Books, New York.
- Rosenthal, D. (1971). A program of research on heredity in schizophrenia. *Behavioral science*, 16(3):191–201.
- Rosholm, M., Scott, K., and Husted, L. (2006). The times they are a-changin': Declining immigrant employment opportunities in Scandinavia. *International Migration Review*, 40(2):318–347.
- Rostila, M. and Saarela, J. M. (2011). Time does not heal all wounds: Mortality following the death of a parent. *Journal of marriage and family*, 73(1):236–249.
- Saarela, J. M. and Elo, I. T. (2016). Forced migration in childhood: are there long-term health effects? *SSM-population health*, 2:813–823.
- Sabin, A. B. (1962). Oral Poliovirus Vaccine: Recent Results and Recommendations for Optimum Use. *Royal Society of Health Journal*, 82(2):51–59.
- Salk, J. E. (1955). Considerations in the preparation and use of poliomyelitis virus vaccine. *Journal of the American Medical Association*, 158(14):1239–1248.
- Sandberg, L. and Steckel, R. H. (1997). Was industrialization hazardous to your health? Not in Sweden! In Steckel, R. H. and Floud, R., editors, *Health and welfare during industrialization*, pages 127–160. University of Chicago Press, Chicago.
- Schultz, T. P. (1985). Changing world prices, women's wages, and the fertility transition: Sweden, 1860–1910. *Journal of Political Economy*, 93(6):1126–1154. Publisher: The University of Chicago Press.
- Schultz, T. W. (1963). *The economic value of education*. Columbia University Press.
- Schultz, T. W. (1981). *Investing in people: The economics of population quality*. Univ of California Press.
- Skolverket (2000). Childcare in Sweden. Technical report, The Swedish National Agency for Education, Stockholm, Sweden.

- Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. *The Quarterly Journal of Economics*, 70(1):65–94.
- Steinmayr, A. (2017). Did the refugee crisis contribute to the recent rise of far-right parties in Europe? *ifo DICE Report*, 15(4):24–27. Publisher: München: ifo Institut-Leibniz-Institut für Wirtschaftsforschung an der
- Sundin, J. and Willner, S. (2007). *Social change and health in Sweden: 250 years of politics and practice*. Swedish National Institute of Public Health.
- Swan, T. W. (1956). Economic Growth and Capital Accumulation. *Economic Record*, 32(2):334–361.
- Tanner, J. (1989). *Foetus into man: physical growth from conception to maturity*. Castlemead Publications, Ware, 2nd edition.
- Verwimp, P. and Van Bavel, J. (2005). Child survival and fertility of refugees in Rwanda. *European Journal of Population/Revue Européenne de Démographie*, 21(2-3):271–290.
- Vogiazides, L. and Mondani, H. (2020). Geographical trajectories of refugees in Sweden: Uncovering patterns and drivers of inter-regional (im) mobility. *Journal of Refugee Studies*.
- Wachter, K. W. (2014). *Essential demographic methods*. Harvard University Press.
- Wells, M. B. and Bergnehr, D. (2014). Families and family policies in Sweden. In *Handbook of family policies across the globe*, pages 91–107. Springer.
- Wesslén, T., Lycke, E., Gard, S., and Olin, G. (1957). Inactivation of poliomyelitis virus by formaldehyde. *Archives of Virology*, 7(2):125–135.