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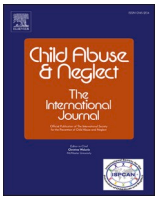

Survival of the nurtured: A 60-year follow-up study on mortality in institutionalised infants

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ABSTRACT

Background: Early childhood institutional placements are hypothesised to have long-term consequences for health and survival. This study examined 60-year mortality outcomes in individuals placed in infant institutions marked by severe psychosocial deprivation.
Participants and setting: The study includes 431 individuals placed in institutions within their first days of life (1958–1961) in Zurich, Switzerland. While they received adequate physical care, they experienced profound psychosocial deprivation (<1 h cumulative adult–infant interaction per 24 h) due to state care measures before law reform in 1981.
Methods: This population-based observational study compares the institutionalised cohort with a representative community sample from the same time and geographical area. Mortality was tracked over 60 years through population registry linkage. Main outcomes were all-cause mortality in both cohorts, time of death, cause-of-death, and predictors of mortality within the institutionalised cohort.
Results: Individuals in the institutionalised cohort showed higher mortality than the community comparison group (Hazard Ratio 1.48; 95% CI = 1.01–2.17; $p = .05$) and resulted in an estimated 12 years of lost life (reached the 95th survival percentiles 12.4 (95% CI 0.6–24.1) years earlier; $p \leq .04$). Deaths before age 40 were twice as common in the institutionalised cohort (22 vs. 9; $p = .08$). The distribution of causes of death differed significantly between cohorts ($p < .001$), with fewer deaths from natural causes in the institutionalised group. Within the institutionalised cohort, longer duration of placement and more placement changes all showed trends towards higher mortality.
Conclusions: Severe psychosocial deprivation during early institutional placement is associated with increased mortality risk persisting into late adulthood, comparable in magnitude to established health risks such as smoking. By eliminating confounding from pre-placement adversity and isolating psychosocial deprivation during the earliest developmental period, this study

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provides novel long-term evidence on the association between infant institutional care and mortality across the life course.
It highlights the risks of insufficient nurturing and social interaction in early childhood and underline the global relevance for the millions of children still growing up under similar institutional care conditions and to children exposed to psychosocial deprivation in other settings.

1. Introduction

The first few years of a human's life are a period of rapid brain maturation and unparalleled development (Black et al., 2017; Shonkoff & Phillips, 2000). In order to grow up healthily, the child requires a nurturing environment and sufficient social interactions with familiar caregivers (Schore, 2001). Studies show that children develop better when they receive adequate nutrition and sufficient physical protection and feel secure, loved, and accepted by their caregivers during the first years of life (Hughes et al., 2017). In addition, they need adequate cognitive stimulation to develop healthily (Berument, 2013; Maclean, 2003). Without such conditions, the formation of synaptic connections and the development of neural pathways may be altered (Caldji et al., 1998; Johnson et al., 2006; Shonkoff & Phillips, 2000). In their seminal work, Hazan and Shaver (1987) showed that the nature of early experiences with caregivers has far-reaching consequences even into adult life. More recent evidence has confirmed that this early developmental period is relevant across the entire lifespan (Black et al., 2017; Shonkoff & Phillips, 2000).

Current evidence from global scientific data suggests that institutional placement is a significant risk factor for healthy development, more so than other child welfare measures (Jackisch et al., 2019). It has been shown to be detrimental to children's physical development and health as it causes growth delay, hearing and vision problems, and motor disorders, including stereotypical behaviours such as body rocking and head banging. In addition, such conditions have been shown to be detrimental to children's cognitive abilities and socioemotional development, including mental health, attachment, and emotion regulation (Berens & Nelson, 2015; Browne, 2009; Center on the Developing Child, 2007; Goldman et al., 2020; IJzendoorn et al., 2020; Johnson et al., 2006; Nelson et al., 2014; Sand et al., 2024b; Schore, 2001; Sherr et al., 2017; Shonkoff et al., 2000; van IJzendoorn et al., 2009). Moreover, certain care circumstances and practices such as age at entry, stability of care, duration of institutionalisation, size of institutions, and children–staff ratio influence the impact of institutionalisation (Berens & Nelson, 2015; Sherr et al., 2017). Pioneers such as Spitz (1945, 1948), Goldfarb (1943, 1945) and Bowlby (1951) first described the detrimental emotional, behavioural, and intellectual effects of deprivation as a result of institutional placement on young children as part of their description of hospitalism during the first half of the 20th century. Moreover, reports on placement in infant care institutions from the first half of the century document that infant mortality in institutions varied widely between 10% and 100%, depending on the quality of the institution (Bakwin, 1942; Chapin, 1915a, 1915b; Schlossman, 1920).

A recent systematic review and meta-analysis (Batty et al., 2022) indicates that institutional placement is related to increased mortality into adulthood. However, a central challenge is disentangling the effects of institutional placement itself from adversities that preceded placement, particularly when children enter care later in childhood following maltreatment or family instability. Moreover, institutional experiences during later childhood may not be comparable to placement during the most sensitive period of early development in infant care institutions characterised by psychosocial deprivation (McLaughlin et al., 2014, 2019; Power et al., 2020). In addition, many studies cannot distinguish whether adverse outcomes stem from psychosocial deprivation or from co-occurring physical deprivation such as malnutrition, poor hygiene, or limited medical care (Carr et al., 2020; Maclean, 2003).

The historical context of infant care institutions in Switzerland in the first half of the 20th century provides a rare naturalistic setting in which severe psychosocial deprivation occurred in the absence of marked physical neglect, offering a unique opportunity to address methodological and ethical challenges that typically limit research on early institutional adversity.

Therefore, this study leverages a cohort placed into infant care institutions within days after birth, reducing confounding by pre-placement adversity and allowing examination of institutional care during the earliest developmental period. The institutional context under study provided adequate physical and medical care, enabling a focus on severe psychosocial deprivation and responding to calls to disentangle specific dimensions of early adversity and their long-term consequences (McLaughlin & Sheridan, 2016).

Against this background, the aim of this study was to examine mortality among individuals placed in infant care institutions in the 1950s under conditions of severe psychosocial deprivation but adequate physical and medical care. Using data from a population-based cohort, we conducted a 60-year follow-up with population registry tracking of individuals who were placed into infant care institutions immediately after birth and compared them with a representative community sample who grew up in families during the same period and in the same geographic region. In total, we examined 830 individuals (431 institutionalised individuals and 399 controls) to estimate the long-term impact of early institutional placement on mortality. We additionally examined causes of death and predictors of mortality among institutionalised individuals.

2. Methods

2.1. Study context

In Switzerland, placing infants in care institutions was quite common in the first half of the 20th century (Businger & Ramsauer, 2019). The main reasons for having a child placed in an infant care institution were either being an unmarried or underaged mother or

being of foreign origin with migrant worker status (Meierhofer & Keller, 1974; Sand et al., 2024a). Having a child as a young, unwed mother was viewed the authorities and society as slovenly (German *liederlich*) and was to be disciplined (see Lengwiler & Praz, 2018; Ramsauer, 2000; Unabhängige Expertenkommission, 2019). For children born illegitimately to unwed mothers, a guardianship was generally established, and the child was placed in an institution without any further explanation or justification; this course of action was supported by a civil constitutional law that was in effect until 1981 (Swiss Civil Code; Schweizerisches Zivilgesetzbuch from 1907 Art. 311). Migrant workers were subjected to serious prejudice and residence permit restrictions, were forced to work long working hours to stay in Switzerland, and therefore were unable to care for their children (D'Amato, 2012; Joris, 2012). Other reasons for placement included precarious living situations such as poverty or the physical disability of a parent, which were a minority of cases (Meierhofer & Keller, 1974).

Generally, infants were placed into institutions at a very young age as early as before the age of two weeks (Huber, 1995). At that time, the infant was seen as a simple reflex-driven being (Meierhofer, 1958), and the belief was prevalent that there would be no harm to infants if they were cared for by strangers (Meierhofer & Keller, 1974). Hard-earned success in reducing child mortality had made preventing the spread of germs a priority, so an institutional practice of isolation was the norm, involving as little physical contact as possible, feeding according to a rigid plan, and stringent hygiene (Jenni, 2022; Ryffel, 2013). In addition, an intense wariness of spoiling children was prevalent, and childcare practices were generally characterised by strict routines that did not take into consideration their emotional needs (Gebhardt, 2009).

In recent decades, Switzerland has engaged in a comprehensive process of examining the state care measures in place before 1981 and of establishing mechanisms for recognition, rehabilitation, and reconciliation for those affected (Unabhängige Expertenkommission Administrative Versorgungen, 2019). This work aligns with international efforts to address historical injustices against children and vulnerable individuals—such as the inquiries into the Residential Schools for First Nations in Canada, institutional and church-run care settings in Ireland, or state-run infant and week-care institutions in Germany (Berth, 2023; Sinclair, 2007; Wright et al., 2017).

2.2. Cohort description

2.2.1. Study design and participants

Between 1958 and 1961, Dr. Marie Meierhofer conducted a population-based study and collected developmental data from all 431 infants ages 0–3 years in all of the 12 infant care institutions in Zurich, Switzerland (Lannen et al., 2021; Meierhofer & Keller, 1974). Between 1969 and 1973, 158 individuals were examined in a follow-up during adolescence (Lannen et al., 2021; Meierhofer & Hüttenmoser, 1975; Meyer-Schell, 1971). This cohort of individuals formerly placed in infant care institutions are here referred to as the MMI cohort (from Marie Meierhofer Children's Institute).

Those data were compared to data from the representative community-based sample of the Zurich Longitudinal Studies and are referred to here as the ZLS cohort. The ZLS individuals grew up in the same geographic location but were raised in families and not placed in infant care institutions ($N = 399$).

Details can be found in the study protocols of both cohorts (Lannen et al., 2021; Wehrle et al., 2021).

In the institutions, children from the MMI cohort were well cared for physically but other than for feeding and changing, they spent most of their time in their cribs. They received less than one hour of cumulative interaction time in 24 h (Sand et al., 2024a). Compared to the children that were never institutionalised, they showed significant developmental delays by the age of three years. Areas of development that were particularly affected were language development and social development, presumably because these are more dependent on external stimulation (Sand et al., 2024a). In addition, these analyses revealed that within the group of institutionalised individuals, longer duration of institutionalisation increased the risk of developmental delays, and more interaction time, regular family contact, and higher birth weight were identified as protective factors.

2.3. Procedures

Between October 2018 and February 2023 all individuals of both cohorts were searched for through the population registry for a 60-year follow-up. In Switzerland, every individual is formally registered with the municipality where he or she resides. Individuals who relocate must give notice of departure with the old municipality and formally register with the new municipality, so individuals can be tracked through the system over time to the present day or until their deaths. In addition, events such as birth, marriage, divorce, and death are registered in the civil population registry in a person's hometown (*Heimatort*).[1]

We applied an active search strategy and tracked individuals through every location they had resided until either we received their current address or were notified of their deaths. When we received notice that an individual had moved abroad, it was possible in many cases to continue to search for their whereabouts by cooperating with the Federal Office for Foreign Affairs and Embassies. In countries with a similar population registry, and when the municipality the person had moved to was known, it was possible to continue the search through the municipal registry system. When a death could be identified, the date of death was registered in the municipal population registry. However, when a participant's trace was lost, the date of final contact was used as a censored event time.

[1] Each resident in Switzerland with Swiss nationality also has a "hometown" (*Heimatort*), similar in function to place of birth in other countries. The office of civil registry (*Zivilstandsamt*) in that hometown holds key documents such as birth certificates and marriage records. The civil registry records the place of residence at the time of events relevant to civil status such as marriage, divorce, and change of name.

Overall, 26.5% (114/431) of individuals in the MMI cohort were lost to follow-up, most of them ($n = 93$; 8.6%) due to moving abroad. However 18 individuals who were lost to follow-up were living in Switzerland at the time of last contact and 3 had unknown address at last contact. In the ZLS cohort, only 5.3% (21/399) of individuals were lost to follow-up. The majority of them ($n = 13$; 61.9%) had moved abroad and this is why they were lost. For 8 individuals (38.1%), it is unclear why they were lost as they had given notice of departure with the old municipality but were not registered in the new municipality. It remains unclear whether they had moved abroad without notice or whether their information was lost over time.

In addition, we were granted access to the official forms recorded by the medical examiner who attended the scene to confirm death. Access was granted by the civil registry in the municipalities where individuals resided at the time of death.

More details of the search strategy are described in the study protocols (Lannen et al., 2021; Wehrle et al., 2021).

This study procedure was evaluated and approved by the Ethics Committee of the Faculty of Philosophy at the University of Zurich (Approval Number 19.4.7).

2.4. Outcomes

The primary outcome was all-cause mortality. This outcome was compared between the two cohorts. For the formerly institutionalised MMI cohort, it was also analysed which characteristics of the institutional placement predicted mortality. Secondary outcomes were causes of death, with four categories: natural, unnatural, unclear, and unknown. On the official form retrieved from population registry, the medical examiner at the scene of death had checked off whether the death was natural or unnatural. Unnatural causes of death included suicide, accidents, and crime. Unclear cause of death was reported on the official form when the medical examiner that confirmed death suspected an unnatural cause of death but was unable to confirm this on site and asked for an autopsy. Unknown cause of death was noted when no records were identified.

2.5. Predictors

The primary predictors for between-group analyses were birth weight and gender. Lower birth weight, an indicator of pre- and perinatal risks, was derived from the records collected during the original studies.

Within the MMI cohort, in addition to birth weight and gender, reason for placement, duration of placement, number of placement changes, and frequency of contact with their families (family visits and children going home to their families) were included as predictors and derived from the historical study records. The reason for placement was operationalised in two categories: children illegitimately born to unwed mothers and all other reasons. This second category included 109 children placed due to migrant background, 34 children placed due to precarious situations or parental disability, and 14 due to other reasons without more specific information. Family visits and children going home to their families were split into two categories: visits every second week at the most and more frequent.

Duration of placement was split in two categories at the median (2.55 years). Placement changes were also split at the median, four placement changes. Duration of placement and placement changes was retrospectively collected as part of the follow-up study during adolescence. The detailed conceptual framework of the historic data and more details on the operationalization of the original variables was published elsewhere (Sand et al., 2024a).

2.6. Hypotheses

From the results indicating how infant institutionalisation affected this cohort during early childhood and the literature review presented in the introduction, we hypothesised that individuals in the MMI cohort have a higher mortality compared to individuals from the ZLS cohort (H1). We also hypothesised that within the MMI cohort, male gender, individuals with lower birth weight, longer duration of placement ($\geq$2.55 years, median), more placement changes (four changes or more), fewer family visits (visits every second week at the most) each have a higher risk of mortality (H2). No hypothesis was formulated for how reason of placement might be related to mortality.

2.7. Statistical analyses

As deaths were recorded only up to 65 years of age among individuals in the MMI cohort, survival times were also administratively censored at this age in the ZLS cohort. The first step included between-group comparison of mortality; the second step was analysis of predictors for mortality within the group of institutionalised individuals in the MMI cohort.

First, the survival times in each cohort were analysed nonparametrically using Kaplan-Meyer curves, with the between-cohort difference tested using a log-rank test (Kaplan & Meier, 1958; Peto & Peto, 1972). Gender- and birth-weight-adjusted analyses were conducted with a Cox proportional hazard regression (Cox, 1972). Birth weight was centred at a median of 3340 g, and the model estimated the linear impact of a 500 g difference in birth weight on survival. Both an additive model with same effect of placement within each gender and an interaction model allowing different effects of placement in each gender (see Table S5) were fitted to the data. Because the interaction effect was not statistically significant ($p = .45$), we focused our interpretation on the additive model, reporting HRs for the placement, gender, and birth weight effects in a between-cohort analysis.

Following initial exploratory analyses comparing the survival in the two cohorts, the model was also refitted after separating the MMI cohort members into two groups by the reason of placement and the survival in each group was then compared with that of the

ZLS cohort. The proportional hazard assumption in Cox regression models was tested with the Grambsch and Therneau test (Grambsch & Therneau, 1994).

As an alternative to Cox regression, Laplace regression (Frumento & Bottai, 2017) (i.e. quantile regression for censored data) was used to model the upper quantiles (95% and 90%) of the survival distribution as a function of predictors when comparing the two cohorts. This analysis and its rationale are presented in section 4 of the Supplementary material.

Second, we used Cox regression to analyse risk factors potentially associated with mortality within the MMI cohort. As a total of 60 deaths were observed in that cohort, we limited the maximum number of predictors included in the multivariate model to six to loosely respect the rule of thumb of one predictor per ten observed events commonly used in survival analysis (Peduzzi et al., 1995).

Some of the theoretically derived predictors had large proportions of missing values (> 50%). Consequently, we used multiple imputations (Rubin, 1987) to retain as much information as possible in multivariable analyses. Because predictors associated with the placement only applied to MMI subjects, multiple imputations were conducted separately in each cohort. The survival outcome was accounted for by including the Nelson-Aalen estimator of the cumulative hazard and the event indicator (0 = alive; 1 = dead) in the imputation model, as suggested in (White & Royston, 2009). All the predictors used in the Cox models above were also used in the imputation model. In the MMI cohort, nationality and the address of last contact, whether in Switzerland or abroad, were used as additional predictors in the imputation model. A total of 100 complete datasets were reconstructed, with results pooled using Rubin's rules (Rubin, 1987).

All statistical analyses were conducted with R version 4.2.2 (R Core Team, 2023). The level of statistical significance set at $p = .050$ but results were primarily interpreted according to the magnitude of effect sizes, whether these effect sizes were statistically significant or not. A relative hazard difference of $> \pm 20\%$ was considered as potentially relevant.

3. Results

This section first reports on the detailed description of the cohorts. It then outlines the between group results on mortality and cause of death. Finally, the section will report on predictors of mortality within the group of institutionalised individuals of the MMI cohort. Additional sensitivity analyses investigating potential sources of bias causing underestimation of the association between placement and mortality can be found in the supplementary material.

3.1. Description of cohorts

Baseline characteristics of eligible individuals for both cohorts are shown in Table 1.

The two cohorts did not differ in gender (46.1% females in ZLS versus 49.2% in MMI, $p = .415$). Due to different eligibility criteria for the original study, in which only families of Swiss nationality were eligible for the ZLS cohort, the two cohorts differed in their distribution of nationality ($p < .001$), with individuals of foreign nationality accounting for 52.3% of the MMI cohort (after excluding 2.4% missing values). Within the MMI cohort, a small proportion (9.7%) of Swiss citizens was living abroad at the time of final contact, whereas this proportion was much larger (43.7%) among foreigners. Although the two cohorts were followed up to 65 years of age, they also differed in their years of birth. The median year of birth in the MMI cohort was 1958. For the ZLS it was 1954 ($p < .001$), with very little overlap between the two distributions. According to observed data, the cohorts did not differ in their birth weight (50 g difference in median birth weight, $p = .423$). However, we note that birth weight was missing in only 2.5% of ZLS subjects, it was missing in nearly half (47.6%) of the MMI subjects, resulting in an overall proportion of missing values of 25.9%. The reason for

Table 1
Cohort characteristics.

	Overall	ZLS	MMI	*p*-Value	% missing
N	830	399	431		
Females (%)	396 (47·7)	184 (46·1)	212 (49·2)	0·415	0·0
Non-Swiss citizens (%)	215 (26·5)	0 (0·0)	215 (52·3)	<0·001	2·4
Year of birth (median [range])	1956 [1952, 1961]	1954 [1954, 1961]	1958 [1952, 1959]	<0·001	0·0
Birth weight [g] (median [range])	3340 [1120, 5000]	3350 [1550, 5000]	3300 [1120, 5000]	0·423	25·9
Observed deaths during follow-up (%)	107 (12·9)	47 (11·8)	60 (13·9)	0·414	0·0
MMI cohort specific					
Illegitimate birth to unwed mothers vs other (%)	NA	NA	214 (57·7)	NA	13·9
Family visits: every second week at most vs more often (%)	NA	NA	26 (14·2)	NA	57·5
Children never going home vs at least every other weekend with family (%)	NA	NA	119 (75·3)	NA	63·3
Nb of placement changes ≥4 vs <4 (%)	NA	NA	82 (51·6)	NA	63·1
Duration of placement ≥2·55y vs <2·55y (%)	NA	NA	141 (50·0)	NA	34·6

Categorical variables were compared using chi-square tests (except citizenship which was tested using Fisher's exact test) and continuous variables were compared using Mann-Whitney tests.

missing data was either that data were not recorded during the original data collection or the information was lost over time. Details have been published elsewhere (Lannen et al., 2021; Sand et al., 2024a).

Table 1 also provides information specific to the MMI cohort's institutional placement, including the proportion of missing values in each variable. Some variables, such as the frequency of family visits and the number of placement changes, also had large numbers of missing values (> 50%). In this cohort, 214 (57.7% of subjects with available information) were placed because they were illegitimately born to unwed mothers. The remaining 42.3% were placed in infant care institutions exclusively because their parents were migrant workers ($n = 109$), due to precarious living situations ($n = 34$) or other unknown reasons ($n = 14$). Among subjects with available information regarding frequency of family visits, 26 subjects (14.2%) had no visit at all at the institution or one visit every other week, and 119 (75.3%) never went home during weekends. The median duration of placement was 2.55 years, and 51.6% of subjects with available information experienced at least four changes during their placement.

3.2. Between-group mortality

Fig. 1 depicts the survival probability of the two cohorts as a function of age. Overall, the MMI cohort shows shorter survival times than the ZLS cohort, but the difference is not statistically significant ($p = .054$) on the log-rank test, therefore the findings should be interpreted cautiously. Table 2 presents hazard ratios (HR) for the cohort, gender and birth weight effects as estimated with the additive Cox model after pooling results from the multiple imputations. After controlling for gender and birth weight, the estimated hazard of death was 1.48 higher in the MMI cohort compared to the ZLS (HR 1.48, 95% CI 1.01–2.17; $p = .050$). Males had a markedly higher mortality compared to females (HR 1.94, 95% CI 1.29–2.92; $p = .002$). A difference of 500 g in birth weight showed no significant association with mortality (HR 0.96, 95% CI 0.75–1.21; $p = .719$). Table S6 in the Supplementary material reports the association between the cohort, gender and birth weight, and the age at which the 95th and 90th percentile of the survival distribution is reached. Individuals in the MMI cohort reached those percentiles significantly earlier than their ZLS peers, with 12.4 (95% CI 0.6–24.1) and 12.9 (95% CI 0.9–24.8) years lost on average for the 95th and 90th percentile, respectively ($p \leq .039$). However, the wide 95% confidence intervals indicate substantial uncertainty around these estimates. Males reached these two percentiles earlier than females, with on average 13.2 and 15.5 years lost, respectively ($p \leq .033$), with comparable uncertainty in the estimation. In contrast to results obtained with the Cox regression model, birth weight had a statistically significant effect on the 95th percentile of survival, with an increase of 500 g associated with 4.4 years gained ($p = .042$). However that gain decreased to 2.3 years at the 90th percentile and was no longer significant ($p = .436$).

3.3. Cause of death

During the follow-up period, a total of 60 deaths (13.9%) were registered among MMI participants, while 47 ZLS participants died (11.8%). Table 3 presents the gender, nationality, year of birth, birth weight, and age at death of the deceased and statistics on the four categories of causes of death: natural, unnatural, unclear, or unknown. Although these data only consider the observed deaths and do not account for the censored events (and thus should be interpreted with caution), they suggest that the distribution of the causes of

Fig. 1. Kaplan-Meyer survival curves for the two cohorts (with 95% confidence intervals). The difference between the two survival curves is tested with a log-rank test.

Table 2
Between-group Cox regression.

	Hazard ratio [95% CI]	p
MMI	1·48 [1·01; 2·17]	0·050
Males	1·94 [1·29; 2·92]	0·002
Birth weight (3340 g, +500 g)	0·96 [0·75; 1·21]	0·719

The model was fitted to 830 individuals with 107 observed deaths.

death differed between the two cohorts (Fisher exact test: $p < .001$), with a significantly smaller proportion of observed natural deaths among MMI subjects (25.0%) compared to ZLS participants (63.8%). However, the proportion of confirmed unnatural deaths was comparable in the two cohorts (16.7% and 17.0%, respectively). Most of the difference was concentrated on the proportion of unknown causes of death which was significantly higher in the MMI cohort (46.7%) compared to ZLS (10.6%). Fig. 2 depicts the timing of the deaths in each cohort. The graph reveals that many deaths in the MMI cohort (mostly with unknown causes) occurred at young ages (< 40 years). In fact, while the same death counts were observed in each cohort after 40 years, the number of deaths occurring before 40 years was twice as large in the MMI cohort compared to the ZLS cohort (MMI: 22 deaths; ZLS: 9 deaths). However, due to the relatively low number of deaths observed below 40 years, this result needs to be interpreted with caution (Chi-square test: $p = .077$). In the MMI cohort, the median age at death was comparable between those born to unwed mothers (48 years) and those placed for other reasons (43 years, Mann-Whitney test: $p = .328$). Also, no association between the causes of death and the reason of placement could be detected in the data (Fisher exact test: $p = .748$).

3.4. Within-group predictors for mortality

Table 4 reports the HR of different potential predictors within the MMI cohort after pooling results from the multiple imputations. As already noted in Table 2 that presents data for both cohorts, a higher mortality among males was also observed within the MMI cohort (HR 1.70, 95% CI 0.97–2.97; $p = .069$). However, the confidence interval was wide, indicating substantial uncertainty around the estimate.

Additionally, four or more placement changes (HR 1.36, 95% CI 0.56–3.32; $p = .507$) and a longer duration of placement (≥2.55 years; HR 1.34; 95% CI 0.70–2.55 $p = .379$) both resulted in potential increases in the risk of death, though confidence intervals indicate uncertainty and results are not statistically significant. Absence or low frequency of family visit was not associated with a higher mortality (HR 1.12, 95% CI 0.42–3.00; $p = .820$). In contrast, institutionalised children who were placed due to being born to unwed mothers had a significantly higher risk of dying than children placed for other reasons (HR 2.28, 95% CI 1.18–4.40; $p = .017$). Consequently, we divided the MMI cohort into two groups, those placed due to illegitimate birth and those placed due to other reasons, and compared the survival in each group with the ZLS cohort after controlling for gender and birth weight (Table 5). In this analysis, MMI subjects placed due to illegitimate birth to unwed mothers were almost twice as likely to die at any given time point as ZLS subjects (HR 1.93, 95% CI 1.28–2.92; $p = .002$). In contrast, the survival of MMI subjects placed for reasons other than illegitimate birth did not differ significantly from that of ZLS subjects (HR 0.82, 95% CI 0.43–1.53; $p = .529$).

4. Discussion

The aim of this study was to investigate the mortality in late adulthood of individuals who suffered psychosocial deprivation in infant care institutions. A population-based cohort of all infants in all of the infant care institutions in Zurich between 1958 and 1961

Table 3
Cohort characteristics for the deceased.

	Overall	ZLS	MMI	p-Value
N	107	47	60	
Females (%)	35 (32·7)	13 (27·7)	22 (36·7)	0·437
Non-Swiss citizens (%)	23 (22·1)	0 (0·0)	23 (40·4)	<0·001
Year of birth (median [range])	1956 [1952, 1959]	1955 [1954, 1957]	1958 [1952, 1959]	<0·001
Birth weight [g] (median [range])	3300 [1550, 5000]	3250 [1550, 5000]	3370 [2600, 4700]	0·511
Age at death [years] (median [range])	49·9 [0·9, 65·0]	54·1 [0·9, 65·0]	46·3 [3·5, 64·9]	0·046
Cause of death (%)				<0·001
Natural	45 (42·1)	30 (63·8)	15 (25·0)	
Unnatural	18 (16·8)	8 (17·0)	10 (16·7)	
Unclear	11 (10·3)	4 (8·5)	7 (11·7)	
Unknown	33 (30·8)	5 (10·6)	28 (46·7)	

Categorical variables were compared using chi-square tests (except causes of death which were compared using Fisher's exact test) and continuous variables were compared using Mann-Whitney tests.
*Comparison only considers the observed deaths and not the censored observations.

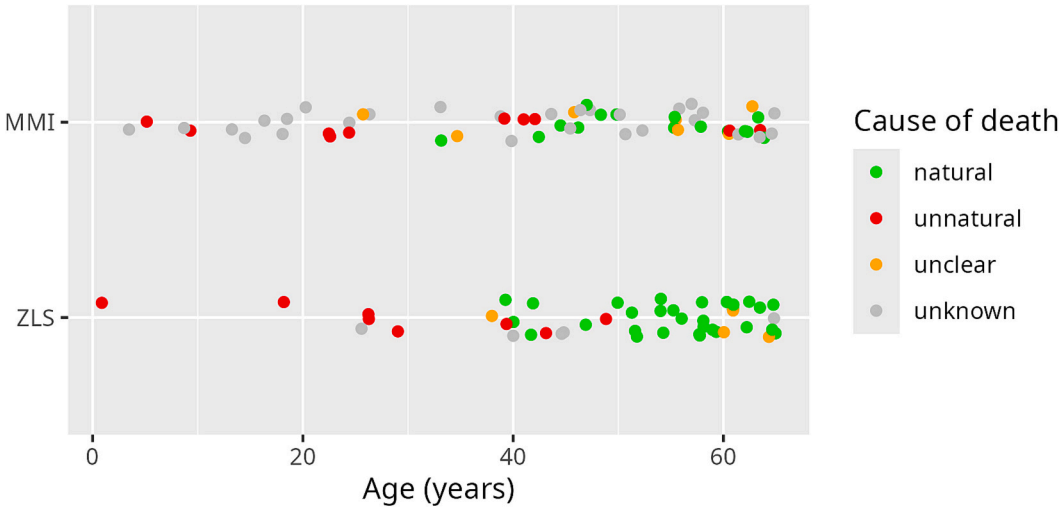

Fig. 2. Timing of deaths in each cohort with associated causes of death.

Table 4
Within-group Cox regression.

	Hazard ratio [95% CI]	p
Illegitimate birth	2·28 [1·18; 4·40]	0·017
Males	1·70 [0·97; 2·97]	0·069
Four placement changes or more	1·36 [0·56; 3·32]	0·507
Placement during 2·55 years or more	1·34 [0·70; 2·55]	0·379
No or few family visits	1·12 [0·42; 3·00]	0·820
Birth weight (3340 g, +500 g)	0·97 [0·67; 1·39]	0·861

The model was fitted to 431 individuals with 60 observed deaths.

Table 5
Between-group Cox regression.

	Hazard ratio [95% CI]	p
MMI (illegitimate births)	1·93 [1·28; 2·92]	0·002
MMI (other reasons)	0·82 [0·43; 1·53]	0·529
Males	1·94 [1·29; 2·92]	0·002
Birth weight (3340 g, +500 g)	0·94 [0·75; 1·19]	0·612

The model was fitted to 830 individuals with 107 observed deaths.

(Lannen et al., 2021) was compared to a representative community sample cohort that grew up in families in the same geographic location at the same time (Wehrle et al., 2021). In a 60-year follow-up, we searched the population registry to identify individuals who had died and their causes of death.

4.1. Mortality after institutionalisation

Individuals that were placed in infant care institutions were about 1.5 times more likely to die than individuals that were never institutionalised, with an estimated 12 years of lost life, thus supporting our Hypothesis 1. Notably, this HR is similar to those found for smoking (Chang et al., 2015; Maag et al., 2013) and to the gender effect (Wong et al., 2006). Furthermore, the survival analysis revealed that, overall and consistent with the general population (Wong et al., 2006), males had a higher mortality than females.

Still, the estimated association between placement and mortality is likely underestimated. Indeed, two potential sources of bias can be suspected in our study. First, individuals who moved abroad, predominantly foreign citizens, formed a large portion of the MMI cohort: 26.5% were known to be living abroad at the time of last contact, but more may have moved abroad and been lost to follow-up. Such individuals were more difficult to track, and the reason for their loss to follow-up may be that they had already died and their deaths were missed. This would result in a correlation between the censoring and event processes, likely to lead to underestimation of the mortality in the MMI cohort. As a sensitivity analysis, we replicated the analysis after restricting the attention to Swiss citizens (which were easier to track) and observed an increased and statistically significant risk of death for the MMI cohort compared to the ZLS (HR 1.63, $p = .032$, see Table S1). Secondly, MMI subjects were born on average four years later than ZLS participants and thus

have a lower chance of dying at any given age due to the general increase in life expectancy (McMichael et al., 2004; Moser et al., 2005). Because it was not possible to control for the year of birth in the model due to non-overlapping distributions between the two cohorts, we conducted a sensitivity analysis (see supplementary materials) that used a plugin estimate for the effect of the year of birth estimated from the Human Mortality Database (Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France), 2025). The resulting adjusted association between placement and mortality was also increased and statistically significant (HR 1.58, $p = .020$).

There is anecdotal evidence of increased mortality as a result of institutional placement under the laws in Switzerland until 1981 (Krüger et al., 2024; Tanner, 1999). And there is some global empirical evidence of long-term effects of a host of adverse childhood experiences, including exposure to violence and/or abuse, parental mental illness and substance abuse, incarceration of a parent, and death of a parent. Such experiences have been identified as key risk factors for lower socioeconomic success, poorer physical and mental health, and mortality (Anda et al., 2006; Brown et al., 2009; Chapman et al., 2004; Felitti et al., 1998; Gao et al., 2017; Kelly-Irving et al., 2013; Rogne et al., 2025; Shonkoff et al., 2012; Yazawa et al., 2022).

However, the findings of this study are specific to placement during the critical period of early childhood. They are not directly comparable to studies that investigate children placed in institutions sometime during childhood after years of exposure to family risks in possibly dysfunctional families (Batty et al., 2022; Jackisch et al., 2021) or possible exposure to additional types of maltreatment, such as abuse, during institutional placement (Carr et al., 2020). This is of particular relevance because evidence is emerging that neglect and deprivation have specific effects distinct from violence and abuse (McLaughlin et al., 2014; Zeanah & King, 2022). Furthermore, the findings of this study are also specific to psychosocial deprivation of children well cared for physically and medically (Sand et al., 2024b).

One might claim that children placed in infant care institutions had inherent developmental risks to begin with, which will result in more unfavourable outcomes. We argue for several reasons that this was not the case. Unfortunately, our data on socioeconomic indicators for the MMI cohort have not been well preserved, and we were unable to include this in the analyses.

However, birth weight is one of the key indicators of exposure to risks pre- and perinatally and has been shown to be a key indicator of developmental risk (Shenkin et al., 2004; Walhovd et al., 2012). We found that the two cohorts did not differ in their birth weights. This fact is an indication that group differences are not merely a manifestation of pre- and perinatal risk factors. Furthermore, because infants were generally placed into institutions only a few days after birth in our study, they were scarcely exposed to possible adverse family conditions after birth but prior to institutional placement. These findings are in line with results from robust longitudinal studies that the effect of institutional placement exceeds risks of socioeconomic indicators and other adverse experiences (Jackisch et al., 2019, 2021; Jackisch & van Raalte, 2025; Rogne et al., 2025). In addition, our findings indicate the potential for a dose–response effect, in which individuals that spent more time in the institutions and/or experienced more placement changes were more affected and those who spent more time with their families were less affected. These findings are consistent with our Hypothesis 2. It is also consistent with findings in a 60-year follow-up on cognitive function of the surviving individuals (Sand et al., 2024b).

4.2. Time of death

We did not find an association of increased infant mortality and placement in infant care institutions as documented by reports in the first half of the 20th century (Bakwin, 1942; Chapin, 1915a, 1915b; Schlossman, 1920). We conclude from our study that the measures taken in the Swiss infant care institutions to improve hygiene and medical care successfully prevented infant mortality. However, deaths in the MMI cohort overall occurred at a younger age than in the ZLS cohort with twice as many deaths occurring before the age of 40 in the MMI cohort. This differs from findings of Jackisch et al. (2021) who identified that the bulk of excess deaths in their study that could be attributed to involvement child welfare services occurred from midlife onward and could be an indication of the specific effects of early psychosocial deprivation in this cohort.

4.3. Causes of death

While the observed proportion of confirmed unnatural deaths was similar between the two cohorts, there was a larger number of deaths from unknown causes in the MMI cohort. This increased proportion of unknown deaths in the MMI cohort is related to the inability to retrieve information on the causes of deaths. This was the case either because death occurred abroad, several decades ago or because information could not be retrieved, presumably because of adoption or name change. We can reasonably assume that unknown causes of death refer to information missing completely at random. In contrast, a death is labelled as unclear by the medical examiner when an unnatural cause of death is suspected but cannot be confirmed on site. If we exclude deaths of unknown causes, the proportion of deaths with unnatural or unclear causes in the MMI cohort (53.1%) was almost twice as large as in the ZLS (28.6%, $p = .057$). These findings may be informative, but they remain uncertain and should not be overinterpreted.

There were also significantly fewer natural causes of deaths recorded in the MMI cohort (25·0%) compared to ZLS participants (63.8%, $p < .001$).

Several studies attribute the association between adverse childhood experiences and mortality to the adoption of health risk behaviour (Anda et al., 2006; Brown et al., 2009; Chapman et al., 2004; Felitti et al., 1998; Kelly-Irving et al., 2013; Shonkoff et al., 2012; Yazawa et al., 2022), which might explain some of the differences in mortality.

Furthermore, a recent review (Graf et al., 2022) concluded that early co-regulation through an attentive caregiver is important to understanding the development of self-regulation competency in children and their processes initiating the pathway to pathology. It is possible that the lack of co-regulatory support by a caregiver led to a compromised ability to self-regulate in individuals exposed to

psychosocial deprivation and hence can contribute to understanding the increased mortality through risk-taking behaviour that arises through a lack of ability to self-regulate (Magar et al., 2008). The trend towards slightly improved survival observed in children that had more contact with their families supports this hypothesis.

4.4. Predictors of mortality for institutionalised individuals

Our results point to a potential dose–response effect in which individuals with more intense exposure to the conditions in the institutions showed trends towards higher mortality: longer duration of placement, more placement changes, and less family contact was associated with a higher risk of mortality. Similar associations were revealead in the data for developmental outcomes during early childhood (Sand et al., 2024a) and in results on cognitive outcomes in survivors at age 60 (Sand et al., 2024b). Dosage effect has been described in the literature (IJzendoorn et al., 2020; Smyke et al., 2010).

We found that children illegitimately born to unwed mothers had a markedly higher risk of dying than children placed for other reasons (HR 2.29) and than ZLS controls (HR 1.90). This remained consistent and was more pronounced when restricting the attention to Swiss citizens (see tables S2 and S3). This result may indicate that something in the specific practices and circumstances of placement for those illegitimately born to unwed mothers led to their higher mortality risk. Explanatory hypotheses may involve a higher exposure of illegitimately born children to the detrimental components of the placement not inherent to family risk. Ultimately, the reason for this effect calls for further empirical investigation.

4.5. Strengths and limitations

This study is one of the longest follow-up of children institutionalised as infants that investigates the associations between institutionalisation and mortality. The study compares a population-based cohort that was tracked through the population registry with a representative comparison group from the same geographic region growing up at the same time, to control for zeitgeist effects. Because the institutionalised children were well-cared for physically and were placed into the institutions directly after birth, the results focus on the isolated associations between psychosocial deprivation and mortality.

Despite these strengths, the study also has some limitations.

The historic data for the MMI cohort has large proportion of missing data. We used multiple imputations to retain as much information as possible in multivariate analyses. However, the large number of missing values in key variables such as the frequency of family visits limited our ability to obtain precise estimates of risk factors and limited the power of the within-cohort model to detect significant effects. Consequently, the reported 95% CI of MMI-specific risk factors are wide and results are mostly inconclusive. This limitation applies to an even greater extent to the within-cohort model fitted in the sensitivity analysis restricted to Swiss citizens (table S3). Indeed, only 36 deaths were observed in this subgroup while the 6 same predictors were used in the model (which is thus prone to overfitting). Therefore, this sensitivity analysis is only of limited value but the magnitude of the estimated hazard ratios remains interesting for explorative purposes. As individuals were only between 60 and 65 years of age at the time of the 60-year follow-up of the study, only 60 deaths in the MMI cohort had occurred, which both limits statistical power and restricts the number of risk factors that can be reliably analysed in multivariate regression. The limited number of events also prevented us from reliably estimating covariate effects on specific quantiles of the survival distribution in the within-cohort analysis.

The historical records on institutional placement also lack information on the detailed journey of infants across the different institutions. As reported in Table 1, half of the infants were placed in 4 different institutions during their placement but the timing and the precise institutions they frequented could not be recovered. As a consequence, it was not possible to account for the nesting of infants in the 12 institutions, which may have led to an increased type-I error rate. However, we note that with an average interaction time between infants and caregivers of about 55 min in 24 h and a standard deviation of 0.36 h, interaction time varied only slightly and remained well below those children who grew up in their families and what children need to develop healthily (Sand et al., 2024a). We thus expect the between-institution variability in mortality rates to be negligible in comparison to the between-cohort effect.

We also experienced some difficulties in the follow-up of individuals who had moved abroad. However, in a sensitivity analysis, we restricted the sample to Swiss citizens as they were easier to track, which somewhat addressed this source of bias. Another limitation is that the two cohorts differed in their years of birth, but we were unable to reliably control for this effect in the sample thanks to the weak overlap in the distribution of the year of birth between the two cohorts. Therefore, we relied on a plug-in estimate derived from period life tables from the HMD to tentatively account for that effect (Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France), 2025). Although valuable, this approach only considered period life tables from Switzerland even though nearly half of the MMI subjects were of foreign origin. This approach also assumed that the plug-in estimate was measured without error and did not vary across years of birth, ages, or gender.

5. Conclusions

The results show that the associations between psychosocial deprivation in infancy and mortality are similar to that for smoking or the gender difference. Additional risk factors associated with the placement, including more changes, and longer duration of placement, tended to raise the risk of mortality further. However, sensitivity analyses suggest that these associations of placement and mortality are likely underestimated in this study. Notably, psychosocial deprivation during institutional placement seemed to be particularly strongly associated with death in life, before the age of 40 and may also be associated with cause of death for these individuals.

6. Relevance

The results are relevant to the historical reconstruction of the consequences of state actions under Swiss civil laws in effect until 1981 and the political reconciliation process and rehabilitation (Unabhängige Expertenkommission, 2019). Although care circumstances in institutions have changed vastly in Switzerland, the results are relevant to the millions of children globally that are cared for under similar conditions as obtained in the 1950s in Switzerland (Desmond et al., 2020) and to children exposed to psychosocial deprivation in other settings.

Most importantly, our findings strongly highlight the crucial relevance of interaction, love, and care to healthy development. So it is, as Louis Cozolino (Cozolino, 2014) called it, survival of the nurtured.

Credit authorship contribution statement

Patricia Lannen: Writing – original draft, Validation, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization. **Hannah Sand:** Writing – review & editing, Project administration, Investigation, Data curation. **Aziz Chaouch:** Writing – review & editing, Formal analysis, Data curation. **Fabio Sticca:** Writing – review & editing, Project administration, Investigation. **Raquel Paz Castro:** Writing – review & editing, Validation, Data curation. **Flavia M. Wehrle:** Writing – review & editing, Supervision, Resources. **Valentin Rousson:** Writing – review & editing, Supervision. **Oskar G. Jenni:** Writing – review & editing, Validation, Supervision, Funding acquisition, Conceptualization.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.chiabu.2026.108040.

Data availability

Data will be made available on request.

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