

Multidimensional Trajectories of Family Adversity in Childhood and Outcomes in Adolescence and Young Adulthood: Population-Based Evidence from Rural South Africa

Brian Houle^{1,2,3}, Collin F. Payne¹, Shao-Tzu Yu⁴, Chodziwadziwa W. Kabudula²

¹ School of Demography, The Australian National University, Canberra, Australian Capital Territory, Australia

² MRC/Wits Rural Public Health and Health Transitions Research Unit (Agincourt), School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Acornhoek, South Africa

³ CU Population Center, Institute of Behavioral Science, University of Colorado at Boulder, Boulder, CO, USA

⁴ Office of Population Research, Princeton University, Princeton, NJ, USA

Abstract

Increasing evidence suggests that adverse events in childhood can have lasting impacts along the life course. We examine the accumulation and interrelation of different dimensions of family adversity in childhood in rural South Africa. We used population-based, longitudinal data from a household census from the Agincourt Health and socio-Demographic Surveillance site in rural South Africa, including children born from 1992 to 2009. We distinguished between three dimensions of family adversity: household vulnerability, loss within the family, and family dynamics. We used a group-based multi-trajectory model to define groups of children aged 0-12 years. We identified four distinct trajectories of family adversity in childhood. Distal outcome models showed that, compared to low adversity children, mortality risks were particularly elevated for children with multiple adversities within all dimensions and throughout childhood. Subsequent models examined outcomes in adolescence and young adulthood. Our results highlight how the accumulation and interrelation of these dimensions of family adversity are important in understanding child development and later wellbeing.

Aims

Childhood adversity, such as bereavement and poverty, has increasingly been linked to premature mortality and disadvantage later in life.¹⁻⁵ However, less is known how these risks may interact over the life course,⁶ particularly in low- and middle-income settings where data with detailed, prospective information on multiple adversities throughout childhood are rare. We aim to describe distinct trajectories of family adversity in childhood using population-based data on over 30,000 children in rural South Africa. We relate these trajectories to socio-economic outcomes in adolescence and young adulthood.

Methods

Data

We used data from the Agincourt Health and socio-Demographic Surveillance System (AHDSS).⁷ AHDSS monitors a geographically defined population over time and conducts a household census to collect prospective information, including demographic indicators, household-level information, and social indicators. AHDSS is located in rural, northeastern South Africa near Mozambique—in 2011 the population under surveillance was approximately 90,000 people. HIV/AIDS has had a significant impact on the population, with child and adult mortality increasing until recently with the rollout of antiretroviral therapy.⁸

Household socioeconomic status (SES) has been collected since 2001 based on a set of household indicators, summarised using principal components analysis.⁹ SES was measured every two years from 2001, and annually since 2013. We summarised SES using quintiles in a given year.

We included all children born between 1992 and 2009 to ensure coverage of children for their entire childhood (0-12 years of age). Using data up to 2022, we were able to follow-up the oldest children for 30 years, while the follow-up time is shorter for children born later in the time period (see Figure 1). In our analysis, we included 10 family adversities categorised into three dimensions: household vulnerability (e.g., household headed by female); loss within the family (i.e., death of a parent); and family dynamics (i.e., lack of parents and other relatives in the household).

Analysis

We used a group-based multi-trajectory model to determine trajectory groups based on the three dimensions of family adversity in childhood.¹⁰ We fit models with 2-8 trajectory groups using zero-inflated Poisson regressions with a cubic trajectory function. We selected the number of trajectory groups based on model fit criteria, separation and size of the groups, and visual inspection of the groups for substantive differences. To explore differential mortality risks between the groups, we then fit a distal outcome model to predict child mortality during the first 12 years of life. We also tested alternate model specifications omitting children who died as well as including mortality as an additional dimension in the model.

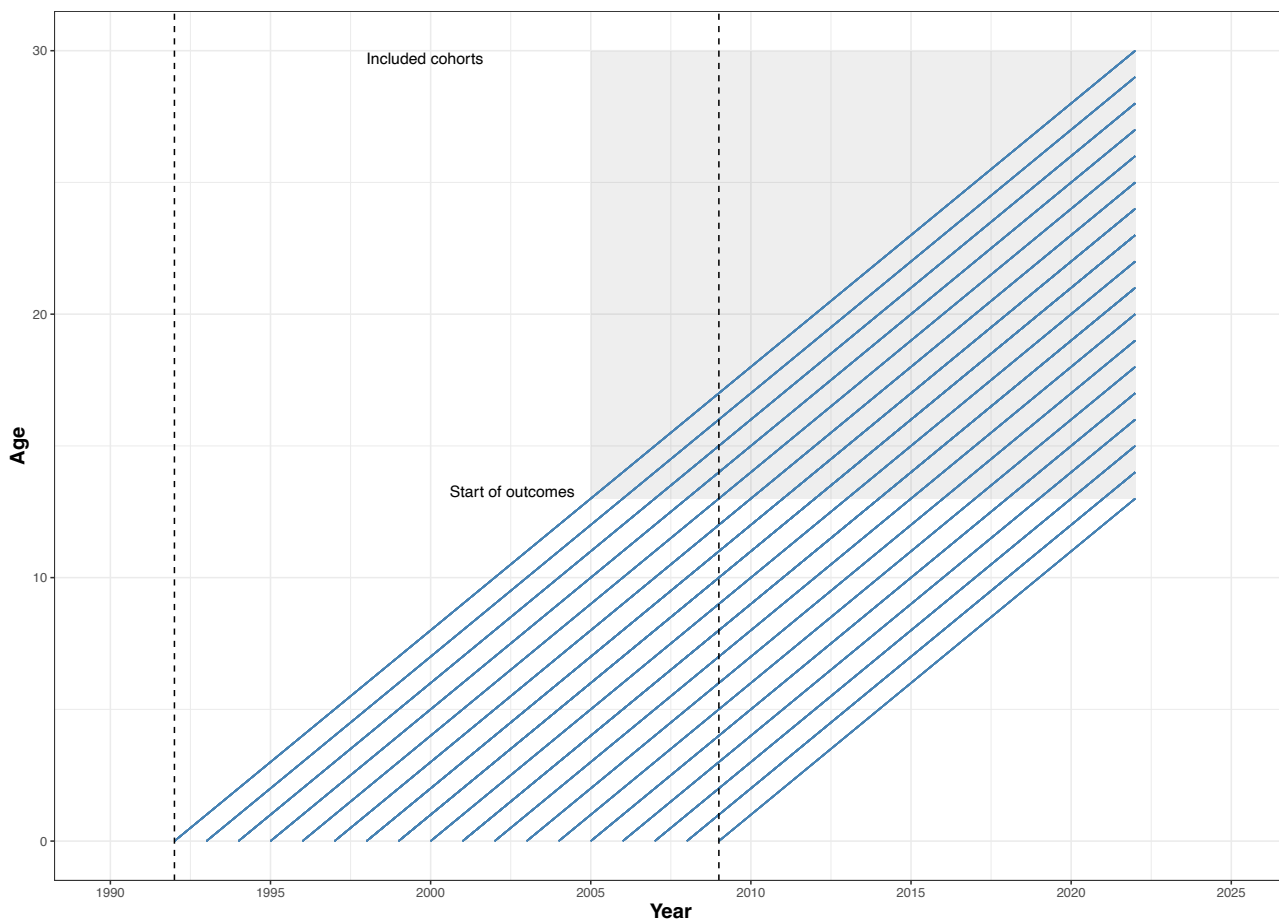
We next related these trajectory groups to socio-economic outcomes in adolescence and young adulthood (ages 13–30). Preliminary models examined associations with education status using two logistic regression models. The first related the trajectories for the latest observation for adolescents ages 15–17 and if they had completed grade 9 or above. The second was similar for the latest observation for adolescents ages 18–21 and if they had matriculated (finished grade 12). Finally, preliminary models examined associations with household asset status using a multinomial logistic regression model. We related the trajectories for the latest observation for adolescent and young adults ages 18–30 and whether they were in a household in the lowest, middle (2nd to 4th), and highest asset quintile in that year.

Before EPC, we plan to extend this work by exploring how durational expectancies in education differ by these trajectory groups, utilizing a microsimulation-based multistate life table approach.^{11,12} Pathways through education in these cohorts are often non-linear—that is, a high probability of individuals may experience periods of non-attendance in formal schooling, but often re-enrol. The multistate life table (MSLT) uses a set of estimated transition probabilities to generate group-specific estimates of average time in schooling for each group. Our analyses will use a discrete-time multinomial logistic regression, stratified by trajectory group, to estimate probabilities in and out of school enrolment, and use these as input to a MSLT. Combining the MSLT with microsimulation provides a rich set of additional information beyond these expectancies; these resulting synthetic cohorts will allow us to estimate

additional parameters such as the expected number of unenrolments, the average duration of periods of unenrolment, and differences in the age-pattern of unenrolments for each trajectory group. These models will provide a nuanced view of how family adversity relates to school attendance throughout childhood, identifying key populations and critical ages to target in potential interventions.

Ethics approval for the Agincourt HDSS was obtained from the Human Research Ethics Committee (Medical) of the University of the Witwatersrand, Johannesburg, South Africa (protocols M960720 and M110138). Informed verbal consent is obtained at each census visit from the head of household or proxy adult respondent, and is standard across all INDEPTH HDSSs, given the impossibility of contacting every person in the HDSS.

Figure 1. Lexis diagram of formation of trajectory groups and subsequent outcome observations.



Preliminary results

We identified four distinct trajectory groups based on combinations of the three sub-trajectory dimensions (Figure 2). Model fit statistics are presented in Table 1.

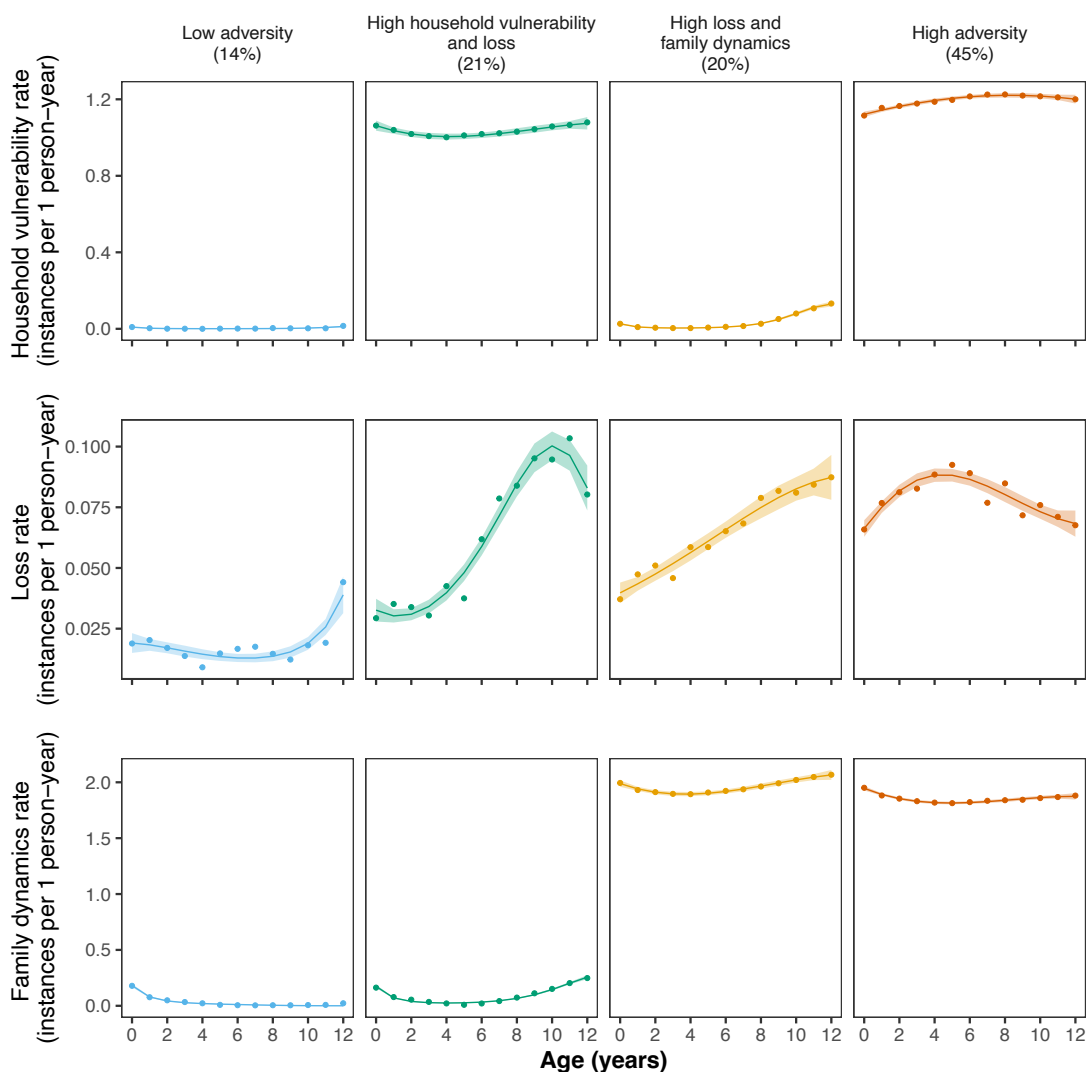
Table 1. Model fit statistics for group-based multi-trajectory models from 2-8 classes.

Bayesian Information Criterion (BIC); Entropy statistic (S).

Number of groups	BIC	S
2	-665031.65	0.72
3	-640002.23	0.729
4	-603676.72	0.89
5	-595786.62	0.557
6	-592399.52	0.515
7	-589991.08	0.533
8	-589350.96	0.349

The low adversity group (14%) was characterised by a low annual rate across all three dimensions (Figure 2). The high household vulnerability and loss group (21%) was characterised by a consistently high rate of household vulnerability and increasing rate of loss after the first 4 years of life. The high loss and family dynamics group (20%) was characterised by a consistently high rate of family dynamics, and increasing rate of loss as children aged. Finally, the high adversity group (45%) was characterised by high annual rates of adversities in all three dimensions.

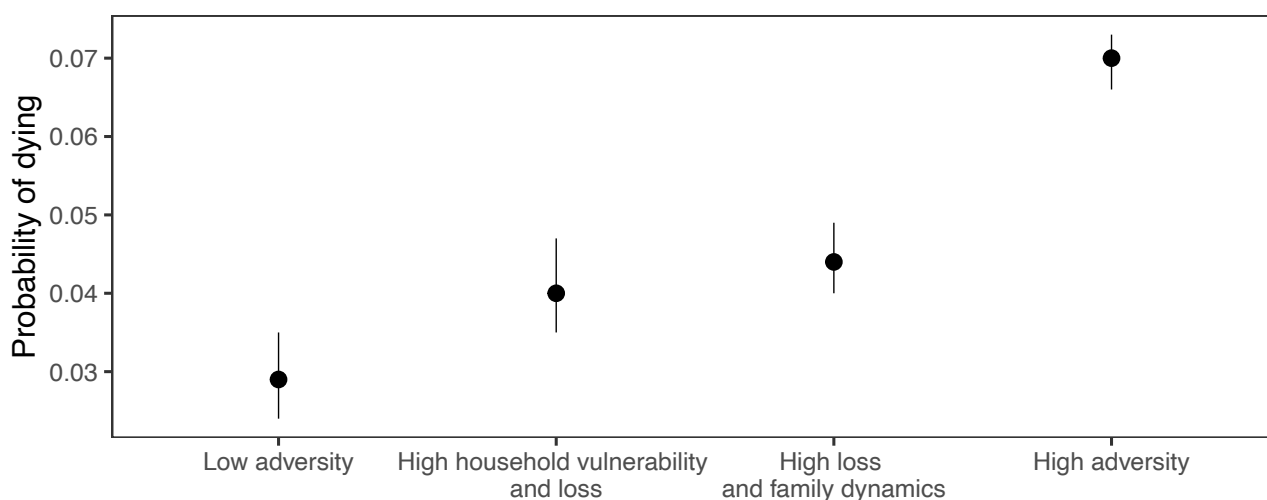
Figure 2. Estimated trajectory groups of family adversities among rural South African children (n=33,124).



The distal outcome model showed elevated probabilities of dying for all groups compared to the children in the low adversity group (Figure 3). Mortality was particularly elevated for

children in the high adversity group (7%; 95% CI 6.6-7.3). Other approaches to accounting for mortality, including omitting children who died and including mortality as an additional dimension, yielded substantively similar results.

Figure 3. Predicted probability of dying by trajectory group among rural South African children.



Given the high differentiation of children by trajectory group (based on model entropy and average posterior probabilities of children assigned to each group), we used the most likely class membership in the subsequent models to examine outcomes in adolescence and young adulthood. In this cohort, the proportion of children born to older mothers was highest in the low adversity and high household vulnerability and loss groups (Table 2). Children in the high household vulnerability and loss group were also more likely to be born to mothers with lower education than the other groups.

Table 2. Characteristics of rural South African children at birth by trajectory group.

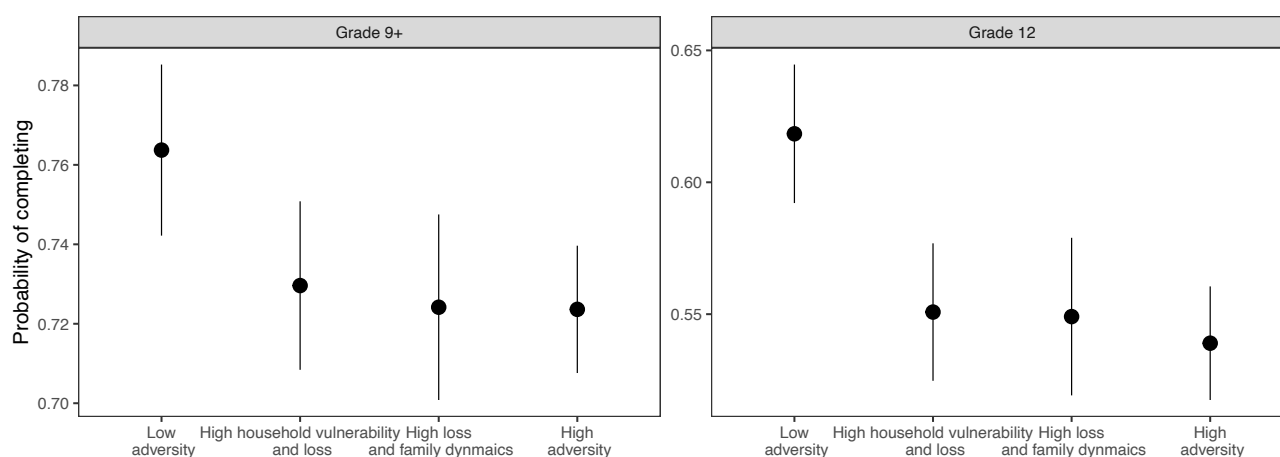
	Low adversity		High household vulnerability and loss		High loss and family dynamics		High adversity	
	N	%	N	%	N	%	N	%
Sex								
Girls	1908	(50.6)	2351	(50.8)	3939	(49.7)	8482	(50.5)
Boys	1861	(49.4)	2278	(49.2)	3987	(50.3)	8318	(49.5)
Birth order								
1	149	(4.0)	169	(3.7)	4536	(57.2)	8046	(47.9)
2	783	(20.8)	806	(17.4)	1741	(22.0)	3803	(22.6)
≥3	2837	(75.3)	3654	(78.9)	1649	(20.8)	4951	(29.5)
Mother's age, years								
<20	62	(1.6)	148	(3.2)	2542	(33.4)	5009	(30.8)

20-29	1486	(39.4)	1923	(41.6)	3797	(49.9)	7725	(47.5)
≥30	2220	(58.9)	2555	(55.2)	1277	(16.8)	3528	(21.7)
Missing	1		3		310		538	
Mother's education								
None/very low (≤3 years)	514	(16.8)	2130	(56.1)	440	(7.9)	2238	(18.8)
Primary (4-8 years)	775	(25.4)	960	(25.3)	1295	(23.2)	3308	(27.8)
Secondary or higher (≥8 years)	1765	(57.8)	704	(18.6)	3844	(68.9)	6369	(53.5)
Missing	715		835		2347		4885	

Preliminary outcome models

Figure 4 shows the probability of completing grade 9 or above by ages 15–17 by trajectory group (n=7,348). Adolescents in the high adversity group were less likely to complete grade 9 or above compared to the low adversity group (aOR 1.24 95% CI [1.07, 1.44]). The next panel shows the probability of matriculating by ages 18–21 by trajectory group (n=5,734). Children in the low adversity group were more likely to matriculate relative to the other groups (e.g., vs. high adversity aOR 1.39 [1.21, 1.61]).

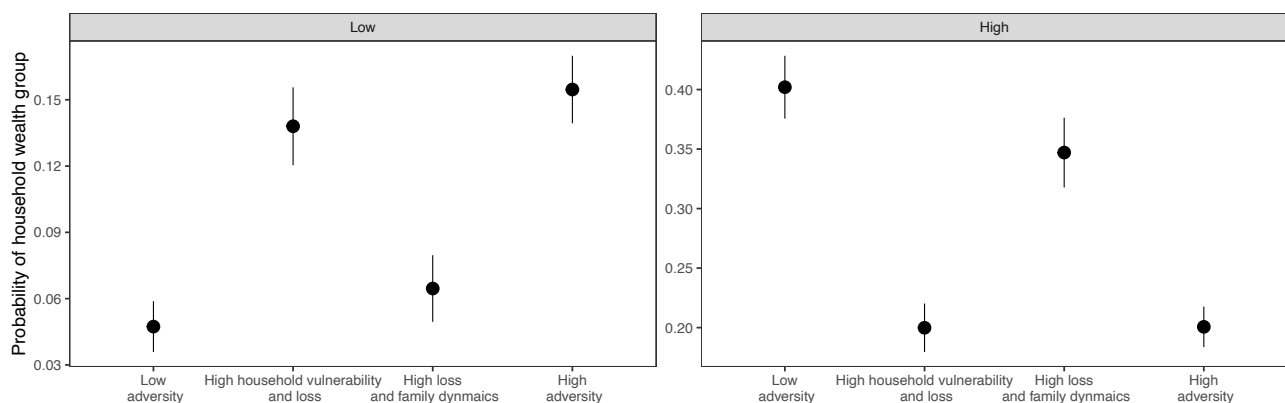
Figure 4. Predicted probability of completing grade 9 or higher (ages 15–17) and grade 12 (ages 18–21) by trajectory group among rural South African adolescents.



Finally, Figure 5 shows the probability of being in either the lowest or highest asset quintile at the last observation at ages 18–30 (n=5,964). Those in the high household vulnerability and loss and high adversity groups were more likely to be in lowest asset quintile and less likely to

be in the highest asset quintile, compared to those in the high loss and family dynamics and high adversity groups. For instance, those in the high adversity group were 57% less likely to be in the highest asset quintile, relative to those in the low adversity group (RRR 0.43 [0.37, 0.50]).

Figure 5. Predicted probability of being in the lowest and highest asset quintile at last census observation by trajectory group among rural South African adolescents and young adults.



Expected findings from the multistate analysis

Our multistate analyses will explore how average duration in education differs across the four adversity groups, identifying how these trajectories may act as barriers to continuing in education. We will also explore how patterns of disenrollment and re-enrolment differ across groups and over age, generating nuanced information on key points in adolescence and young adulthood where individuals may be particularly likely to leave formal schooling.

Summary

In a population-based cohort of more than 30,000 children in rural South Africa, we identified four distinct trajectories of family adversities. Almost half of the children experienced a high rate of adversities in all three dimensions during their childhood and had markedly higher childhood mortality than all other groups. Conversely, less than one-fifth of children experienced a low rate of adversities across all three dimensions. Preliminary outcome models showed children in the low adversity group were also more likely to progress to secondary school and matriculation compared to the other groups. Finally, in young adulthood, children in the high household vulnerability and loss, and high adversity groups were less likely to be in relatively high SES households compared to the other groups. Our expected results from the MSLT analyses will highlight differences in educational expectancies

across trajectory groups, and identify the underlying processes of drop-out and re-enrolment driving these differences.

We acknowledge study limitations. Our measures of family adversities in childhood are based on available measures that have been measured consistently in the AHDSS over time. While this means we have prospective information on an unselected cohort of children over a long time span, our measures of adversities are not as detailed and exhaustive as other studies. Our preliminary adolescence and young adulthood outcome analyses were based on assigned trajectories and did not consider class membership uncertainty for each child. This could lead to underestimated variance estimates in our models. However, given the high level of trajectory group differentiation (Table 1), and that the posterior probabilities of group membership were high, it is unlikely that this would affect the overall conclusions.¹³

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