A Sequence-Analysis Approach to the Study of Partnership and Fertility Transitions in Low- and Middle-Income Countries

Maria Sironi,[*] Luca Maria Pesando,[†] Nicola Barban,[‡] and Frank F. Furstenberg[§]

Abstract

This study investigates whether young people in low- and middle-income countries (LMICs) have experienced the same processes of de-standardisation of the life course that have been observed in industrialized countries. We provide three contributions to the relevant literature. First, we use data from 247 Demographic and Health Surveys (DHS) across 84 LMICs, offering the richest account of transition to adulthood patterns in the developing world existing to date. Second, we move beyond single summary measures of life-course heterogeneity and characterize the life-course complexity by detailed sequences of events, namely first sex, first union, and childbearing. Third, we look not only at the transition to childbearing and birth-sequencing, but also at the sex-composition of births. Preliminary results show that it is important to investigate cross-national differences in partnership and fertility trajectories, and to look at the interrelation among different events. We document important differences by macro-regions and between countries within regions.

Introduction and Background

Adolescence and early adulthood are critical periods of human development that set young people on trajectories that shape their future roles as adults, alongside their capacity to make informed decisions about the timing of key life events (Lloyd 2005). During adolescence, important decisions are made relating to transitions out of school, into work, sexual relations, marriage, and parenthood. Although these transitions are not homogenous across contexts, it is indisputable that they significantly shape the rest of people's lives and – in an intergenerational perspective – the context in which children are born and raised (Bongaarts et al. 2017).

Over the past century, there have been significant changes in the prevalence, timing, density, and complexity of transitions to adulthood in the United States and Europe. These have been extensively documented and studies have provided evidence of increasing "de-standardisation" (or disorder) of family formation trajectories (e.g., Billari and Liefbroer 2010; Elzinga and Liefbroer 2007; Rindfuss et al. 1987; etc.). As far as low- and middle-income countries (LMICs) are concerned, instead, the literature is still in its infancy, yet interest has been growing steadily in light of the significant socio-economic and demographic transformations these countries have been undergoing (Juárez and Gayet 2014; Lloyd 2005). Massive educational expansion, changes in family forms and behaviours, high

[*] Corresponding author. Department of Social Science, University College London, m.sironi@ucl.ac.uk
[†] Population Studies Center, University of Pennsylvania, lucapes@sas.upenn.edu
[‡] ISER, University of Essex, nicola.barban@essex.ac.uk
[§] Department of Sociology and Population Studies Center, University of Pennsylvania, fff@sas.upenn.edu

unemployment rates, different health vulnerabilities, and modified preferences regarding marriage types – all occurring within a framework of poverty – are likely to manifest in a world in which fewer certainties result in new ways of experiencing the transition to adulthood (Beguy et al. 2011).

Similarly to more industrialized societies, throughout the developing world we have been witnessing a transfer of responsibility from family to other societal agencies, and emerging new institutions with the potential to alter the timetable for growing up in nations where significant educational expansion has occurred (Grant and Furstenberg 2007). Yet the extent to which the dynamics and the contexts in which youth make transitions to adulthood in developing countries resemble those of developed economies is still an open question. Behrman and Sengupta (2005) undertook an investigation of this kind, finding that developing countries have converged – with East Asia and the Pacific converging the most and sub-Saharan Africa converging the least – towards the characteristics of the developed countries in a number of respects, such as the higher dependence on markets rather than family enterprises, formal schooling rather than working, more awareness of options and lifestyles from contexts broader than the local community, smaller gender gaps favouring males, and much more mobility in several dimensions. Conversely, more recent scholarly reviews (Juárez and Gayet 2014) point towards a vast diversity of situations in different regions of the world, with tensions arising from globalization leading to imitate Western lifestyles in some respects, and circumstances of social inequality, poverty, and exclusion unique to the developing world influencing the timeframe in which transitions occur in other respects. Although globalization could have contributed to a homogenization of the transitions on a global scale, it seemed to result instead in even greater diversification of life paths – some of which unique to LMICs.

How (dis)ordered and (un)structured the transition to adulthood in LMICs looks like is ultimately an empirical question. Given the variation in institutional contexts across countries, both by region and level of economic development, the question we raise in this article is thus whether young people in LMICs have experienced the same processes of de-standardisation of the life course that have been observed in industrialized countries. As the expansion of universal school attendance to the secondary level is a key force in standardising the ages at which young people begin the transition to adulthood – and in many (mostly) sub-Saharan African countries universal primary enrolment has not been achieved yet (Hewett and Lloyd 2005) – we expect to observe widespread heterogeneity in the experience of early life-course transitions. In its aim and research question, this paper is closest to Grant and Furstenberg (2007), who examined whether increases in female school

participation, the timing of marriage, and socio-economic changes in Africa and Latin America influenced the timing and pattern of the transition to adulthood. Surprisingly, they observed relatively small changes in the age-specific index of heterogeneity they constructed from the first to the most recent survey in each country, raising concerns on the validity of single heterogeneity indices for summarizing large volumes of life-course information.

This study capitalizes on Grant and Furstenberg (2007) and enriches it by describing the life-course trajectories of women aged 15 and above by means of detailed sequences of events. We focus on three life-course transitions, namely first sexual intercourse, first union, and childbearing. We provide three contributions to the relevant literature. First, we use data from 247 Demographic and Health Surveys (DHS) across 84 LMICs, thus providing the richest account of transition to adulthood patterns in the developing world existing to date. Second, we move beyond single summary measures of heterogeneity that capture the complexity, fluidity, and variability of status combinations at stages in the life course – as done, for instance, in Billari (2001) and Grant and Furstenberg (2007) – and characterize instead the life-course complexity by detailed sequences of events. To the best of our knowledge, this is the first study to describe sequences of multiple events using comparative data across LMICs. In the context of LMICs, sequence analysis has been employed for single-country cases to study family planning trajectories in Malawi (Furnas 2016), relationship quality and well-being in Malawi (Frye and Trinitapoli 2015), and the use of time among the elderly in South Africa (Grapsa and Posel 2016). Third, we innovate over the relevant literature by looking not only at the transition to childbearing and birth-sequencing, but also at the sex-composition of births. In LMICs, where most births occur within resource-deprived contexts with social norms and cultural traditions playing a key role, taking into account the sex-composition of births can shed important light on patterns of son preference and sex-selective abortion.

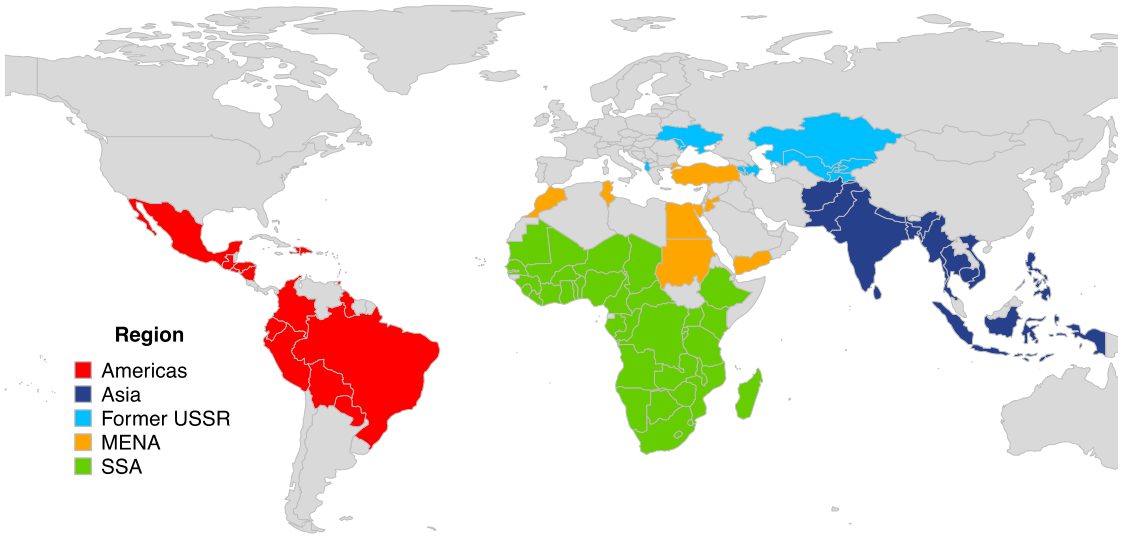
Data and Methods

Data

To illustrate how partnership and fertility transitions changed over time and how they differ across countries we use data from several low- and middle-income countries drawing upon all available Demographic and Health Survey (DHS) waves. Each survey is representative of the national population of women aged 15-49, and includes information on some key variables of interest, e.g., age at first sexual intercourse, age at first marriage, and complete fertility histories. We have information

on 84 countries (247 DHS surveys) between 1985 and 2016. The number of survey waves and the availability of data for a specific year vary by country. An illustration of the countries included in the analysis can be found in Figure 1.[**]

Figure 1: Map of countries included in the analysis, grouped by macro-region: Americas, Asia, Former Union of Soviet Socialist Republics (USSR), Middle-East and North Africa (MENA), and sub-Saharan Africa (SSA)



Methods

In this work we look at a combination of life-course events that are closely interrelated, namely first sexual intercourse, first union (marriage), and childbearing. For the fertility history we also look at the gender composition of births and distinguish between sons and daughters.

Rather than analysing the median age at different life-course events (e.g. age at marriage and children progression), we use sequence analysis to describe the occurrence, timing, and sequencing (i.e., the ordering) of different family events. In sequence analysis, each life-course trajectory is

[**] Afghanistan, Albania, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Bolivia,, Botswana, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Colombia, Comoros, Congo, Cote d'Ivoire, Democratic Republic of the Congo, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Gabon, Gambia, Ghana, Guatemala, Guinea, Guyana, Haiti, Honduras, India, Indonesia, Jordan, Kazakhstan, Kenya, Kyrgyzstan, Lesotho, Liberia, Madagascar, Malawi, Maldives, Mali, Mauritania, Mexico, Morocco, Mozambique, Myanmar, Namibia, Nepal, Nicaragua, Niger, Nigeria, Pakistan, Paraguay, Peru, Philippines, Republic of Moldova, Republic of Vietnam, Rwanda, Sao Tome and Principe, Senegal, Sierra Leone, South Africa, Sri Lanka, Sudan, Swaziland, Tajikistan, Tanzania, Thailand, Timor-Leste, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, Uzbekistan, Yemen, Zambia, Zimbabwe

represented by a string of characters, which resembles the one used to code DNA molecules in biological sciences. Hence, every trajectory is made up of a number of values that correspond to the number of years (or months) each individual is observed for. Trajectories can be analysed by representing the data as a categorical time series. Each individual *i* can be associated to a variable s_{it} indicating the individual's life-course status at time *t*. In other terms, trajectories can be represented as strings or sequences of characters, with each character denoting one particular state that describes a specific family role.

Sequence analysis is associated to a family of algorithms used to quantify dissimilarities between life-course trajectories. Optimal Matching algorithm (OM) is the most known technique that has been applied to social science. The development of OM started in the seventies and the technique has been described in details by Kruskal (1983). Basically, OM expresses distances between sequences in terms of the minimal amount of effort, measured in terms of edit operations (insertion; deletion and substitution), that is required to change two sequences such that they become identical. Abbott (1995) adapted OM to social sciences assigning to three elementary operations different costs, based on the 'social' differences between states (Lesnard 2006). The choice of the operations' costs determines the matching procedure and influences the results obtained. Sequence analysis algorithms identify differences in trajectories due to changes in *timing* (when events happen), *quantum* (what and how many transitions), and *ordering* (in what order) of life-course events (Billari and Piccarreta 2005; Billari et al. 2006).

After we build partnership and fertility trajectories for all the individuals in our sample, we use cluster analysis to identify patterns in the data and highlight typical life-course pathways (Abbot and Tsay 2000; Aisenbrey and Fasang 2010; Barban and Billari 2012; Barban 2013). Once we classify individuals into typologies, we are able to explore cluster distributions by regions, countries, and birth cohorts in order to ascertain differences and changes in typical transitions over time.

Preliminary Findings

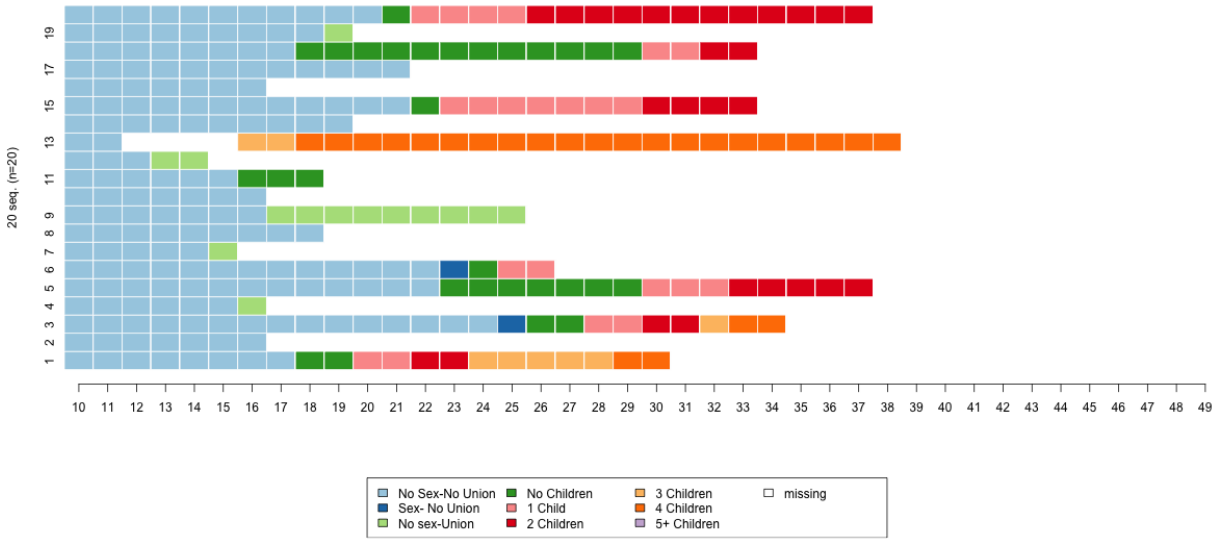
As a preliminary analysis, we extracted a random subsample of approximately 20,000 individuals for each macro-region (Table 1). For this subsample we construct partnership and fertility trajectories using a state-space composed by 9 different states: 'no sexual intercourse – not in a union', 'sexual intercourse – not in a union', 'no sexual intercourse – in a union', 'sexual intercourse – in a union, no children', 'sexual intercourse – in a union, 1 child', 'sexual intercourse – in a union, 2 children', 'sexual intercourse – in a union, 3 children', 'sexual intercourse – in a union, 4 children', 'sexual intercourse –

in a union, 5+ children'. Figure 1 shows an example of trajectories for 20 random individuals, irrespective of region. All of them start at age 10 – technically 15 in the DHS – by not being in a union and not having had sexual intercourse. By age 20 some of them are still in the same state, some others had their first sexual intercourse and are in a union, and a few had children. By age 30 most of them had at least on child.

Table 1. Data used in preliminary description (subsamples of 20,000 from each region)

Region	Frequency	%	Cumulative %
Americas	19,454	19.83	19.83
Asia	19,565	19.94	39.77
Former USSR	20,000	20.38	60.15
MENA	20,000	20.38	80.54
SSA	19,096	19.46	100.00
Total	98,115	100.00	

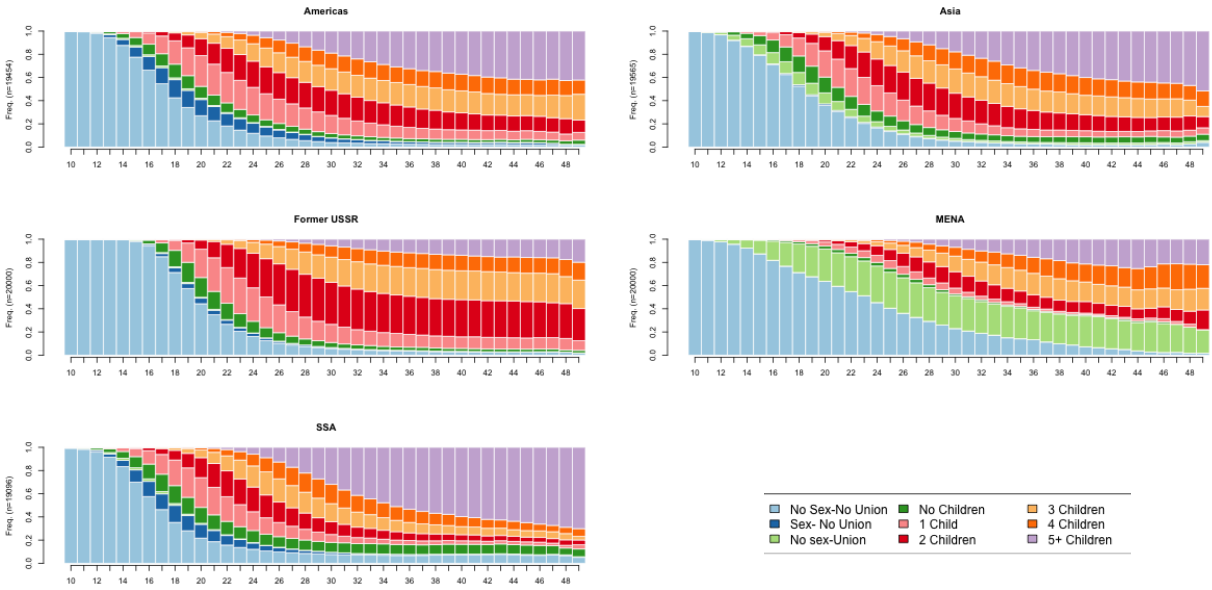
Figure 1. 20 Examples of partnership and fertility trajectories



When we look at the partnership and fertility transitions by region (Figure 2) we start to notice visible cross-regional differences. In Central and South America there is a quite early transition from 'no sex – no union' to 'sex – no union' and to 'sex – in a union'. By age 21, 50% of the sample in the Americas had their first child. The picture looks quite similar in Sub-Saharan Africa, with the difference that transitions here happen earlier and that fertility rates are higher. In fact, by age 35 at least 50% of the women in SSA have 5 or more children. In countries of the former USSR, MENA, and Asia we can see how having the first sexual intercourse before entering the first union is much less frequent (former

USSR) or not happening at all (Asia and MENA). In Asian countries there is a quick transition from 'no sex – no union' to 'no sex – in a union', followed by the first sexual intercourse and childbearing. In the MENA region the transition into the first union happens later than everywhere else. As a matter of fact, the median age at first union is 25. This is followed by a period of being in a union but without having the first sexual intercourse, and finally by the transition into parenthood. Generally, the number of children is lower in this region than in other regions of the sample.

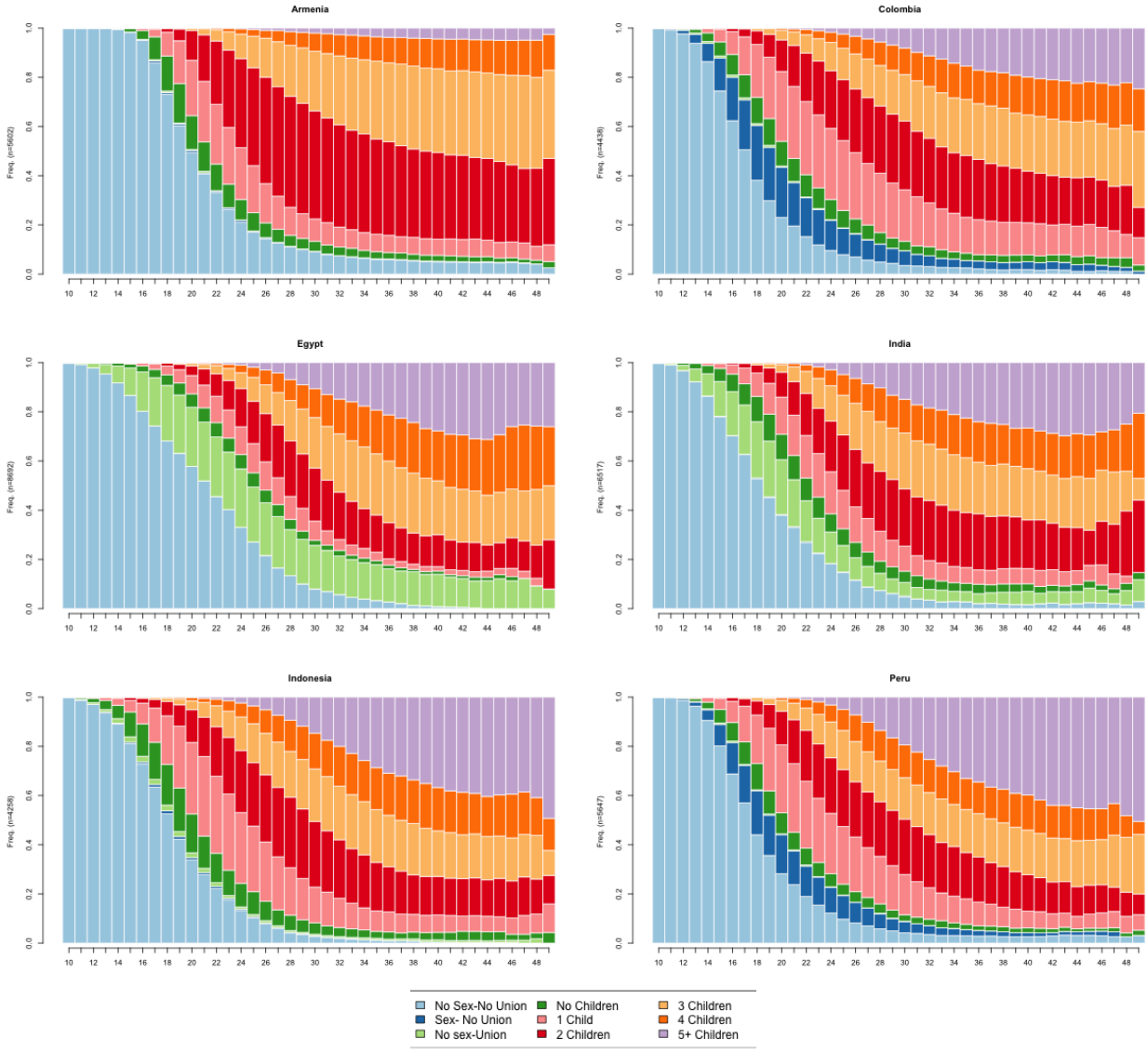
Figure 2. Partnership and fertility trajectories by macro-region



Finally, we provide some examples of trajectories by country (Figure 3). These examples allow us to observe that there is some heterogeneity not only across macro-regions, but also across countries within the same region. If we consider India and Indonesia, we can see how in Indonesia there is an early transition from 'no sex – no union' to 'sex – in a union, no children', while in India women move from 'no sex – no union' to 'no sex – in a union', to then slowly transition into parenthood.

These preliminary findings suggest that it is important to investigate cross-national differences in partnership and fertility trajectories, and to look at the interrelation among different events, such as the age at first sex, age at first union, and fertility history. **The next step of the analysis will be to build partnership and fertility trajectories for all the individuals in our sample, incorporating also the sex-composition of births. We will then use cluster analysis to identify patterns in the data and highlight typical life-course pathways. Once we classify individuals into typologies, we will be able to explore cluster distributions by regions, countries, and birth cohorts in order to ascertain differences and changes in typical transitions over time.**

Figure 3. Examples of trajectories by country



References

Abbot A, Tsay A. (2000). Sequence Analysis and Optimal Matching Methods in Sociology: Review and Prospect. *Sociological Methods & Research* 29:3–33.

Abbott A. (1995). Sequence Analysis: New Methods for Old Ideas. *Annual Review of Sociology* 21:93–113.

Aisenbrey S, Fasang AF. (2010). New Life for Old Ideas: The "Second Wave" of Sequence Analysis Bringing the 'Course' Back Into the Life Course. *Sociological Methods & Research* 38:420–462.

Barban N. (2013). Family Trajectories and Health: A Life Course Perspective. *European Journal of Population* 29:357–385.

Barban N, Billari F.C. (2012). Classifying Life Course Trajectories: A Comparison of Latent Class and Sequence Analysis. *Journal of the Royal Statistical Society Series C: Applied Statistics* 61:765–784.

Beguy D, Kabiru CW, Zulu EM, Ezeh AC. (2011). Timing and Sequencing of Events Marking the Transition to Adulthood in two Informal Settlements in Nairobi, Kenya. *J. Urban Health: Bull. N.Y. Acad. Med*. 88(Suppl. 2):S318–40.

Behrman, J. R., Sengupta, P. (2005). Changing Contexts in Which Youth are Transitioning to Adulthood in Developing Countries: Converging Toward Developed Economies? In: *The Changing Transitions to Adulthood in Developing Countries: Selected Studies* (pp. 13–55). Washington, D.C.: National Academies Press.

Billari, F. C. (2001). The Analysis of Early Life Courses: Complex Descriptions of the Transition to Adulthood. *Journal of Population Research*, 18, 119–142.

Billari F. C., Fürnkranz J, Prskawetz A. (2006). Timing, Sequencing, and Quantum of Life Course Events: A Machine Learning Approach. *European Journal of Population* 22:37–65.

Billari F. C., Piccarreta R. (2005). Analyzing Demographic Life Courses through Sequence Analysis. *Mathematical Population Studies* 12:81–106.

Billari F. C., Liefbroer A. C. (2010). Towards and New Pattern of Transition to Adulthood. *Advances in Life Course Research* 15: 59-75.

Bongaarts, J., Mensch, B. S., Blanc, A. K. (2017). Trends in the Age at Reproductive Transitions in the Developing World: The Role of Education. *Population Studies* 71(2): 139-154.

Elzinga C. H., Liefbroer A. C. (2007). De-Standardization of Family-Life Trajectories of Young Adults: A Cross-National Comparison Using Sequence Analysis. *European Journal of Population* 23: 225-250.

Frye M., Trinitapoli, J. (2015). Ideals as Anchors for Relationship Experiences. *American Sociological Review* 80(3): 496-525.

Furnas, H. E. (2016). Capturing Complexities of Relationship-Level Family Planning Trajectories in Malawi. *Studies in Family Planning* 47(3): 205-221.

Grant M., Furstenberg F F (2007). Changes in the Transition to Adulthood in Less Developed Countries. *European Journal of Population* 23: 415-428.

Grapsa E., Posel D. (2016). Sequencing the Real Time of the Elderly: Evidence from South Africa. *Demographic Research* 25 (35): 711-744.

Hewett, P. C., Lloyd, C. B. (2005). Progress Toward Education for All: Trends and Current Challenges for sub-Saharan Africa. In: *The Changing Transitions to Adulthood in Developing Countries: Selected Studies* (pp. 84–115). Washington, D.C.: National Academies Press.

Juarez F., Gayet C. (2014). Transitions to Adulthood in Developing Countries. *Annual Review of Sociology* 40: 521-538.

Kruskal J. B. (1983). An Overview of Sequence Comparison: Time Warps, String Edits, and Macromolecules.

SIAM Review 25:201–237.

Lesnard L (2006) Optimal Matching and Social Sciences. Centre de Recherche en Économie et Statistique Working Paper Series 2006:

Lloyd, C. B. (2005). *Growing Up Global: The Changing Transitions to Adulthood in Developing Countries*. Panel on Transitions to Adulthood in Developing Countries. Washington, DC: National Academies Press.

Rindfuss, R. R. (1987). Disorder in the Life Course: How Common and Does it Matter? *American Sociological Review* 52(6): 785-801.