



DEMOGRAPHIC RESEARCH

A peer-reviewed, open-access journal of population sciences

DEMOGRAPHIC RESEARCH

VOLUME 55, ARTICLE 24, PAGES 767–810

PUBLISHED 21 OCTOBER 2026

<https://www.demographic-research.org/Volumes/Vol55/24/>

DOI: 10.4054/DemRes.2026.55.24

Research Article

Projection of family life courses of the descendants of immigrants in England and Wales using microsimulation

Andrew Ibbetson

Hill Kulu

Sanny D. Afable

Júlia Mikolai

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Projection of family life courses of the descendants of immigrants in England and Wales using microsimulation

Andrew Ibbetson¹

Hill Kulu²

Sanny D. Afable³

Júlia Mikolai³

Abstract

BACKGROUND

This study projects family life courses of the descendants of immigrants in England and Wales using microsimulation. While previous projections have estimated the size of ethnic groups, this is the first study to examine how the family and age structures of the descendants of immigrants evolve across generations and over time.

OBJECTIVE

Our aim is to explore how the future age, partnership, and parity distributions of immigrant descendant populations develop in the United Kingdom.

METHODS

We develop a microsimulation model of fertility and partnership transitions from ages 20–49, using partnership formation, dissolution, and fertility rates from previous research. We construct a base population using data from the 2011 Census.

RESULTS

The results show, first, significant heterogeneity in partnership and fertility patterns among migrant populations. Second, this heterogeneity is reduced among the descendants of immigrants, especially for fertility levels. Third, the distribution of the descendants of immigrants by partnership and parity gradually becomes similar to that of the native population.

¹ Institute for Environmental Design and Engineering, University College London, London, UK.

² Corresponding author. School of Geography and Sustainable Development, University of St. Andrews, St. Andrews, UK. Email: Hill.Kulu@st-andrews.ac.uk.

³ School of Geography and Sustainable Development, University of St. Andrews, St. Andrews, UK.

CONCLUSIONS

This study shows an increasing similarity in the family behaviour of majority and minority populations, and also that it may take a generation or two before the differences vanish. This study also demonstrates that microsimulation is a useful tool for projecting the life histories and family structures of the descendants of immigrants.

CONTRIBUTION

This is the first study to project partnership and parity structure for the descendants of immigrants, improving our understanding of how migrant populations change across generations.

1. Introduction

In recent decades there has been a significant rise in the share of immigrants and their descendants in European countries (Castles and Miller 1998; Eurostat 2023; Raymer, de Beer, and van der Erf 2011). Hence, the demographic behaviours of immigrants and their descendants will increasingly shape Europe's future population structure. In the United Kingdom, immigrants and their descendants made up over one-fifth of the population in 2011 (ONS 2015), rising to around a quarter in 2021 (ONS 2021). Projections of the UK population by ethnic group suggest that it will become increasingly diverse over the coming decades (Coleman 2010; Norman, Rees, and Wohland 2014). This, coupled with research that shows heterogeneity in partnership and fertility patterns among immigrants and their descendants in the United Kingdom (Harrison et al. 2023; Mikolai and Kulu 2022), suggests that the ethnic composition of the UK population will be an important driver of its future partnership and parity structure.

Migrant populations change over time. Since the late 1940s the United Kingdom has received migrants from diverse origins, many of whom have remained and formed families (Hatton and Price 2005). Their descendants – the second generation – have had children who now form the third generation. These descendant generations represent an important and growing segment of the United Kingdom's population. Their demographic behaviour is shaped by cultural identities and socioeconomic integration within an increasingly multicultural society. Previous research on migrant families in Europe shows that partnership and childbearing patterns among the descendants of immigrants are often more similar to those of the native population than to those of their parents' generation, although the pace of change varies across migrant groups (Berrington 2018; Harrison et al. 2023; Kulu et al. 2024). Briefly, the heterogeneity in family patterns that exists among immigrant populations is reduced among their children and it is likely to disappear among their grandchildren. With the gradual assimilation of migrant

populations across generations, heterogeneity is expected to decline and differences to the native populations are expected to vanish (Alba and Nee 1997).

The aim of this study is twofold. First, using a synthetic cohort approach, we examine the family life courses of natives (UK-born individuals with two UK-born parents), and immigrants and their descendants from different origin groups. This exercise allows us to assess differences in fertility and partnership behaviours across migrant backgrounds and generations. Second, we analyse how the family structures of immigrants' descendants will change over future decades, given their current age and family distribution. To achieve these aims, we develop a microsimulation model of the family life-courses of natives and the descendants of immigrants aged 20–49 in England and Wales.

Previous studies have projected the size of ethnic minority populations, without any information on their composition. The novelty of our study is the projection of partnership and parity distribution by age and descendant-origin group. To project future population structure to 2031 we apply our model to a 2011 base population. Another novelty is that we estimate the share of the second and third generation in 2011 and show how their share is expected to change by 2031. We then produce projections for the descendants' partnership and childbearing behaviours based on two scenarios: first we assume that the 3G behaves similarly to the 2G, and then we assume that they behave similarly to the native population. Such an exercise will significantly improve our understanding of how migrant populations change across generations and whether and when their behaviours become similar to those of the native population. The focus of this paper is to project partnership and fertility histories of the descendants of immigrants (second and third generation). However, in order to better understand changes across migrant generations, we also present findings for immigrants.

2. Background

2.1 Projection of ethnic groups in the United Kingdom

Population projections in Europe (Lanzieri 2011), the United States (Frey 2018), and the United Kingdom (Coleman 2010; Rees, Wohland, and Norman 2013) suggest that there will be an increase in population diversity over the coming decades, largely driven by migration streams. In the United Kingdom the magnitude of the estimated increase in population diversity is uncertain, with significant variation between projection models (Rees et al. 2012). Possible explanations for these differences include varying assumptions of future migration streams, methodological variety, and the use of different data sources. For example, due to data or computational constraints, many studies group

ethnicity into broad classes, such as White instead of White British, White Irish, and White Other, despite the large heterogeneity within these groups (Coleman 2010; Lomax et al. 2019). A notable exception is the work of Rees, Wohland, and Norman (2013), which uses all 16 ethnic groups in the 2001 Census for England and Wales.

Lomax et al. (2019) show the importance of international migration for the future diversity of the UK population. They report that increases in the Mixed, Pakistani, and Bangladeshi ethnic groups are more likely to persist under reduced international migration compared to other ethnic groups, because of their age structure and higher fertility rates. They also show that under all migration scenarios, the UK population is likely to become increasingly diverse. Rees, Wohland, and Norman (2013) conduct projections for UK local areas; the study shows that across all local authorities and ethnic groups, immigration will have a positive impact on population size. By contrast, below-replacement fertility will reduce populations, whereas the assumption of declining mortality will slightly increase them. The relatively young age structure will also contribute to population growth.

Our study is novel in two aspects. First, to the best of our knowledge this is the first study to separate ethnic groups into immigrants and their descendants, despite the considerable heterogeneity in partnership and fertility patterns that exists between migrant generations (Mikolai and Kulu 2022). Second, we project the partnership status and parity distribution of immigrants' descendants by age and origin group. The focus of previous projections has largely been to estimate the population numbers of ethnic groups rather than their family structures. Many studies have highlighted the relevance of household and family projections to public policy by linking household and family structure with issues such as old age care, sustainability, welfare spending, housing development, and water consumption (Börsch-Supan 1986; Keilman 2003; Liu et al. 2003; Lo Conte et al. 2023; Reader, Portes, and Patrick 2022; Rees, Clark, and Nawaz 2020; Van Imhoff and Keilman 1992). While we do not explicitly model households in this paper, we take a first step towards doing so by being the first study to project partnership and parity structures by migrant background.

2.2 Theories explaining the partnership and fertility patterns among immigrants and their descendants

Several theories have been put forward to explain the partnership and fertility behaviours of immigrants and their descendants (Kulu et al. 2019). For immigrants, the focus is usually on the debate between socialisation versus adaptation. The socialisation theory argues that family preferences such as the timing of partnership formation and expected family size are developed early in life and shaped by the social environment during youth

and young adulthood. This suggests that family patterns among immigrants after migration normally resemble those of the countries of origin rather than the host country (Kulu et al. 2019). By contrast, the adaptation theory states that with time, immigrants' family behaviour such as partnership formation and family size will converge to the behaviour of the native population. Immigrants, particularly those who arrived at young ages, exhibit family behaviours more similar to those of the natives than recently arrived immigrants or individuals living in the origin countries (Kulu et al. 2019).

For the descendants of immigrants, the focus is on the extent to which mainstream society and minority subculture shape their family patterns (Kulu et al. 2019). The second generation may grow up under the influences of mainstream society and are thus socialised into the norms and behaviours of the native population. Therefore, we expect to observe similar family patterns for the descendants of immigrants and the native population. However, they may also grow up under the influence of a minority subculture and therefore exhibit family behaviour that is similar to those of immigrants and which differs from the family patterns of the native population (Kulu et al. 2019). It is likely that both mainstream society and minority subculture are important, with different influences in school among peers and coming from the family. In such cases the descendants of immigrants will exhibit family patterns that are in between those of immigrants and the native population (Kulu and González-Ferrer 2014).

2.3 Heterogeneity in partnership and fertility patterns among immigrants and their descendants in the United Kingdom

Most research on immigrant partnerships and childbearing in the United Kingdom in the past decade has aimed to test one of the theories on migrant family formation and fertility. Hannemann and Kulu (2015) study partnership formation among immigrants and their descendants in the United Kingdom, finding that migrants from Western European countries exhibit partnership behaviours similar to those of the native UK population. By contrast, cohabitation remains rare among immigrants from India, Pakistan, and Bangladesh and their descendants. Many of the immigrants from these groups marry directly, although the share of individuals who cohabit or separate is larger among UK-born South Asians than among immigrants. Caribbean immigrants and their descendants exhibited unique behaviours: they have high cohabitation rates, low marriage rates, and high divorce risks, which the authors attribute to the specific patterns of family dynamics that dominate in the Caribbean countries. Berrington (2020) studies expectations of family formation among the descendants of immigrants in the United Kingdom and shows that UK-born individuals of Bangladeshi or Pakistani origin still have low expectations of forming a cohabiting union and high expectations of marrying.

There is also a growing literature on migrant fertility. Coleman and Dubuc (2010) study the fertility of ethnic minority women in the United Kingdom and show that their total fertility declined significantly in the last decades of the 20th century. Additionally, the fertility levels of the descendants of immigrants were lower than those of immigrants. Interestingly, while fertility was low among women of Indian and Black Caribbean origin, it was relatively high among women of Pakistani and Bangladeshi descent. Similarly, Norman, Rees, and Wohland (2014) find total fertility among Caribbean and Indian ethnic groups to be relatively similar to that of the White group, whereas fertility is significantly higher among Pakistani and Bangladeshi groups.

A study by Kulu and Hannemann (2016) supports that fertility is lower among the descendants of immigrants than immigrants, but confirms that fertility among women of Pakistani and Bangladeshi origin is still relatively high. Analysis of fertility by parity shows little variation in first- and second-birth rates between groups, whereas third- and fourth-birth rates are elevated among UK-born Pakistani and Bangladeshi women. The high fertility among women of Pakistani and Bangladeshi origin is attributed to cultural factors, such as stronger religiosity and larger size of family of origin. Wilson and Kuha (2017) also report high fertility among descendants of Pakistani and Bangladeshi immigrants and attribute it to factors related to childhood socialisation in residentially segregated ethnic communities. Berrington (2018) shows that among the cohorts born in the 1960s and 1970s, a large majority of UK-born Pakistani and Bangladeshi women have become mothers by age 30. By contrast, there has been a significant delay and less ethnic diversity in the timing of entry into motherhood among more recent cohorts. This trend is explained by the educational aspirations and the postponement of childbearing among all groups, including women of Pakistani and Bangladeshi descent.

Finally, Kulu et al. (2025) simultaneously study partnership and fertility changes among immigrants and their descendants in three European countries, including the United Kingdom. Their analysis supports that migrants from other European countries and their descendants tend to cohabit prior to marriage, and their fertility (in unions) is often similar to that of the native population in the host countries. By contrast, South Asians and Turkish populations exhibit marriage-centred family behaviour with somewhat elevated third-birth rates. Individuals of sub-Saharan African or Caribbean origin display higher rates of non-marital family transitions. The study also reveals some changes in partnership and childbearing patterns across migrant generations. Interestingly, these changes are stronger for fertility than for partnership patterns, which the authors attribute to different explanatory factors: cultural-normative factors are important in shaping partnership behaviour, whereas structural-economic factors may play a more important role in fertility decisions. This interpretation suggests that some patterns may persist across future migrant generations (e.g., preference for marriage vs. cohabitation), whereas others are likely to vanish (e.g., large families).

Overall, previous studies show, first, a significant heterogeneity in partnership and fertility patterns among immigrants, and second, that this heterogeneity is reduced among the descendants of immigrants. Fertility among most migrant descendant groups is similar to that of the native population, whereas there is more heterogeneity in partnership behaviour, with some groups exhibiting specific patterns.

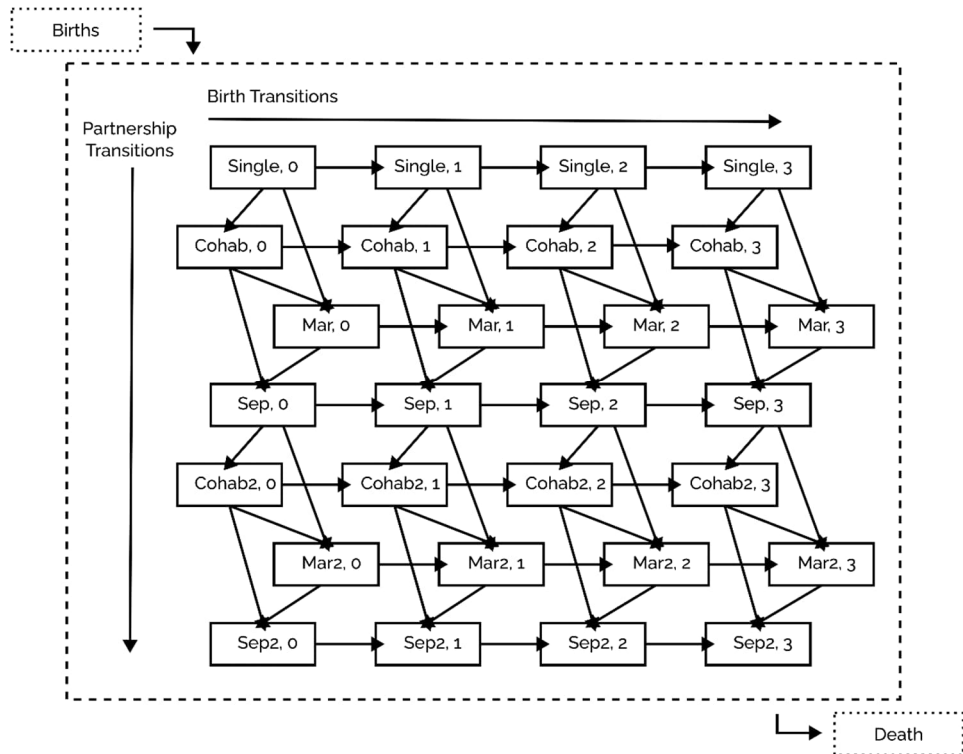
3. Methods

3.1 Microsimulation

Microsimulation is an increasingly popular tool for performing population projections. Several studies have applied microsimulation to investigate family dynamics (Bélanger, Morency, and Spielauer 2010; Thomson et al. 2012; Wilson and Rees 2005; Winkler-Dworak et al. 2021). Microsimulation involves simulating events at the individual level using Monte Carlo methods. The simulated life histories of individuals are then typically aggregated to produce population estimates. Microsimulation has several advantages over macrosimulation approaches, including the ability to extract the full event histories of individuals (Wilson and Rees 2005), as is the case when modelling repeated partnership and fertility outcomes. However, the computational complexity of microsimulation is much greater, often requiring the use of high-performance computing to reduce model run times, particularly when assessing model uncertainty.

Microsimulation requires several inputs, including the state space, transition rates, simulation horizon, and base population. The state space of our microsimulation model consists of four parity states: (1) no children, (2) one child, (3) two children, and (4) three or more children, combined with four partnership states: (1) single, (2) cohabiting, (3) married, and (4) separated, and one absorbing state: death. In total, we have 17 states that individuals may occupy at any one time. Furthermore, we allow repeated partnership transitions; for example, it is possible to marry, separate, and remarry, which extends the state space to higher order partnerships (Figure 1).

Figure 1: Partnership and fertility states and transitions



Note: Cohab = Cohabitation, Mar = Marriage, Sep = Separation.
Source: Adapted from Mikolai and Kulu 2022.

We define movement between states using a transition matrix. From singlehood, individuals may experience cohabitation, marriage, or birth; from cohabitation, individuals may experience marriage, separation, or birth; from marriage, individuals may experience separation or birth; and from separation, individuals may experience cohabitation, marriage, or birth.⁴ It is possible to experience death from any state. Individuals are censored at age 50, as our focus is on family transitions which are largely complete by this age (although changes in partnerships also occur later in life).

⁴ For the purposes of our projections to 2031, which require consistency with census data, persons who have never married and transition from cohabitation to single are considered single. For our projections of family life histories using a synthetic cohort approach, which do not require consistency with census data, they are considered separated.

We generate two sets of microsimulation models. First, we project the family life histories of the natives, immigrants, and each descendant group by applying model transition rates to a synthetic birth cohort. We describe the calculation of these transition rates in Section 3.2. Second, we project the partnership and parity distribution of immigrants' descendants (2G+) in 2031 by applying our transition rates to the 2G+ population of England and Wales in 2011. As section 3.4 explains, we further create a scenario where the third generation follows the native population's transition rates. Because the third generation is not identifiable from the 2011 Census, we project to 2031 the family life courses of simulated individuals born to the second generation from 1991 to 2011, using the 1991 population of England and Wales. The construction of the 2011 and 1991 base populations is described in sections 3.3 and 3.4 respectively.

For each microsimulation exercise, we run the model for each descendant origin and generation (2G or 3G) separately, using a sample size of 10,000 persons for each simulation. Because some groups are smaller than others, we choose to run models for each descendant origin and generation separately for computational efficiency. If we were to simulate all groups in a single simulation we would need to use very large sample sizes to be able to extract meaningful results for each group. In the projection of 2031 populations these separate simulations are combined in post-processing, using scaling factors derived from 2011 population numbers for each of these groups.

We programme our microsimulation model in R (R Core Team 2023) and use the *fastMicSim* package, a user-written, faster version of the *MicSim* package by Zinn (2013). The *fastMicSim* package is available online: <https://github.com/bieneSchwarze/fastMicSim>. See Appendix for more details.

3.2 Estimation of transition rates

In defining our transition rate functions, we use mortality rates at single-year ages, while our partnership and fertility rates are held constant within each 5-year interval. The microsimulation operates in continuous time, in which individual life course events are scheduled stochastically from the competing hazards at each moment, rather than at fixed discrete time steps.

We use partnership and fertility rates by age, sex, birth cohort, migrant origin, and migrant generation published (male transition rates unpublished) by Mikolai and Kulu (2022), who have performed a multilevel multistate event history analyses of Waves 1–9 (2009–2019) of the UK Household Longitudinal Study (UKHLS) (University of Essex 2020), a large, nationally representative household panel. They include individuals born 1940–2003 in their analysis and we use an adjusted version of their rates that only includes individuals born in 1970–2003 (supplementary Table A-1).

We use ONS life tables to model age- and sex-specific mortality transitions (ONS 2024). Because we focus on the projection of the family life courses of the descendants of immigrants in 2031, only those individuals who were living in the United Kingdom and aged 0–29 in 2011 are relevant, as they will be of family formation ages (i.e., aged 20–49) in 2031. We allow neither emigration nor return migration for the descendants of immigrants, which are reasonable assumptions given that observed emigration rates among the descendants are low and so are their numbers living abroad.

3.3 Estimation of the 2011 base population

To project descendant populations to 2031, we construct a base population by estimating the joint probability distribution of our state space by age, sex, and migrant origin and generation from the Census 2011 Household Microdata sample for England and Wales (ONS 2011). The microdata contains around 1.9 million persons aged under 50. Immigrants and descendants' origin group is assigned using the ethnic group variable in the 2011 census, while the country of birth variable is used to assign their generation. For example, a person of African (ethnic) origin born in the United Kingdom is assigned a migrant origin of Africa and a generation of 2G. In other words, they are the descendants of African immigrants, whereas a person of African (ethnic) origin not born in the United Kingdom is considered an African immigrant.

In this study we examine the life courses of Indian, Pakistani, Caribbean, African, and European and Western (including North America and Australasia) migrants and their descendants and compare them with the native population. Our models do not allow mixed unions. This assumption is well justified for South Asians, who have low levels of mixed unions, but less so for Caribbeans and Europeans, who have more mixed unions (Kulu and Hannemann 2018). Therefore, we are likely to overestimate the future Caribbean and European population. However, our main focus is on the distribution of groups by partnership and parity status – the impact of a partner's origin is incorporated into the observed transition rates. Additionally, for computational reasons, we do not include in simulations the Bangladeshi group, which is the smallest of six, and the 'Other group', which is very heterogeneous.

We exclude those with missing country of birth or ethnicity, reducing the initial sample of 1.9 million by around 40,000 or 2%. Furthermore, around 300,000 persons have missing information on the number of dependent children in the household, which serves as our proxy variable for parity. Listwise deletion of these individuals introduces significant bias in the base population estimates, specifically underestimating separated males, who have disproportionately higher numbers of missing information. Instead, we fill the missing observations using multiple imputation. We assume that the missing value

is missing at random, that is, the missingness of the number of dependent children in the household is not related to the value of this variable but only the value of the observed variables. Our multiple imputation uses a multinomial model regressing the number of dependent children on age, sex, partnership status, ethnicity, and country of birth. We impute 11 datasets that generate a distribution of the number-of-dependent-children variable for each person, from which we take the median. To validate our base population estimate, we compare our estimated proportion of separated persons aged 16–49 with ONS census data for 2011 (ONS 2018). Our estimates are 5.1% and 8.7% for males and females respectively, whilst the ONS estimates are 5.1% and 8.8% respectively.

Aside from this, the number of dependent children is a biased proxy measure of parity at younger and older ages. For example, at older ages it is more likely that children have left home, which means that we will underestimate parity, while at younger ages we cannot distinguish between those who have left the parental home and had children and those who live with parents and have young siblings. To reduce this bias, we calibrate parity for those aged 20–44 to ONS data on the mean number of children per female by age (ONS 2020a). For females, this is done by randomly assigning or removing children from persons in the microdata so that the mean number of children at each age group is equal to the mean number of children in the ONS data. As there is no equivalent data for males, we assume that males have the same mean number of children as females. This calibration step is complicated by the microdata grouping individuals with 3 or more dependent children in a household into a single group; therefore, the mean number of children cannot be estimated directly. To address this, we use ONS data on the distribution of women by number of live-born children, by age and year of birth of woman, to calculate the mean number of children for those with 3 or more children (ONS 2020a). For persons aged 45–49, because ONS data on mean number of children only extends to age 45, we arbitrarily assume that they have the same probability distribution of parity within partnership status as persons aged 40–44, while for persons aged less than 20 we arbitrarily assume that they do not have any children.

We validate the age distribution of our 2011 base population estimate using 2011 ONS data on the number of persons by age, sex, and migrant origin and generation (ONS 2015). This shows that the microdata underestimates the number of persons aged 15–20 (supplementary Figure A-1). We speculate that this is due to difficulties in capturing those in higher education living in communal residences. In addition, for migrant origin and generation groups with smaller sample sizes, there were larger differences in age distribution between the ONS data and our estimates. To remove these differences, we calibrated the age distributions of our base population to the ONS data.

3.4 Estimation of third generation in 2011

It is not possible to identify the third generation (3G) using census data. Therefore, to estimate the number of third generation individuals in 2011, we project the population of England and Wales from 1991 to 2011. During this period, we consider anyone born to a 2G individual to be a 3G person. We use the same transition rates described in Section 3.2 and construct a 1991 base population using 1991 census data and the same process described in Section 3.3

Our estimate assumes that there were no individuals belonging to the 3G before 1991. Evidence suggests that there are likely to be limited numbers of South Asian and African 3G before 1991, as the majority of South Asians migrated to the United Kingdom in the 1960s and 1970s following the partition of India (Peach 2006), while most Africans migrated from countries gaining independence from the 1960s onwards (Domboka 2017). However, given that Caribbeans began migrating to the United Kingdom in large numbers following the British Nationality Act 1948 (Hansen 2000), there are likely to be more Caribbean 3G by 1991. As a result, we are likely to underestimate the 3G Caribbean population in 2011 at ages above 20. The 1991 census does not allow the identification of European and Western migrants, so we cannot estimate their 3G numbers in 2011.

3.5 Model validation

We validate the results of our simulations by comparing them with external data sources. For marriage, we compare the results of our projection of family life histories for the native population with ONS estimates of the proportion of individuals who experience transition to first marriage by age and sex (ONS 2020b). For parity, we compare the same results with ONS estimates of first births and average number of children by age among females (ONS 2020a). Simulation results for transitions to first marriage in the native population lie approximately between the ONS 1970–1974 and 1980–1984 birth cohorts (supplementary Figure A-2), while the results for first births and for births per woman are close to the ONS 1970–1974 cohort (supplementary Figure A-3). Overall, this is reassuring, given that our transition rates are based on those born in 1970–2003.

3.6 What-if scenarios

Due to the small numbers and young ages of the third generation in the United Kingdom, our knowledge of their partnership and fertility behaviours is limited. We explore this uncertainty using two scenarios. First, we assume that the partnership and fertility

behaviour of the third generation is the same as that of the second generation. Second, we assume that their partnership and fertility patterns are similar to those of the native population. We generate these scenario-based projections for all groups except the European and Western groups, as the data only allow us to identify European and Western 2G, whose projected family life courses we nonetheless present.

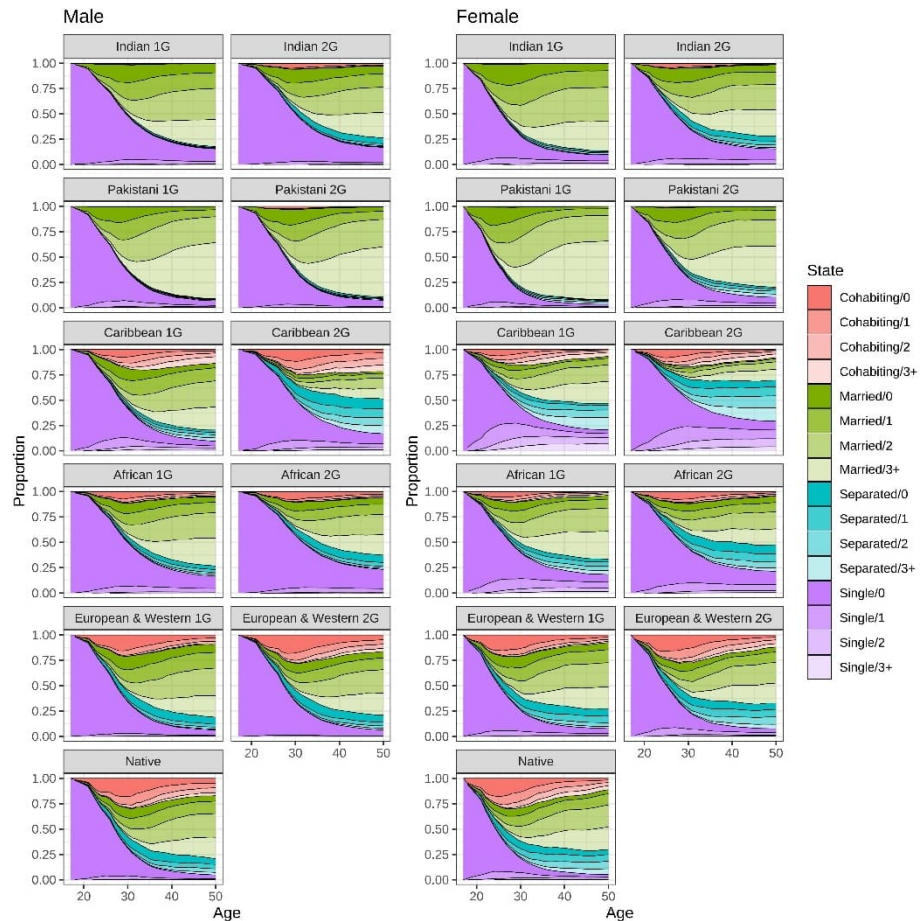
4. Results

4.1 Projection of family life histories

We can use our transition rates to illustrate the family life courses of different groups by applying them to a synthetic birth cohort (Figure 2). While the focus of this study is on the descendant generations, we include here information on the native population, immigrants (1G), and their descendants (2G), in order to illustrate differences to/similarities with the native population and generational changes among migrant populations. Next, we briefly summarise the patterns observed among women. (The patterns among men are largely similar, although the proportion of separated individuals is slightly lower at older ages.) At age 15, everyone is single and childless (Figure 2). By age 50, most natives are married and have children, but there is a sizeable share who are single, cohabiting, or separated. At around ages 20–30, around a quarter of natives cohabit, and this share declines as the share of married individuals increases with age.

By contrast, most Indian and Pakistani immigrants are married before age 50, very few are single and separated, and even fewer are cohabiting. Additionally, many of them have 3 or more children, especially immigrants from Pakistan, but a significant share also has smaller families. Interestingly, the patterns are relatively similar among the descendants of Indian and Pakistani immigrants: most people are married before age 50 and many still have 3 children, although the share of individuals with large families has significantly declined compared to immigrants, especially among Indians. The share of 2G Indian and Pakistani individuals who are single or have experienced separation is also greater than that of immigrants with the same origins. Interestingly, however, very few cohabit before marriage.

Figure 2: Partnership and parity states by age, migrant origin, and generation, using model transition rates



Note: 1G = first generation (migrants); 2G = descendants of immigrants.

Immigrants from Caribbean countries show specific patterns. There is much more heterogeneity among this group than any other. Before age 50 nearly half of individuals are married; the share of individuals who are either single or separated is higher than in any other immigrant group, and cohabitation is also common. Family size varies considerably, although, interestingly, the share of those with 3 children is the largest. The

descendants of immigrants exhibit even more intra-group heterogeneity. Although most of them are unpartnered at age 50, the majority have been in a union early in their life. A considerable share, however, have experienced separation – outnumbering those who were married or cohabiting at age 50. The distribution by the number of children shows that the various groups are of equal size.

Finally, immigrants from African and other European countries exhibit patterns relatively similar to those of the native population. Most of them are married and have children by age 50. There are also individuals who are single or cohabiting and those who have experienced separation. The patterns among their descendants are not that different, although compared to immigrants more are single or have experienced separation, especially among 2G Africans. The share of cohabitants is somewhat larger among the descendants of immigrants from Europe than from Africa. Additionally, the share of those with large families is significantly smaller among the descendants of African immigrants than other groups.

4.2 Population projections 2011–2031

4.2.1 The age, sex, and generation structure of descendant groups

Table 1 presents the population of England and Wales (i.e., the base population) aged 0–49 in 2011, by origin and generation. Immigrants and their descendants formed a quarter of the total population, and the share of the descendants was 12%. The largest descendant groups were those of European and Western, Indian, and Pakistani origin. With respect to the population of descendants, the estimated share of the third generation was the largest among those of Caribbean (42%), Indian (38%), and Pakistani (28%) descent, while it was the smallest among those of African (10%) and Bangladeshi (11%) descent. These differences in cohort sizes are largely a reflection of immigration history. After the Second World War the Caribbean group was the first to arrive in the United Kingdom, which means that by 1991 the share of 2G Caribbeans of reproductive age was greater than that of the other 2G groups – hence their greater share of 3Gs in 2011. This wave of migration was followed by people from India and Pakistan; Africans and Europeans, in turn, are the most recent groups (see supplementary Figure A-4 for the 2011 population pyramids).⁵

⁵ For computational reasons we decided not to include in simulations the smallest of the six, the Bangladeshi group, nor the ‘Other group’, which is very heterogeneous.

Table 1: Population of England and Wales aged 0–49, by origin and generation in 2011. Number of persons (1000s).

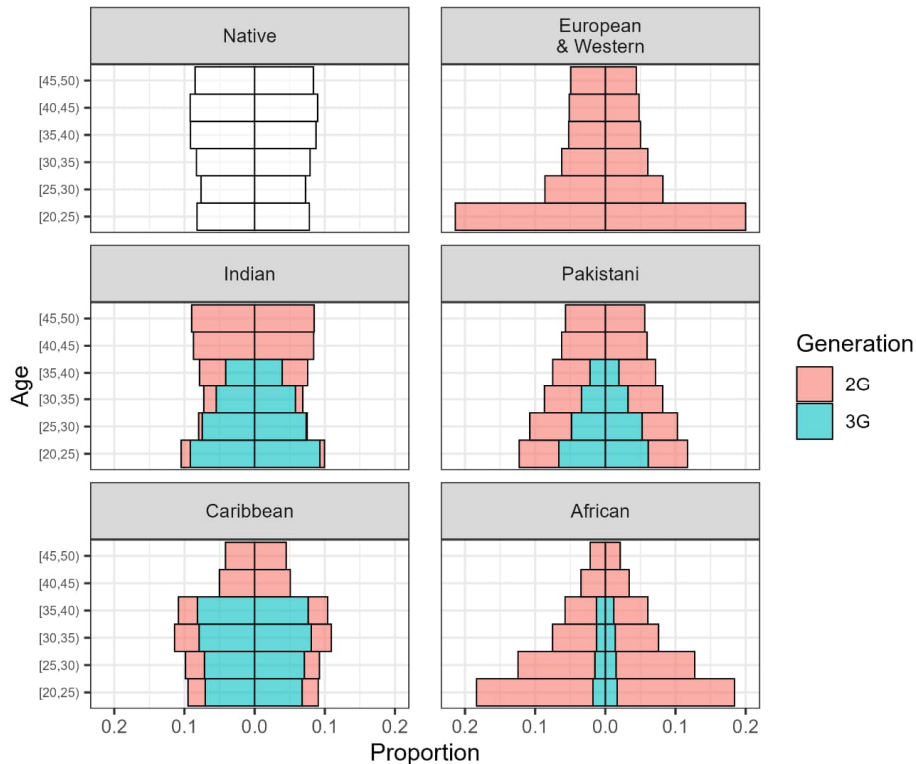
Origin and Generation	Number	% of total population	% of 3G among 2G+
Native	28,338	75.4	
Migrants (1G)	4,917	13.1	
Immigrants' descendants (2G+):			
African 2G+	319	0.8	10
Bangladeshi 2G+	230	0.6	11
Caribbean 2G+	463	1.2	42
European & Western 2G+	493	1.3	-
Indian 2G+	600	1.6	38
Other 2G+	1,591	4.2	14
Pakistani 2G+	625	1.7	28
Total	37,576	100.0	

Note: 2G+ = descendant generation; 3G = third generation.

Share of 3G is estimated from authors' microsimulation of births from second generation using the 1991 ONS data. The 1991 ONS data do not identify European & Western migrants, and so the share of their 3G descendants could not be estimated.

It is not surprising that, in 2031, there will be many 3G individuals among the Caribbean, Indian, and Pakistani groups (Figure 3). Interestingly, however, the third generation mostly dominates among young adults, whereas the second generation prevails among people aged 30 and over. On the one hand, this is partly related to the assumption we had to make, i.e., that the third generation was only born between 1991 and 2011. Their size is thus underestimated. On the other hand, this exercise also illustrates how UK-born ethnic minority populations will transform, and it will take some time before the third generation emerges. For the population of African origin the second generation dominates in 2031, although we observe an emerging third generation at younger ages among the African group.

Figure 3: Projected population structure of immigrants' descendants in 2031, by migrant origin and generation. Left-hand side = Male; right-hand side = Female



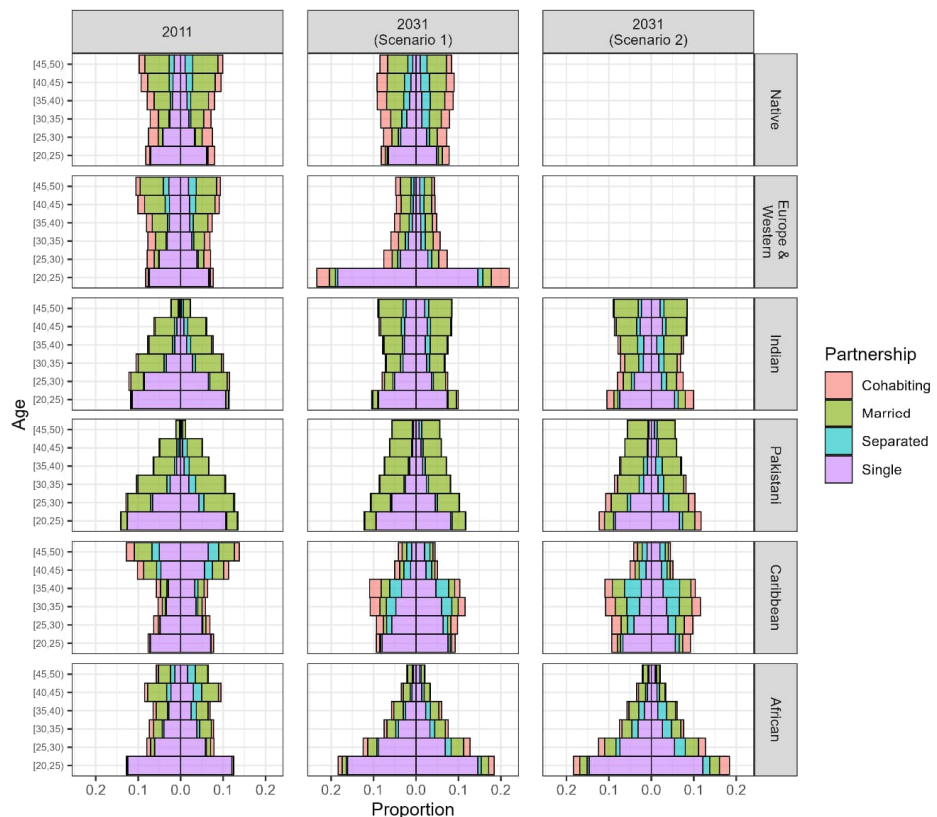
Note: 2G = second generation; 3G = third generation; pyramid for the native population is provided for comparison.

4.2.2 The age, sex, and partnership status structure of descendant groups

Figure 4 shows the partnership distribution of immigrants' descendants in 2011 and our projections for 2031 based on the two scenarios. First, at ages 40+, most natives were married in 2011, and this pattern is projected to remain in 2031, although the shares of cohabiting and separated individuals are projected to rise. If the third generation follows the second generation's partnership behaviours (Scenario 1), we will observe some consistency in the partnership distribution of people of Indian and Pakistani origin aged

20–49 in 2011 and 2031, but also some changes. Most people aged 30+ are married in both 2011 and 2031, and there are very few who are cohabiting or are separated. However, more individuals aged 30 and over are projected to be single in 2031 than were observed in 2011, suggesting either the postponement of marriage or an increased share of single people, or both. If the descendants’ partnership trajectories follow that of the native population (Scenario 2), we will further observe a considerable share of cohabiting individuals at the younger ages, which are virtually absent in Scenario 1.

Figure 4: Population structure of immigrants’ descendants, by partnership state and migrant origin, 2011–2031. Left-hand side = Male; right-hand side = Female



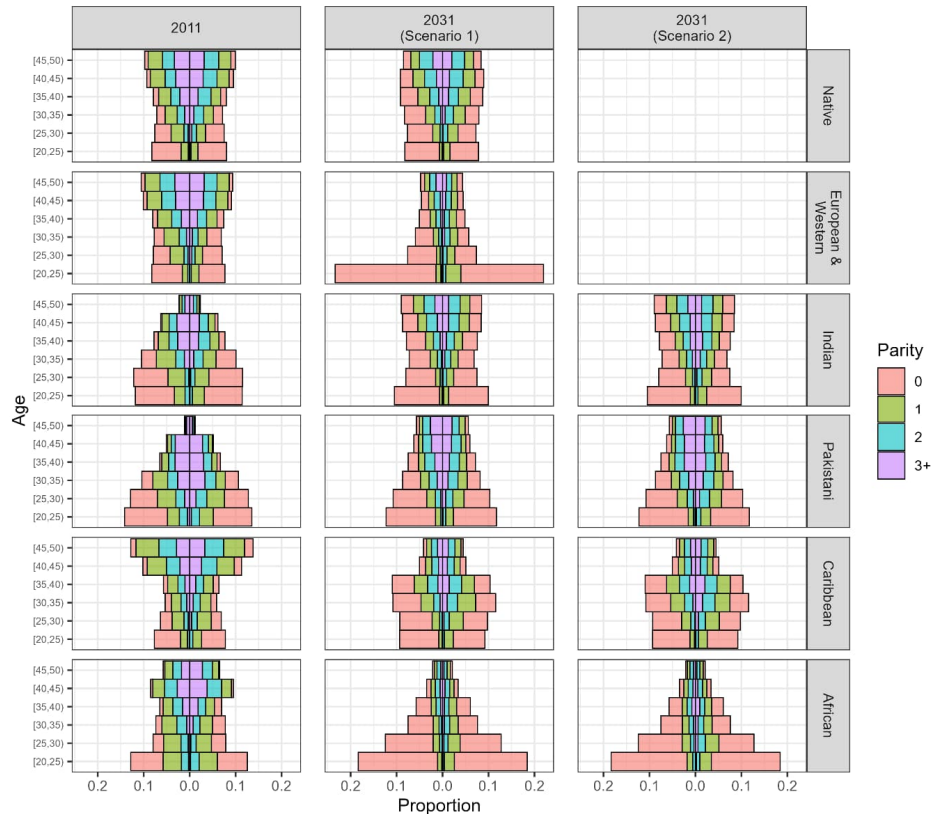
Note: Pyramids for the native population are provided for comparison.

By contrast, heterogeneity is large and will persist in 2031 among people of European and Western, African, and particularly Caribbean descent, as expected. At ages 20–24, a sizeable share will be single among the descendants of European and Western immigrants. At ages 25+, however, most of them will either be cohabiting or married, while there is a constant share of separated individuals. Among Caribbeans, there is a considerable difference between the two scenarios. If the 3G follows the 2G behaviours, most descendants of immigrants will be single, while a significant share will be separated, even outnumbering married individuals. By contrast, if they follow the transition rates of the native population, a larger share of individuals is projected to be married, especially between ages 20–40; there is also a projected increase in the share of those who will be separated, while fewer will be single. Finally, among those of African origin, single individuals are projected to dominate among those in their 20s and 30s. If the third generation behave like the native population, there will be more cohabitations and separations in 2031.

4.2.3 The age, sex, and parity status structure of descendant groups

Similarly, we developed two scenarios for fertility (Figure 5). As opposed to partnerships, there are fewer differences in the projected parity distributions among the descendants across the two projection scenarios. For all descendant groups, the share of individuals with 3 children will be smaller in 2031 than it was in 2011. Likewise, we observe an increase in the share of childless people at the younger ages, which partly reflects postponement of fertility, especially among the third generation. Among people of Indian origin, however, a substantial share of individuals aged 40+ are childless, indicating rising childlessness among the second generation. We also prepared graphs to illustrate the projected descendant populations by combined partnership and parity states (Figures A-5.1 to A-5.6).

Figure 5: Population structure of immigrants' descendants, by parity and migrant origin, 2011–2031. Left-hand side = Male; right-hand side = Female



Note: Pyramids for the native population are provided for comparison.

5. Discussion

This study investigates the family life courses and future population structure of the descendants of immigrants in England and Wales. To our knowledge, this is the first study to develop a microsimulation model that projects the family size and partnership status of the second and third generations. The aim is to improve our understanding of how migrant populations change across generations and over time. Our analysis supports,

first, significant heterogeneity in family patterns among migrant populations. Continental Europeans, Africans, and the Caribbean population show family patterns similar to those of the native UK population. Many of them cohabit prior to marriage, some experience dissolution of their first unions, some have a birth outside of a union, and their fertility levels in unions are similar to those of the natives. By contrast, South Asians exhibit more conservative family patterns: they have high marriage rates and low separation levels, childbearing outside of marriage is uncommon, and many have 3 or more children. Second, we observed similarities between immigrants and their descendants regarding partnership patterns. For example, South Asian immigrants in the United Kingdom exhibit high marriage and relatively low cohabitation rates. However, cohabitation and especially separation are more common among the descendants compared to immigrants. They also have smaller families.

Third, our projections show that the distribution of the descendants of immigrants by partnership and parity gradually becomes similar to that of the native population. The changes are expected to be faster for family size and somewhat slower for partnership patterns, especially for individuals of South Asian origin. Meanwhile, the partnership distribution of immigrants' descendants in 2031 will depend on the extent of the convergence towards the partnership trajectories of the native population. For most groups, the convergence will result in fewer marriages and more cohabitations. An interesting exception is Caribbeans, who will experience more marriages, if the third generation follows the partnership behaviour of the native population. The reality, we posit, is somewhere in between these two scenarios.

Nonetheless, the notion of the 'third generation' requires some clarification. In this study, we use this notion only for analytical purposes to distinguish the descendants of the descendants of immigrants from a mid-term projection perspective. However, conceptually, the use of the category is not without problems and certainly needs some discussion. In high-income countries with a long migration history, such as the United States, Canada, or Australia, such a definition is hardly, if ever, used in the literature, for various reasons. For example, it is difficult to determine the 'native population'. Naturally, the native population consists of everyone who, for example, are US-born with US-born parents (wherever their grandparents come from). However, in Europe, where nation states have a long history, the use of the concept of the 'third generation' is common (Weber, Ferry, and Ichou 2024). This is supported by research in Britain on minorities, which mostly focuses on ethnicity (or 'minority ethnic groups') (Khattab and Johnston 2015). For example, a UK-born individual with two UK-born parents may still be considered a member of a 'minority ethnic group' rather than the 'white British majority'. This approach is supported by the collection of information on individuals' ethnicity and also the institutionalisation of ethnicity for administrative purposes (e.g., to monitor inequalities).

The study has some limitations. First, we assume that future transition rates will remain constant when they are likely to change. For example, fertility rates in the United Kingdom have been declining steadily for the last few decades and are projected to continue to decline over the coming decades (ONS 2022). Therefore, we are likely to overestimate fertility. Similarly, marriage is increasingly delayed until older ages and cohabitation is rising in popularity. Therefore, we are likely to overestimate marriage and underestimate cohabitation (Hannemann and Kulu 2015). Our microsimulation model could thus be further developed to explore various scenarios. For example, microsimulation can be applied to investigate the effect of the (increased) educational level or a reduced number of siblings on the population's family structure. Second, as we mentioned earlier, our simulation model does not consider mixed partnerships, which would affect the results of the groups where mixed marriages are increasingly common, such as people of European or Caribbean origin. Finally, our input rates are based on model estimates, which are subject to sampling error. Future research should explicitly incorporate uncertainty in microsimulation models. This includes the uncertainties associated with our model input rates, estimation of our base population, and assumptions around how our input rates will evolve in the future.

Overall, we have demonstrated that microsimulation is a useful tool for projecting the life courses and family structures of migrants and their descendants. Although established macro-demographic approaches like multistate life tables can capture transitions between discrete states, the number of states they can accommodate is limited by the sample size, which especially becomes a problem when modelling the life courses of minority groups. Additionally, aggregate measures based on life tables typically treat life domains independently. Through microsimulation, we are able to visualise how the highly related processes of partnership formation/dissolution and childbearing unfold simultaneously over the life course. Relatedly, although the cohort-component method is a well-established method for projecting populations, the addition of multiple dimensions on top of age and gender introduces enormous complexity – something that microsimulation-based projections can address by applying transition rates to individuals instead of aggregates (Puga-Gonzalez et al. 2022; Zagheni 2015).

This exercise has revealed that population processes involve some inertia, especially if driven by cohort changes. Our projections show that differences between individuals with migrant family background and the native population are reduced but will persist in the next decades. This is because the second generation will still be the main group among the descendants aged 30 to 50, while the third generation represents a young and growing segment, especially among Indian and Caribbean groups. We expect that these differences will attenuate once the third generation becomes the predominant population among the descendants. Additionally, there is significant heterogeneity in family patterns among the native population, and this heterogeneity is projected to increase. Should

descendant populations become similar to the natives in their family life courses, they will also exhibit a significant intra-group heterogeneity in partnership and childbearing behaviour. This heterogeneity is a natural part of contemporary European societies, but may also be a sign of segmentation of societies characteristic of both the native and ethnic minority populations, especially if coupled with inequalities in other life domains, such as labour market attachment.

6. Acknowledgements

This paper is part of the MigrantLife Project that has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme (Grant agreement no. 834103).

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Appendix

Software for implementation of the microsimulation model

Our model consists of six scripts: (1) `read_pop.R` reads in the population data; (2) `init_pop.R` processes the population data into the desired format for the *fastMicSim* package; (3) `transition_rates.R` reads in the transition rates data and defines the transition functions; (4) `simulation_parameters.R` defines simulation parameters, such as transition matrices, the start and end date of the simulation, and the number of individuals to simulate; (5) `main.R` runs the microsimulation model and stores results; and (6) `results.R` processes and graphs the results of the simulations. Demonstration codes for estimating the microsimulation model and generating Figure 2 are available here: <https://github.com/sbdafable/micsim-migrantlife-demres>.

Table A-1: Model transition rates adapted from Mikolai and Kulu 2022.
Transition types: C = cohabitation; M = marriage; B = birth; Sep = Separation

State	Name	Coefficient	
		Female	Male
Single	Age 16–19	0.442	0.268
Single	Age 20–24	1.000	1.000
Single	Age 25–29	1.197	1.744
Single	Age 30–34	0.886	1.573
Single	Age 35–39	0.510	1.090
Single	Age 40–44	0.333	0.661
Single	Age 45–49	0.093	0.370
Single	C#, Native	9.398	9.600
Single	C#1G, European & Western	7.077	7.904
Single	C#1G, Indian	0.690	0.731
Single	C#1G, Pakistani	0.466	0.500
Single	C#1G, Caribbean	3.962	4.146
Single	C#1G, African	3.019	3.791
Single	C#2G, European & Western	8.030	8.626
Single	C#2G, Indian	1.791	2.180
Single	C#2G, Pakistani	0.472	1.478
Single	C#2G, Caribbean	3.798	5.223
Single	C#2G, African	3.332	2.957
Single	M#, Native	1.000	1.000
Single	M#1G, European & Western	2.022	1.835
Single	M#1G, Indian	7.558	5.795
Single	M#1G, Pakistani	11.394	8.631
Single	M#1G, Caribbean	1.610	3.368
Single	M#1G, African	3.019	2.387
Single	M#2G, European & Western	1.209	1.084
Single	M#2G, Indian	4.941	4.043
Single	M#2G, Pakistani	7.471	7.867
Single	M#2G, Caribbean	0.500	0.720
Single	M#2G, African	2.041	2.020

Table A-1: (Continued)

State	Name	Coefficient	
		Female	Male
Single	B#, Native	2.974	1.544
Single	B#1G, European & Western	1.716	1.223
Single	B#1G, Indian	1.821	1.327
Single	B#1G, Pakistani	2.166	2.399
Single	B#1G, Caribbean	6.934	3.887
Single	B#1G, African	3.231	1.615
Single	B#2G, European & Western	2.635	0.497
Single	B#2G, Indian	1.326	0.753
Single	B#2G, Pakistani	2.244	1.144
Single	B#2G, Caribbean	4.565	2.611
Single	B#2G, African	1.832	1.010
Single	Constant	0.001	0.001
Single	Separated	1.348	1.465
Single	Parity 0	1.000	1.000
Single	Parity 1	1.235	1.733
Single	Parity 2	0.917	1.391
Single	Parity 3+	0.862	1.189
Cohabiting	Age 16–19	1.159	1.076
Cohabiting	Age 20–24	1.000	1.000
Cohabiting	Age 25–29	1.046	0.969
Cohabiting	Age 30–34	1.046	1.030
Cohabiting	Age 35–39	0.847	0.873
Cohabiting	Age 40–44	0.616	0.642
Cohabiting	Age 45–49	0.458	0.357
Cohabiting	M#, Native	1.033	0.997
Cohabiting	M#1G, European & Western	1.159	1.333
Cohabiting	M#1G, Indian	2.726	2.506
Cohabiting	M#1G, Pakistani	1.818	3.230
Cohabiting	M#1G, Caribbean	0.961	1.065
Cohabiting	M#1G, African	1.251	1.744

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Table A-1: (Continued)

State	Name	Coefficient	
		Female	Male
Cohabiting	M#2G, European & Western	0.894	1.006
Cohabiting	M#2G, Indian	0.931	0.973
Cohabiting	M#2G, Pakistani	0.793	1.748
Cohabiting	M#2G, Caribbean	0.717	0.363
Cohabiting	M#2G, African	1.000	1.108
Cohabiting	Sep#, Native	1.000	1.000
Cohabiting	Sep#1G, European & Western	1.067	1.103
Cohabiting	Sep#1G, Indian	1.168	0.884
Cohabiting	Sep#1G, Pakistani	0.779	0.000
Cohabiting	Sep#1G, Caribbean	1.223	0.266
Cohabiting	Sep#1G, African	0.973	0.969
Cohabiting	Sep#2G, European & Western	0.989	0.955
Cohabiting	Sep#2G, Indian	1.534	1.774
Cohabiting	Sep#2G, Pakistani	1.982	1.202
Cohabiting	Sep#2G, Caribbean	1.550	1.588
Cohabiting	Sep#2G, African	1.481	1.182
Cohabiting	B#, Native	1.085	0.908
Cohabiting	B#1G, European & Western	0.623	0.588
Cohabiting	B#1G, Indian	1.363	0.589
Cohabiting	B#1G, Pakistani	1.299	0.000
Cohabiting	B#1G, Caribbean	1.572	1.464
Cohabiting	B#1G, African	1.367	1.098
Cohabiting	B#2G, European & Western	0.884	0.968
Cohabiting	B#2G, Indian	0.438	0.515
Cohabiting	B#2G, Pakistani	1.586	0.874
Cohabiting	B#2G, Caribbean	1.573	1.225
Cohabiting	B#2G, African	0.703	0.665
Cohabiting	Constant	0.009	0.010

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Table A-1: (Continued)

State	Name	Coefficient	
		Female	Male
Cohabiting	Parity 0	1.000	1.000
Cohabiting	Parity 1	1.068	1.004
Cohabiting	Parity 2	0.779	0.747
Cohabiting	Parity 3+	0.770	0.656
Married	Age 16–19	0.832	0.658
Married	Age 20–24	1.000	1.000
Married	Age 25–29	0.928	1.056
Married	Age 30–34	0.903	1.051
Married	Age 35–39	0.569	0.814
Married	Age 40–44	0.196	0.437
Married	Age 45–49	0.052	0.216
Married	Sep#, Native	0.211	0.144
Married	Sep#1G, European & Western	0.133	0.095
Married	Sep#1G, Indian	0.056	0.039
Married	Sep#1G, Pakistani	0.098	0.068
Married	Sep#1G, Caribbean	0.216	0.224
Married	Sep#1G, African	0.130	0.096
Married	Sep#2G, European & Western	0.203	0.097
Married	Sep#2G, Indian	0.108	0.043
Married	Sep#2G, Pakistani	0.142	0.063
Married	Sep#2G, Caribbean	0.482	0.250
Married	Sep#2G, African	0.200	0.073
Married	B#, Native	1.000	1.000
Married	B#1G, European & Western	1.008	0.967
Married	B#1G, Indian	0.902	0.977
Married	B#1G, Pakistani	1.414	1.504
Married	B#1G, Caribbean	0.901	0.761
Married	B#1G, African	1.154	1.218
Married	B#2G, European & Western	1.016	1.110
Married	B#2G, Indian	1.063	1.089
Married	B#2G, Pakistani	1.287	1.486
Married	B#2G, Caribbean	1.269	1.169
Married	B#2G, African	1.094	1.219
Married	Constant	0.021	0.017
Married	Parity 0	1.000	1.000
Married	Parity 1	0.890	0.913
Married	Parity 2	0.396	0.392
Married	Parity 3+	0.364	0.337

Figure A-1: Comparison of the age distribution of our 2011 base population, estimated from Census 2011 microdata for England and Wales, with 2011 ONS data for England and Wales on the number of persons, by age, sex, and migrant origin and generation

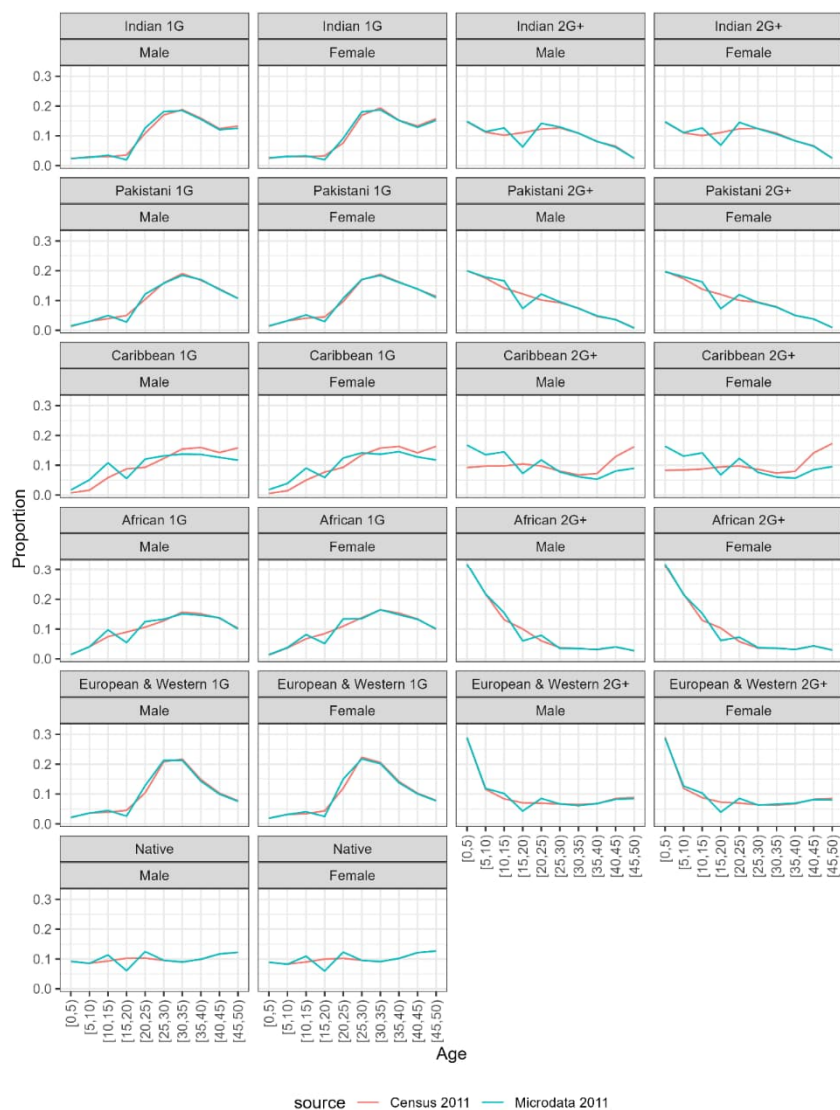


Figure A-2: External validation of first marriage for the native female population using simulated and ONS data (ONS 2020b)

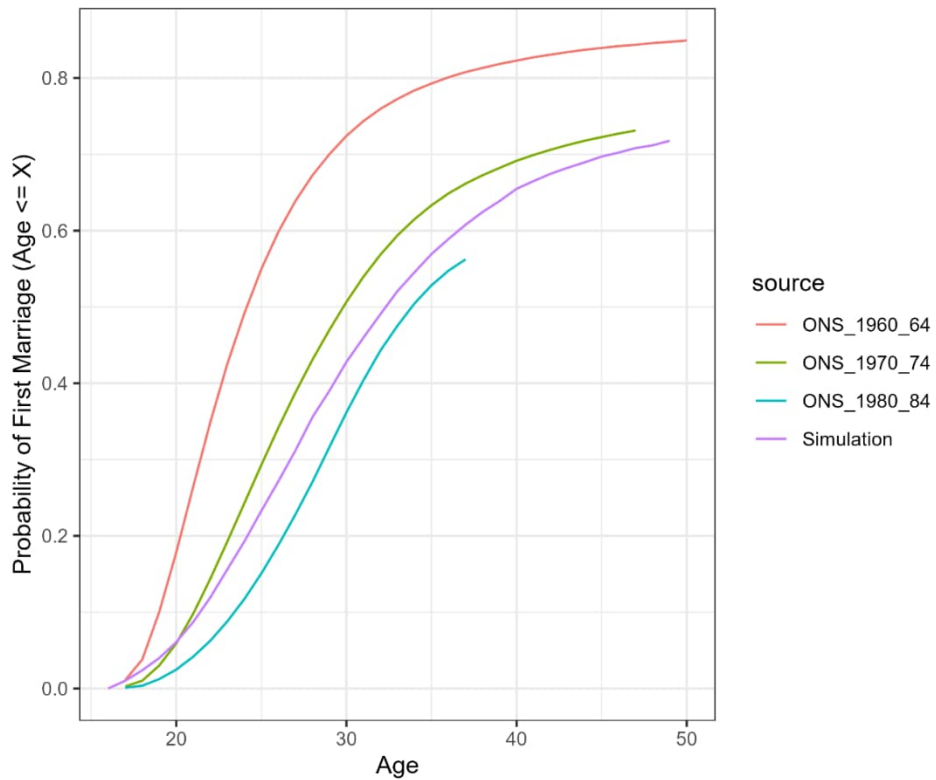


Figure A-3: External validation of first births and births per woman for the native female population using simulated and ONS data (ONS 2020a)

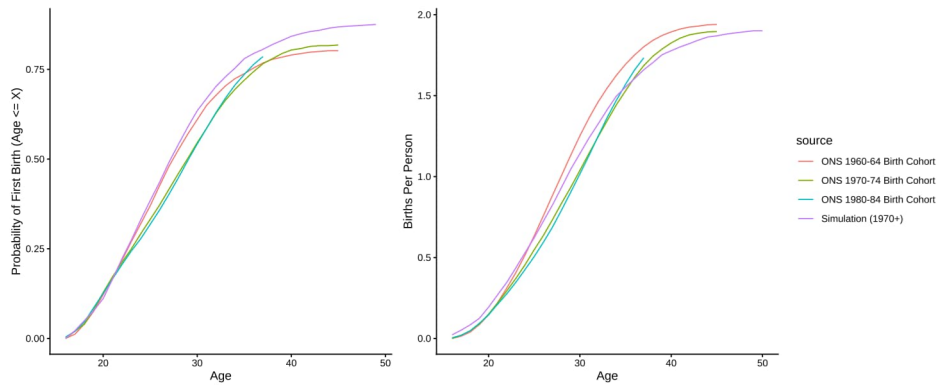
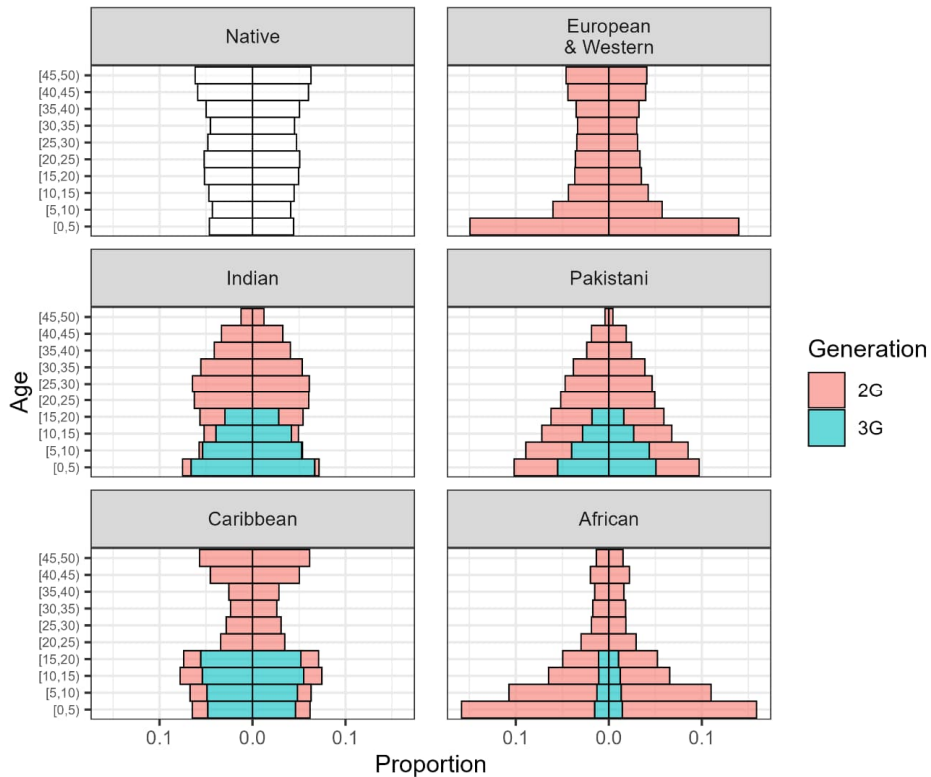
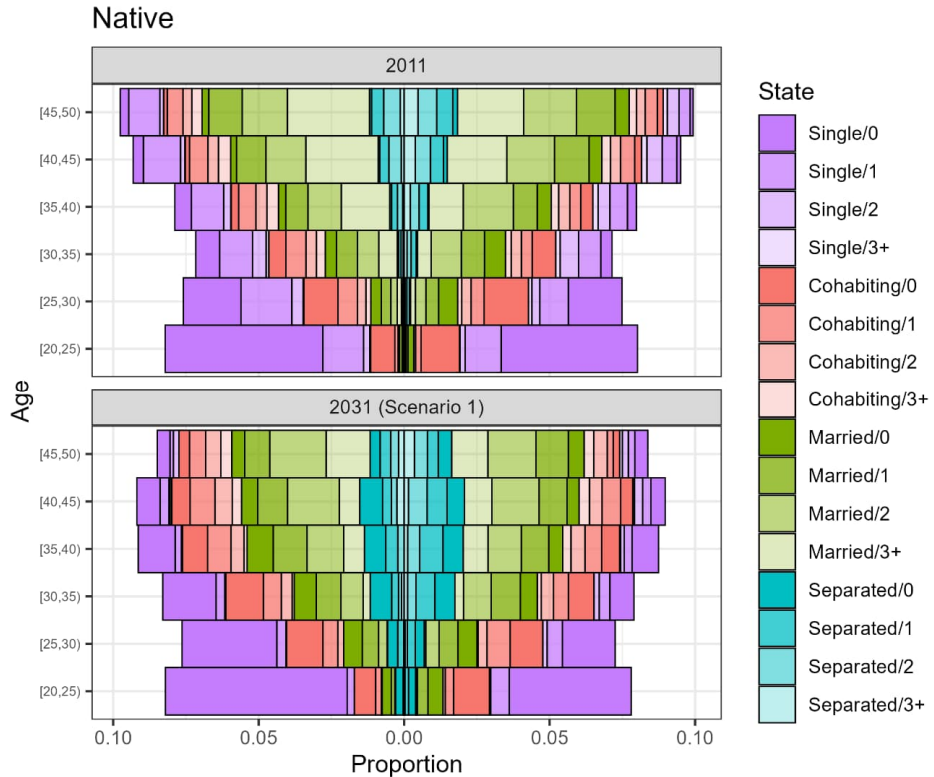


Figure A-4: Population pyramids of the descendants of immigrants in England and Wales in 2011. The population structure of the native population is also provided for comparison



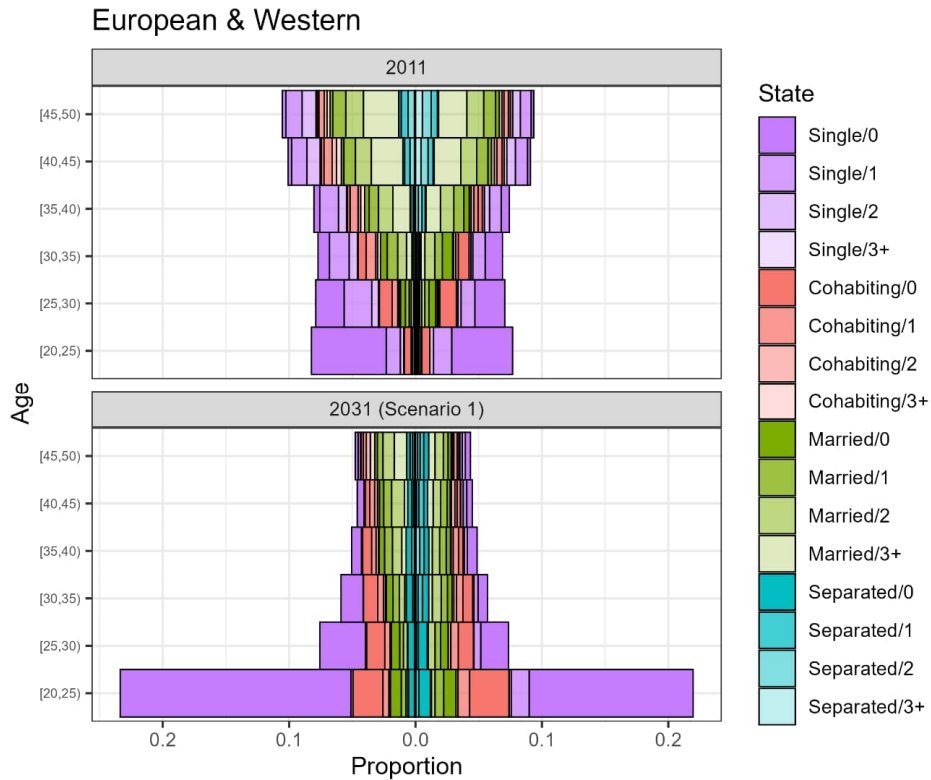
Note: 2G = second generation; 3G = third generation. The share of 3G is estimated from authors' microsimulation of births from second generation using the 1991 ONS data. The 1991 ONS data do not identify European & Western migrants, and so the share of their 3G descendants could not be estimated.

Figure A-5.1: Population structure of the native population in England and Wales, by combined partnership and parity states, 2011–2031.
Left-hand side = Male; right-hand side = Female



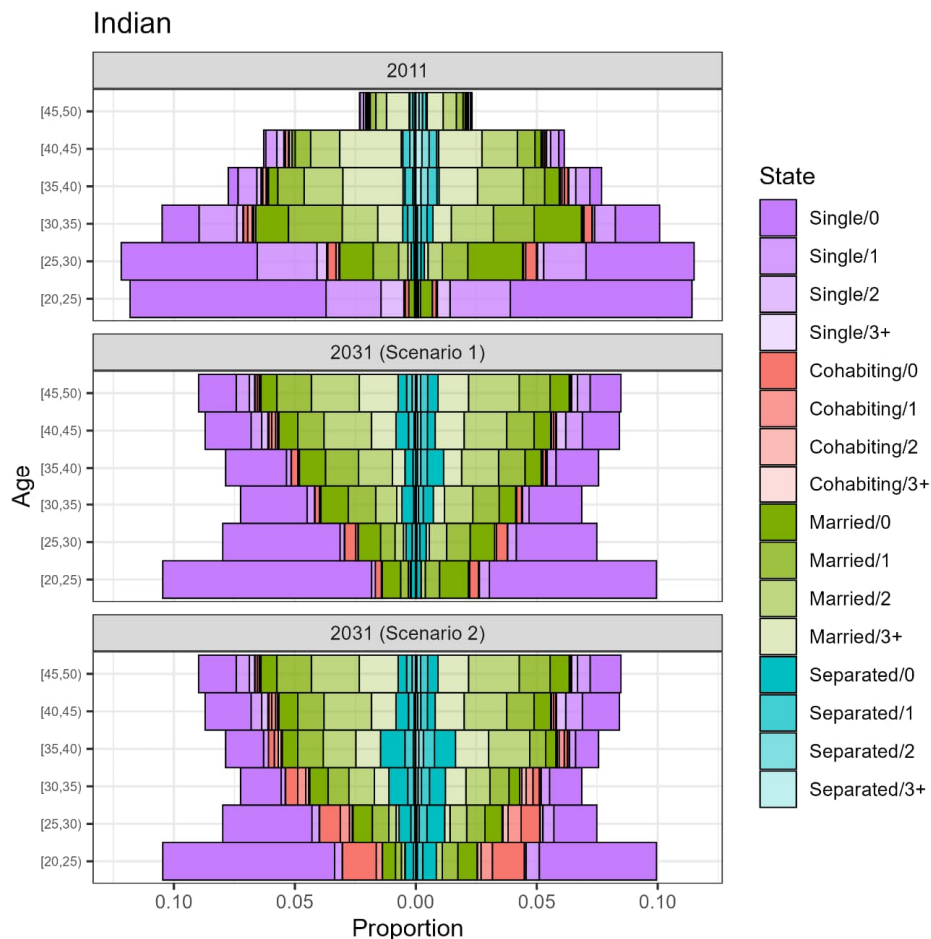
Note: 2011 pyramid is based on ONS data, while 2031 pyramid is based on authors' population projection using microsimulation.

Figure A-5.2: Population structure of the descendants of European and Western migrants in England and Wales, by combined partnership and parity states, 2011–2031. Left-hand side = Male; right-hand side = Female



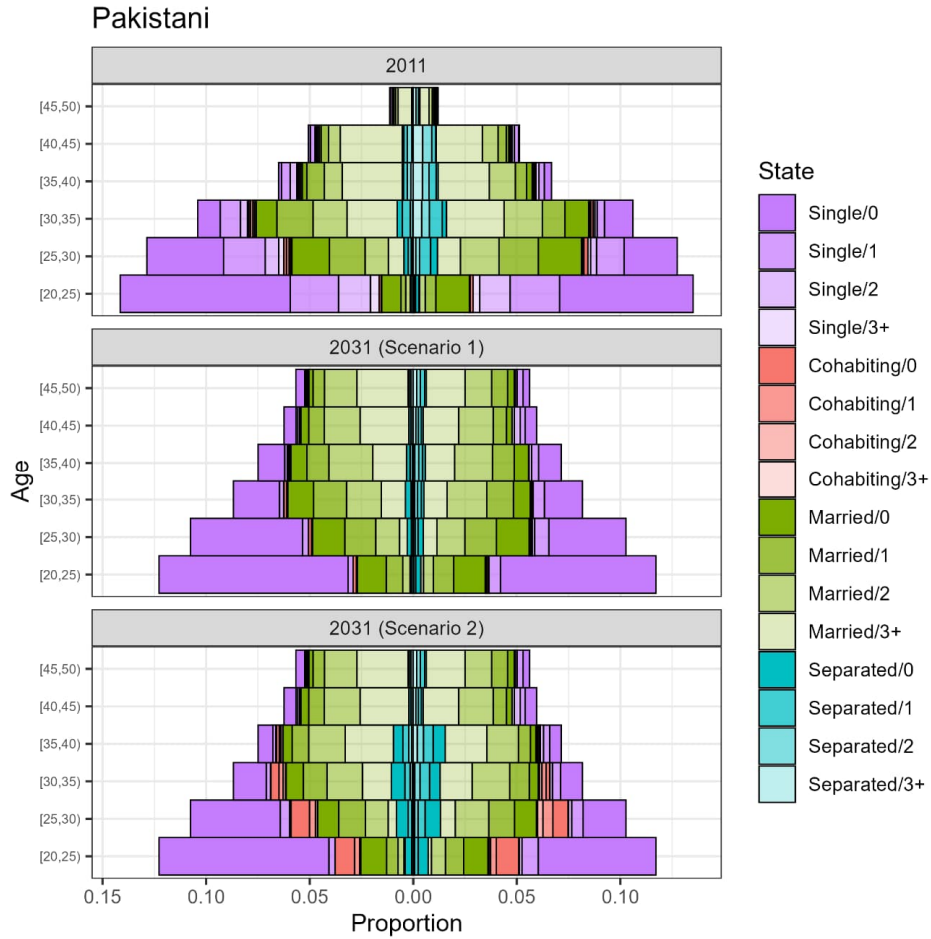
Note: 2011 pyramid is based on ONS data, while 2031 pyramid is based on authors' population projection using microsimulation.

Figure A-5.3: Population structure of the descendants of Indian migrants in England and Wales, by combined partnership and parity states, 2011–2031. Left-hand side = Male; right-hand side = Female



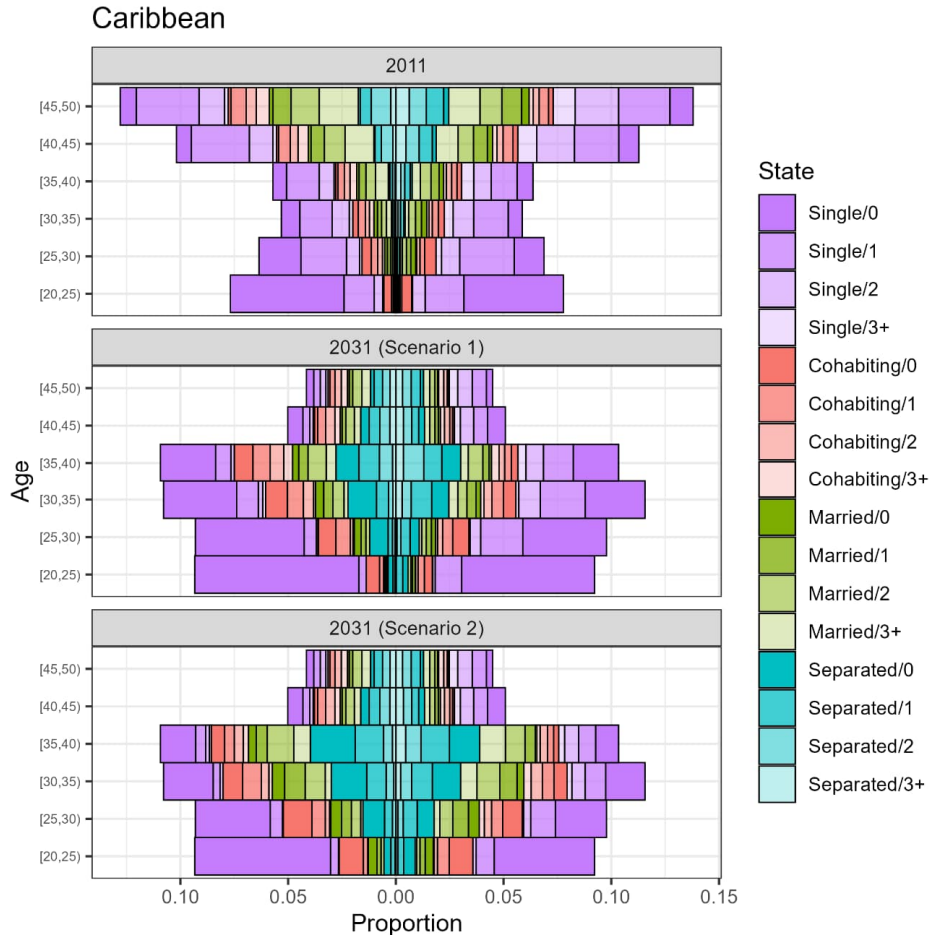
Note: 2011 pyramid is based on ONS data, while 2031 pyramids are based on authors' population projection using microsimulation. Scenario 1 assumes that the third generation follows the second generation's transition rates, while Scenario 2 assumes that the third generation follows the native population's transition rates.

Figure A-5.4: Population structure of the descendants of Pakistani migrants in England and Wales, by combined partnership and parity states, 2011–2031. Left-hand side = Male; right-hand side = Female



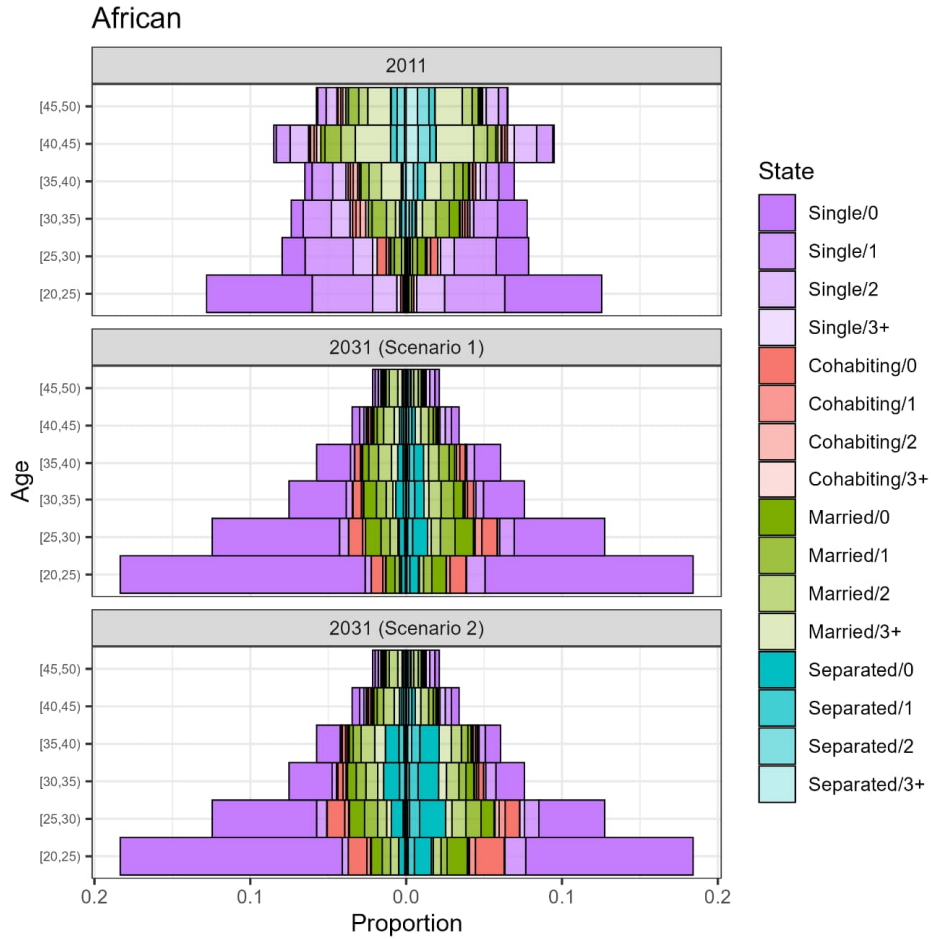
Note: 2011 pyramid is based on ONS data, while 2031 pyramids are based on authors' population projection using microsimulation. Scenario 1 assumes that the third generation follows the second generation's transition rates, while Scenario 2 assumes that the third generation follows the native population's transition rates.

Figure A-5.5: Population structure of the descendants of Caribbean migrants in England and Wales, by combined partnership and parity states, 2011–2031. Left-hand side = Male; right-hand side = Female



Note: 2011 pyramid is based on ONS data, while 2031 pyramids are based on authors' population projection using microsimulation. Scenario 1 assumes that the third generation follows the second generation's transition rates, while Scenario 2 assumes that the third generation follows the native population's transition rates.

Figure A-5.6: Population structure of the descendants of African migrants in England and Wales, by combined partnership and parity states, 2011–2031. Left-hand side = Male; right-hand side = Female



Note: 2011 pyramid is based on ONS data, while 2031 pyramids are based on authors' population projection using microsimulation. Scenario 1 assumes that the third generation follows the second generation's transition rates, while Scenario 2 assumes that the third generation follows the native population's transition rates.

