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Poor health, low mortality? Paradox found among immigrants in England and Wales

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Abstract

The 'healthy immigrant effect' and 'migrant mortality advantage' describe the better health and lower mortality of international immigrants as compared with the native-born populations of high-income countries. However, a growing body of evidence suggests that it is much more common to observe low mortality among immigrants than it is good health, pointing to the existence of a potential paradox that mirrors the well-known gender paradox in health and mortality. To investigate this, we used the Office for National Statistics Longitudinal Study, a large-scale representative 1% sample of the England and Wales resident population comprising linked individual-level health, mortality, and socio-demographic data. We compared health and mortality within and across major immigrant groups over 20 years using logistic regression for health and discrete-time survival analysis for mortality, both before and after adjusting for socio-demographic factors. Of the eight origin subgroups studied, we found persistent evidence of a health-mortality paradox within three: men and women from India, Pakistan and Bangladesh, and the Caribbean. We discuss potential explanations and implications of this paradox and suggest that decision makers need to react to help these subgroups preserve their health in order to delay the onset of limiting illnesses and emergence of this paradox.

KEYWORDS
healthy immigrant effect, inequality, international immigration, limiting long-term illness, migrant mortality paradox

1 | INTRODUCTION

The 'healthy immigrant effect' and 'migrant mortality advantage' describe the better health and lower mortality of immigrants compared with the native-born populations of the high-income countries where they live (Guillot, Khlat, Elo, Solignac, & Wallace, 2018). Whereas the latter is one of the most pervasive findings from the social sciences in recent decades (Aldridge et al., 2018; Neels, Wood, Surkyn, & Gadeyne, 2020), the former is much less prevalent. Recent reviews of the literature on the health and mortality of immigrants in France (Khlat & Guillot, 2017) and Canada (Vang, Sigouin, Flenon, & Gagnon, 2017) indicate a paradox in which immigrants appear to be living longer but in worse health than the native-born do. This disparity, evocative of the 'gender paradox'—in which women have worse health but live longer than men (Case & Paxson, 2005; Nathanson,-1975; Van Oyen et al., 2013)—has received little attention. Indeed, it

has only been studied a handful of times before, largely in Australia (Kouris-Blazos, 2002; Kouris-Blazos & Itsiopoulos, 2014; Stanaway et al., 2020) and occasionally in Europe (Carnein, Milewski, Doblhammer, & Nusselder, 2014; Cezard, 2020; Cezard, Finney, Marshall, & Kulu, 2020; Reus-Pons, Kibele, & Janssen, 2017).

Of these previous studies, just one has investigated the paradox at the micro-level using linked health and death data (Stanaway et al., 2020). Others have instead compared macro-level measures of overall and healthy or disability free life expectancies (Carnein et al., 2014; Cezard, 2020; Reus-Pons et al., 2017) or reviewed previous evidence (Kouris-Blazos, 2002; Kouris-Blazos & Itsiopoulos,-2014). Additionally, nearly all of the studies have focused on one origin group (Carnein et al., 2014; Cezard et al., 2020; Kouris-Blazos, 2002; Kouris-Blazos & Itsiopoulos, 2014; Stanaway et al., 2020). Thus, here, using a large-scale, representative individual-level 1% sample of the England and Wales population, we provide new evidence by examining the paradox among multiple origin groups, considering the role of socio-demographic factors in the observed health and mortality differences between foreign- and native-born, and by explicitly investigating the links between health, mortality, and immigrant origins. We also extend the theoretical framework by discussing the paradox in light of the main explanations of the migrant mortality advantage, theorising how explanations such as data artefacts, selection, cultural factors, and salmon bias effect could account for lower mortality in the absence of better health.

Our aim is to determine how prevalent the paradox is among different immigrant groups in the United Kingdom. Our findings should be relevant to policy makers and researchers in the United Kingdom and beyond. As the relative share of immigrants in nearly all high-income countries continues to grow, diversify, and age (Lanzieri, 2011; Rendall & Ball, 2004; United Nations, 2019), this creates new challenges for national health care, welfare, and social systems to adapt in order to more effectively understand, manage, and maximise the health of immigrants (Abubakar et al., 2018; Rechel, Mladovsky, Ingleby, Mackenbach, & McKee, 2013). Currently, the impression that immigrants are living longer in worse health than native-born populations, combined with the more established finding that the often sizeable initial health and mortality advantages of immigrants begin to deteriorate immediately after arrival in the new country (Anikeeva et al., 2010; Argeseanu Cunningham, Ruben, & Venkat Narayan, 2008; Biddle & Weldeegzie,-2017; Chiswick, Lee, & Miller, 2008; Harding, 2003, 2004; Vang et al., 2017; Wallace, Khlat, & Guillot, 2019), indicates that many high-income countries are so far failing to adapt.

In what follows, we summarise the existing evidence of the immigrant health and mortality paradox and introduce potential explanations. After presenting the data, methods, and results, we round out the article by discussing our findings in relation to how well the patterns reflect these explanations and by placing our findings in the context of wider evidence. We conclude with policy recommendations and suggestions for future avenues of research.

2 | BACKGROUND

2.1 | Previous findings

Kouris-Blazos (2002) first indirectly studied this phenomenon among immigrants over a decade ago. Using data and/or findings from different sources, the author found that, despite the increased prevalence of cardiovascular disease (CVD) risk factors (obesity, diabetes, smoking, hypertension, and sedentary lifestyles) in Greek men and women in Australia, the group continued to display 35% lower overall and CVD mortality than native-born. The finding persisted even among those who had lived in the country for 30 years+. Building upon this, Kouris-Blazos and Itsiopoulos (2014), again by reviewing findings from previous articles, showed that elderly Greek immigrants had the lowest risk of death paired with the highest obesity rates and other CVD risk factors that were said to have been developed early after migration with the introduction of energy dense foods.

Stanaway et al. (2020) represent the only study to have examined the migrant health-mortality paradox at the individual level using linked health and mortality data for the same people. The paper studied the paradox among Italian men aged 70+ in Australia, using small-scale (n < 1,500) longitudinal data. Initially, no mortality advantage was observed. However, after adjusting for socio-economic factors, lifestyle, and morbidity differences, a large mortality advantage emerged, in spite of the higher smoking rates and general morbidity of Italian men. Stanaway et al. (2020) concluded that Italian men aged 70+ were at risk of a longer period with higher levels of morbidity at the end of life, a finding that contrasts with the hypothesised compression of health associated with increased longevity. Nevertheless, these findings should be interpreted in context of the lower response rate in the survey (50%) linked to the follow-up survival data, the smaller sample size, and the focus on a single immigrant group and sex only.

In Europe, several studies from Germany (Carnein et al., 2014), Scotland (Cezard, 2020), and a multi country study of the Netherlands, Belgium, and England and Wales (Reus-Pons et al., 2017) have compared total and healthy life expectancy among several immigrant groups with their native-born counterparts. Calculating expected years of life for Germans and Turkish immigrants between ages 50 and 79, Carnein et al. (2014) found that Turkish men and women had higher life expectancies, combined with a greater number of years spent living with health limitations. Then, in an micro-level regression of health limitations only, they found age, marital status, education level, duration of stay, language fluency, satisfaction with living conditions, and subjective well-being to be salient predictors of health limitations (Carnein et al., 2014). A study from Scotland contrasted healthy and disability-free life expectancy with life expectancy at aged 65 for the major ethnic minority groups (Cezard, 2020). The author found that individuals in the Indian and Pakistani ethnic groups, especially women, had higher life expectancy at age 65 than White Scots, but lower proportions of life spent in good health or without disability. Finally, Reus-Pons et al. (2017) showed that while life expectancy at age 50 was higher among Western and especially non-Western

immigrants in Belgium, the Netherlands, and England and Wales, they could also expect to live fewer years in good health.

These three studies, although important in uncovering an initial health mortality paradox among immigrants in European countries, did not consider the role of socio-demographic factors in health and mortality differences between foreign- and native-born and how this might affect the observation of the paradox. Furthermore, the observation of the paradox among certain ethnic minority groups in Scotland (Cezard, 2020) needs to be interpreted somewhat differently given that ethnicity combines immigrants with their descendants. We know from previous research that descendants do not benefit from the same low mortality as immigrants; they often have higher mortality than the ancestral native-born do (Guillot, Khlat, & Wallace, 2019; Manhica, Toivanen, Hjern, & Rostila, 2015; Tarnutzer et al., 2012; Wallace, 2016), so it is conceivable that their health might differ too. Finally, while Reus-Pons et al. (2017) included England and Wales in their study, to ensure comparability across contexts, they operationalised immigrant's country of origin as a broad binary (Western vs. non-Western) combining a diverse range of origins and making an effective and nuanced interpretation of the findings difficult.

We can also derive indirect evidence from two systematic reviews of the literature, from Canada (Vang et al., 2017) and France (Khlat & Guillot, 2017). The latter reviewed 19 health studies and 17 mortality studies, all of which spanned considerable periods and investigated similar origin groups. Khlat and Guillot (2017) found that an advantage only presented consistently in mortality studies (particularly among male immigrants and young adult ages). Most of the health studies conducted observed findings in line with the representation of immigrants as vulnerable groups, particularly when the outcome was self-rated health (SRH; Khlat & Guillot, 2017). The former reviewed 40 health studies and 14 mortality studies. They too spanned a long period and examined similar origin groups (Vang et al., 2017). Immigrants younger than 65 years old had similar to better health than native-born when the outcomes concerned mental health, chronic conditions, functional limitations, and risk behaviours. However, in studies with SRH outcomes, the findings were heterogeneous and varied depending on origin group and length of stay. Immigrants older than 65 years had no health advantages, and SRH was worse. For mortality, the advantage was systematic across the studies included in the review.

We also highlight a 2000s review of SRH studies among immigrants in Europe (viz., Belgium, the Netherlands, Spain, Sweden, and United Kingdom) between 2000 and 2010. The authors found most immigrants groups to be disadvantaged compared with native-born in their host country after adjusting age, gender, and socioeconomic characteristics (Nielsen & Krasnik, 2010). Additionally, a study using the Survey of Healthy Aging and Retirement in Europe demonstrated that, immigrants aged 50 years+ in 11 European countries tended to have worse health over a range of subjective and objective measures than respective native-born populations (Solé-Auró & Crimmins, 2008). They found very little evidence of a healthy immigrant effect at old ages and warned that growing numbers of immigrants may develop health issues in the future. Interestingly, around the same time, migrant mortality advantages were documented in many of the same countries included in the two studies: Belgium (Vandenheede, Willaert, Grande, Simoens, & Vanroelen, 2015), Holland (Uitenbroek, 2015), Spain (Moncho et al., 2015), France (Wallace et al., 2019), Sweden (Juárez, Drefahl, Dunlavy, & Rostila, 2018) and the United Kingdom (Wallace & Kulu, 2014b).

2.2 | Potential explanations

2.2.1 | Data artefacts

Some of the articles cited above were reviews of the literature covering findings from separate studies that differ in terms of the dataset used, the outcomes and explanatory covariates, and period, cohort, and age parameters. Thus, it could be that the paradox is generated by not comparing the same risk populations, a point raised by Vang et al. (2017). Of course, data artefacts still arise when analysing the same risk population. For example, we must be wary of the size of our study windows. Too short, and we may fail to capture mortality increases from changes in health (Kouris-Blazos, 2002); too long, and our mortality estimates become subject to censoring bias (Wallace & Kulu, 2014b). An example of the former is a French study that found low mortality among Moroccan men despite their high smoking rates (Khlat & Courbage, 1996). The study concluded that changes in smoking habits were too recent to have affected their death rates. Censoring bias, meanwhile, refers to the bias introduced into mortality rates by unregistered emigration. With no evidence of departure, we assume that some people remain resident and continue to include them in analyses, even after they have left and even died elsewhere (Wallace & Kulu, 2014b). The longer the risk period is, the larger the bias becomes.

2.2.2 | In-selection effects

This explanation refers to the idea that immigrants are not reflective of the population that they leave behind. Rather, they are positively selected directly on their good health and mortality and indirectly on factors linked to good health and lower mortality, such as education. In general, selection effects are said to be strongest just after immigrants arrive and wear off over time due to the diminishing influence of selection, accelerated by their negative health exposures (e.g., discrimination and adverse living conditions) in the host country (Guillot et al., 2018). Under this explanation, poor health and lower mortality could coexist, as the negative health exposures would have to fully erode the initial additional survival advantage generated by selection before the excess mortality emerged.

2.2.3 | Cultural factors

In the case of Greeks in Australia, most of the debate focused around protective cultural factors as an explanation for the paradox, with the idea that Greeks continued to eat large amounts of protective foods that may have helped nullify other cardiovascular (CVD) risk factors and reduce the risk of mortality (Kouris-Blazos,-2002). Kouris-Blazos and Itsiopoulos (2014) later focus in on this protective effect, arguing that Greeks mitigate other CVD risk factors because of their adherence to a Mediterranean diet and the consumption of legumes. They argue that this type of diet is working to reduce the risk of death and counteract established CVD risk factors by beneficially altering gut microbiome and its metabolites. If cultural factors were the primary explanation of this paradox, then we might only expect to find it among those immigrant groups with similarly protective behaviours (such as diet, particularly low smoking, and alcohol consumption). If this were the case, it would also be unlikely that the paradox would present systematically across groups.

Another cultural explanation relates to variation in how different groups evaluate their health. Most of the review papers cited earlier involved studies of SRH. When interpreting SRH differences, we need to consider factors such as who the frame of reference is (e.g., other immigrant groups, native-born in the host country, or the origin country), health norms in the origin country, the stigma of illness, and how the severity of different illnesses are perceived (Berchet & Jusot, 2010). In the United Kingdom, Chandola and Jenkinson (2000) found that poor SRH was associated with greater morbidity across ethnic groups, with little evidence that the association differed across groups. However, Woo and Zajacova (2017) found that SRH did not predict mortality as well for Hispanic and Black populations in the United States as for non-Hispanic Whites, even after adjusting for socio-economic status, migrant status, and cause of death. Similarly, Assari, Lankarani, and Burgard (2016) found that SRH continued to predict mortality among White, but not Black, men and women after having adjusted for chronic medical conditions. We should question whether these findings can be applied to other national contexts but acknowledge that certain subgroups may assess their health differently to others. Given that our health outcome is self-reported limiting long-term illness (LLTI), we will evaluate our findings with care.

2.2.4 | Out-selection (salmon bias) effects

One final explanation for the existence of a genuine migrant health-mortality paradox concerns return migration. When exits from the host country are motivated directly by poor health and a desire to die in familiar surroundings under the care of relatives by returning to their place of birth, then this is known as the salmon bias effect (Wallace & Kulu, 2014a). Here, we could envisage a scenario in which the poor health status of immigrants who ultimately return to their origin country is *included* in calculations of health, but their deaths are *excluded* from calculations of mortality (through merit of having emigrated). Combined, these processes would serve to lower the overall health of immigrants relative to the native-born *and* inflate their relative migrant mortality advantage.

2.3 | Summary and study objectives

Although the body of work on the migrant health mortality paradox remains small, the evidence does consistently point to a combination of lower mortality yet poorer health among international immigrants. The studies from Cezard (2020) on ethnic minority groups in Scotland and Reus-Pons et al. (2017) on western vs. non-western immigrants in England and Wales are of particular interest here, as they suggest that we are also likely to find evidence of the paradox. Presently, most previous studies have conducted macro-level analyses that do not consider the role of socio-economic characteristics in health and mortality differences between foreign- and native-born and how this might influence the paradox. In the one study that did, the paradox emerged *after* adjusting for such differences. Finally, nearly all of the studies have examined the paradox in a specific origin group. Here, we pose four research questions to complement our main aim, add to the evidence base, and help advance our understanding of this potential paradox:

1. Is the health-mortality paradox more prevalent among immigrant men or immigrant women?
2. Does the paradox present across all country and/or region of origin groups?
3. Does the paradox persist after adjusting for socio-demographic factors. Alternatively, if a paradox is not initially found, does it emerge after adjusting for socio-demographic factors?
4. Do the observed patterns give any indication as to what might explain the paradox?

3 | DATA

3.1 | The ONS LS

The Longitudinal Study (LS) links census and life event data for a representative 1% sample of the England and Wales population. It is the largest longitudinal resource available in the United Kingdom, starting in 1971 and sampling people born on one of four anonymous birth dates. The sample is dynamic, with information on existing LS members refreshed at each census (if they are present) and for life events through the National Health Service (NHS) data and civil registers. Individuals can enter into the sample between censuses through birth and immigration and can exit through death or emigration. The LS has information on over one million people spanning over 40 years.

4 | OUTCOMES

4.1 | Limiting long-term illness

We use limiting LLTI to measure health status. In 1991, the question asked "Do you have any long-term illness, health problem or handicap which limits your daily activities or the work you can do?" In 2001, the question asked "do you have any long-term illness, health problem, or disability which limits your daily activities or the work you can do?" Respondents could answer "yes" or "no". A 2012 study of LLTI using two nationally representative cohorts aged 40–59 examined differences in LLTI between 1991 and 2001 for major ethnic groups in the United Kingdom. Smith and Grundy (2011) documented a higher prevalence of LLTI across all groups in 2001 compared with 1991, which was largest in Pakistani and Bangladeshis and smallest in the Black African and Chinese groups. The authors cautiously attributed the increased prevalence to a change in the wording of the question between censuses. They found the variation in increased prevalence harder to explain but suggested that cultural variation in the interpretation of LLTI and the inability of the socioeconomic variables used to capture the material disadvantage (that might lead directly to the symptoms of an LLTI) could be responsible. Such findings are relevant here, and so we account for this issue explicitly in our study design.

4.2 | All-cause mortality

Mortality is captured through NHS registration systems and civil registers. The quality of the mortality data in the LS is known to be very high. Virtually all deaths taking place in England and Wales are recorded, as this is required by law. However, the recording of a death may be delayed, but not missed, if an inquest is required or if the death was abroad (Shelton et al., 2019). Wallace and Kulu (2014b) have compared the LS with the Human Mortality Database and found it to be representative in terms of mortality by age, sex, and period. Further, for the larger immigrant groups in England and Wales, all-cause and cause-specific mortality for the 1971 cohort has been shown to be similar to mortality in the full cross-sectional data (Harding & Balarajan, 2002). No recent checks on the representativeness of migrant mortality rates in the LS data are currently available.

5 | EXPLANATORY COVARIATES

We define immigrants by country of birth, into the categories (i) India, (ii) Pakistan & Bangladesh (iii) the Caribbean (iv) Sub-Saharan Africa (v) Europe (European Union [EU]) (vi) Europe (non-Europe) (vii) Ireland (viii) United States, Canada, Australia & New Zealand, and (ix) Rest of the World. The choice of categories reflects the immigration history of Great Britain post-World War II. Some countries are grouped into broader regions as we lack the sample size to be able to analyse them independently. However, when grouping countries, we have taken characteristics such as geographic proximity and language into account to *maximise* subpopulation sample size and *minimise* the heterogeneity introduced by grouping different countries together. We also have detailed information on age, sex, and marital status all of which are derived from the censuses. Age is coded in 5 year groups from 20 to 85+. Marital status is coded as one of: single, married, divorced, or widowed.

We used two variables to measure individual socioeconomic background: education level and Carstairs deprivation index. The former is coded to "degree level +" and "less than degree". The inability to provide a more detailed categorisation is restricted by the way in which the census question was first worded in 1991 ("Have you obtained any qualifications *after reaching the age of 18*?"). The latter is a socio-spatial index that captures material deprivation in small areas. Specifically, Carstairs represents an unweighted combination of four aspects: unemployment, overcrowding, car ownership, and low social class. Although it represents an average value for all individuals living in a ward, which would contain households or individuals with deprivation that differ from the average, it has performed well when used to explain variation in health, and it is often used to illustrate inequalities (Morgan & Baker, 2006). Carstairs is split into quintiles from the least to the most deprived. We selected these two variables because they complement each other well, capturing different aspects of one's socioeconomic background. To elaborate, education level represents the more abstract knowledge and skills of individuals, while Carstairs capture the more tangible material conditions that people live in.

6 | SAMPLE

For the first time period that we analyse (1991–2001), only people enumerated at the 1991 Census are eligible for analysis; they are included in the cross-sectional health analysis and enter into the longitudinal mortality analysis from the date of the 1991 Census (April 21, 1991). For the second period that we analyse (2001–2011), only those enumerated at the 2001 Census are eligible for analysis; they are included in the cross-sectional health analysis and enter into the longitudinal mortality analysis from the date of the 2001 Census (April 29, 2001). For the mortality analysis, we do not allow individuals to enter between censuses. Although we can identify entry between census years through NHS registration, we lack information on the sociodemographic characteristics of new arrivals until they fill in a census form, a process contingent upon individuals remaining alive between arrival and the next census. People exit the mortality analysis by dying or reaching the end of a study period, signified by being enumerated at the next census. For the first period, this would be April 29, 2001; for the second period, this would be March 27, 2011.

In line with the recommendation of a study on censoring bias (Wallace & Kulu, 2014b), we exit people midway through a period if evidence suggests that they have made an unregistered emigration. There are two conditions for this: (i) not appearing at the next census and (ii) not recording life events after the date of the next census. We exit people with registered exits in the given year. This ensures that the bias induced by censoring bias on immigrant mortality patterns is

TABLE 1 Sample sizes and descriptives of outcomes and explanatory variables, females

Female	Engl & Wales		Ireland		US...NZ		Eur (EU)		Eur (nEU)		India		Pak Bang		Caribbean		SS Africa		Rest of the World	
	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
Deaths	26,832	21,882	490	456	97	82	235	253	244	210	199	264	49	94	105	94	84	102	162	214
PY 00s	17,135	16,592	285	232	101	128	220	262	125	158	278	326	169	271	104	97	172	273	282	384
% age																				
20–39	36	32	23	16	51	52	34	39	18	36	42	26	62	50	26	11	60	43	49	35
40–64	38	43	49	47	31	36	45	35	44	33	46	57	36	44	61	63	34	49	40	51
65+	26	25	28	37	17	13	21	25	38	31	11	18	2	6	13	26	6	7	12	14
% with LLTI																				
20–39	4	8	2	6	2	4	3	7	5	8	5	7	7	10	4	6	5	7	3	6
40–64	14	21	16	25	9	12	13	18	16	23	21	31	23	42	25	31	17	21	13	19
65+	45	52	40	50	34	45	38	46	47	56	47	63	44	66	47	63	43	53	38	54
% having died																				
20–39	1	1	0	1	1	0	0	1	0	0	1	0	1	0	3	1	1	1	0	1
40–64	7	5	8	8	6	3	6	4	7	3	5	4	4	4	8	4	5	3	4	3
65+	51	44	49	43	44	41	40	33	45	41	41	34	31	25	41	29	48	27	34	30
% with degree																				
20–39	14	18	23	37	34	56	20	44	14	42	9	28	2	10	16	27	22	35	22	39
40–64	11	17	14	21	34	54	13	31	17	36	9	20	3	9	17	31	18	30	19	32
65+	4	5	10	9	14	13	4	9	4	9	8	7	5	5	3	7	13	12	7	9
% deprived																				
20–39	40	40	52	49	36	45	37	46	49	54	72	72	85	86	73	65	56	62	47	52
40–64	33	32	51	48	27	28	34	32	34	41	64	68	80	83	76	75	54	57	44	48
65+	37	34	47	50	21	24	36	36	38	39	48	59	56	76	83	87	25	49	41	48
% not married																				
20–39	42	56	54	57	45	52	45	60	22	39	10	12	11	13	60	54	32	46	27	33
40–64	22	29	28	38	26	27	20	33	26	32	16	18	15	24	41	57	24	31	24	27
65+	62	58	64	65	56	60	55	50	59	67	63	58	56	43	54	62	61	56	58	60

Note. Ages broadly equate to "peak migration" (20–39), "upper working" (40–64), and "retirement" (65+) ages; % deprived refers to proportion living in more to most deprived areas, that is, quintiles four and five of the Carstairs deprivation index score; and % not married refers to proportion who are single, divorced, or widowed. Source: authors' own calculations based upon the Office for National Statistics Longitudinal Study (ONS LS)

Abbreviations: EU, European Union; LLTI, limiting long-term illness.

TABLE 2 Sample sizes and descriptives of outcomes and explanatory variables, males

Male	Engl & Wales		Ireland		US…NZ		Eur (EU)		Eur (nEU)		India		Pak Bang		Caribbean		SS Africa		Rest World	
	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001	1991	2001
Deaths	23,686	19,694	500	391	93	86	149	128	403	297	294	321	134	154	132	112	87	135	205	233
PY 00s	15,410	15,222	244	184	80	98	141	176	126	119	286	310	196	292	100	84	166	246	269	349
% age																				
20–39	39	34	22	16	50	49	42	45	13	31	34	20	51	43	21	10	56	41	46	37
40–64	42	46	55	51	32	36	43	41	30	26	55	59	45	46	64	59	40	52	45	50
65+	19	20	24	33	17	15	14	14	56	43	11	20	4	11	15	31	4	7	9	13
% with LLTI																				
20–39	5	9	5	9	3	5	4	8	5	8	5	4	7	8	6	8	3	5	4	7
40–64	16	21	21	28	10	9	12	16	24	22	18	25	29	35	21	23	11	18	13	19
65+	42	49	38	45	30	41	36	46	37	55	41	53	39	58	39	48	42	48	43	49
% having died																				
20–39	1	1	1	2	0	0	1	1	2	1	2	1	1	0	3	1	1	1	1	1
40–64	10	7	14	11	10	2	9	4	16	6	9	6	11	5	10	6	7	5	7	4
65+	57	47	57	49	52	53	48	39	50	55	46	35	40	28	42	31	46	37	45	35
% with degree																				
20–39	16	18	19	39	33	54	17	40	14	27	11	39	7	16	13	17	28	39	26	36
40–64	15	18	5	14	33	59	12	25	14	28	17	29	7	16	4	13	23	39	24	36
65+	8	8	5	4	12	19	9	13	6	6	8	20	8	8	2	8	13	16	13	14
% deprived																				
20–39	40	39	57	48	35	48	43	44	66	63	73	71	83	85	68	67	56	58	48	59
40–64	33	32	54	49	27	29	37	34	51	56	61	67	80	80	79	78	56	56	47	48
65+	36	32	55	53	29	27	34	37	48	48	62	61	75	82	82	78	52	56	52	55
% not married																				
20–39	51	62	50	58	48	52	49	62	30	36	14	19	14	13	54	49	36	45	38	41
40–64	19	27	26	32	20	29	15	28	23	24	7	9	5	7	33	45	14	19	12	20
65+	28	29	31	34	22	26	20	23	29	29	22	19	16	15	44	42	25	25	26	23

Note. Ages broadly equate to "peak migration" (20–39), "upper working" (40–64), and "retirement" (65+) ages; % deprived refers to proportion living in more to most deprived areas, that is, quintiles four and five of the Carstairs deprivation index score; and % not married refers to proportion who are single, divorced, or widowed. Source: authors' own calculations based upon the Office for National Statistics Longitudinal Study (ONS LS)

Abbreviations: EU, European Union; LLTI, limiting long-term illness.

limited. We split analyses into two periods to acknowledge the change in definition of LLTI between censuses (Smith & Grundy, 2011) and also to understand whether migrant health and mortality varies over time. For mortality, which is unaffected by this definitional change, we also fit a longer model from 1991 to 2011. We only study adults age 20+ because of the small number of child migrants in the LS and because the risk of poor health and death is very low at these ages.

"Unlinked" LS members are excluded from our analyses (i.e., an LS member who cannot be found on the NHS registration systems). Although we have census data for these people (~7,800; 1.2%), we do not have information on their life events. Previous studies by the Office for National Statistics (ONS) find that this group is selective. Unlinked LS members are more likely to be young adults, born outside of the United Kingdom, living in a communal establishment, and living in London (Lynch, Leib, Warren, Rogers, & Buxton, 2015). We remove LS members tagged as having moved to Scotland (~220; 0.03%). Tables 1 (females) and 2 (males) provide summary data on our groups according to the outcomes and explanatory covariates. In period one, we investigate health and mortality among 170,185 men and 188,709 women. In period two, we investigate health and mortality among 170,719 men and 188,226 women.

7 | METHODS

7.1 | Logistic regression

To capture the health status of immigrants and native-born at baseline, we use logistic regression to estimate the odds of having an LLTI for immigrants as compared with native-born at the 1991 and 2001 Censuses. This model is specified as follows:

$$ln\frac{p(Y_i=1)}{1-p(Y_i=1)} = \propto + \sum_k \beta_k x_{ik},$$

where $p(Y_i = 1)$ is the probability of suffering from an LLTI for individual i,$\propto$ is a constant, and x_{ik} is the value of the vector of explanatory variables for individual i, with k variables.

7.2 | Discrete-time survival analysis

To determine the mortality of immigrants as compared with native-born, we use survival analysis. Specifically, we fit discrete-time survival models that treat time as being divided into discrete units and refer to the conditional probability of experiencing an event given survival to that point. Here, we refer to the conditional probability of a person dying over the course of a specified period relative to being alive and censored at the end of it. We fit models using logistic regression on a set of pseudo-observations. For example, suppose person i dies or is censored at time point $t_{j(i)}$; we generate death indicator $d_{ij} = 1$ if person i dies at time j and $d_{ij} = 0$ if not. We do this for each time point, creating one per year from 1991 (t_1) to 2011 $t_{j(i)}$. We assign a copy of covariate vector xi and a label j to the time indicators. We then adjust for time. For the period analyses, we just drop time points relating to the other period. The model is specified as:

$$logit\lambda(t_j|x_i) = \alpha_j + xb,$$

in which $\alpha_j = logit\lambda_0(t_j)$ is the logit of the baseline hazard and $x_i'\beta$ represents the effect of the covariates on the baseline hazard. The model treats time as a discrete factor by introducing a parameter $\propto_j$. for each time of event t_j. Interpretation of parameters β associated with other explanatory variables follows along the same lines as the logistic regression (i.e., odds ratios [ORs] above 1 would represent excess mortality and ORs below 1 would represent a mortality advantage).

7.3 | Analytical strategy

We fit three models per outcome separately by sex, a baseline model (Model 1), an intermediate model (Model 2), and a final model that formally brings our outcomes together (Model 3). In the baseline model, we only adjust for two explanatory variables: age and origin group. For mortality, we also adjust for time. In the intermediate model (Model 2), we further adjust marital status, education level, and Carstairs deprivation index. This model improves upon the baseline model by telling us whether the initial effect of origin group on health and mortality persists *net* of compositional differences in background factors that affect health and mortality, factors that might affect the two outcomes differentially. ORs for origin group from the baseline and final model are shown in Tables 3 (women) and 4 (men), with the full models found in the supplementary materials. In the final model (Model 3), we include LLTI as an explanatory variable in our all-cause mortality models and specify an interaction between LLTI and origin group. From this, we calculate predicted probabilities of death for each origin group by LLTI status.

8 | RESULTS

Tables 1 (females) and 2 (males) provide information on sample sizes, outcomes, and explanatory variables by country of origin group and time period. Specifically, we show person-years (PYs in hundreds of years), the age distribution (for peak migration [20–40], upper working [40–65] and retirement [65+] age groups) and proportion within each age group that: reported an LLTI, died, obtained a degree, were living in deprived areas, and not married. Expectedly, the age structure of the immigrant groups is younger than native-born, notably immigrants from Pakistan and Bangladesh and Sub-Saharan Africa. Exceptions are immigrants from Ireland and the Caribbean who have older age distributions than native-born that also shift up across the two time periods.

For LLTI, we observe a systematic increase in proportions of LLTI between periods for all origins and ages, consistent with (Smith & Grundy, 2011). As for specific regions, larger proportions of men and

TABLE 3 Odds ratios for limiting long-term illness and all-cause mortality among immigrants relative to England and Wales-born, women

Female	LLTI 1991		Mortality 1991–2001		LLTI 2001		Mortality 2001–2011		Mortality 1991–2011	
	OR	95% CIs	OR	95% CIs	OR	95% CIs	OR	95% CIs	OR	95% CIs
Reference group = born in England and Wales										
Model 1 (baseline)										
Ireland	0.99	0.89–**1.09**	1.05	0.96–1.16	1.01	0.91–1.11	**1.12**	1.02–1.23*	**1.09**	1.02–1.16*
US…NZ	**0.64**	0.51–0.81**	0.93	0.76–1.14	**0.57**	0.48–0.69**	0.87	0.70–1.08	0.91	0.78–1.05
Europe (EU)	**0.87**	0.77–0.99*	0.88	0.77–1.01†	**0.85**	0.77–0.94**	**0.86**	0.76–0.98*	**0.87**	0.80–0.96**
Europe (nEU)	1.13	0.98–1.30†	0.92	0.81–1.04	1.11	0.98–1.26†	0.89	0.78–1.03	**0.91**	0.83–1.00*
India ✓	**1.53**	1.37–1.70**	0.90	0.78–1.04	**1.59**	1.46–1.72**	**0.88**	0.77–0.99*	**0.88**	0.81–0.97**
Pak & Bang ✓	**1.88**	1.62–2.18**	0.91	0.68–1.21	**2.34**	2.14–2.56**	0.88	0.72–1.09	**0.88**	0.67–0.94**
Caribbean ✓	**1.77**	1.52–2.07**	1.11	0.91–1.34	**1.67**	1.45–1.92**	0.83	0.67–1.02†	0.95	0.83–1.10
SS Africa✓	**1.31**	1.11–1.54**	1.00	0.81–1.25	1.10	0.99–1.22†	**0.81**	0.67–0.99*	0.88	0.76–1.02†
Rest of World	0.90	0.79–1.02†	**0.73**	0.63–0.86**	0.97	0.89–1.06	**0.71**	0.62–0.81**	**0.72**	0.65–0.80**
Model 2 (intermediate)										
Ireland	**0.90**	0.81–0.99*	1.03	0.94–1.13	**0.89**	0.81–0.99*	1.08	0.98–1.19	1.06	0.99–1.13†
US…NZ	**0.71**	0.56–0.90**	1.00	0.81–1.23	**0.66**	0.54–0.79**	0.92	0.74–1.15	0.97	0.83–1.13
Europe (EU)	0.88	0.78–1.01†	0.88	0.77–1.01†	**0.87**	0.79–0.97**	0.88	0.77–1.00†	**0.88**	0.80–0.96**
Europe (nEU)	1.13	0.98–1.31†	0.92	0.81–1.05	1.10	0.97–1.25	0.88	0.77–1.01†	**0.91**	0.82–1.00*
India ✓	**1.40**	1.25–1.56**	0.88	0.76–1.01†	**1.41**	1.29–1.53**	**0.85**	0.75–0.96**	**0.86**	0.78–0.94**
Pak & Bang ✓	**1.59**	1.37–1.85**	0.86	0.65–1.14	**1.87**	1.70–2.05**	**0.78**	0.63–0.97†	**0.80**	0.65–0.95**
Caribbean ✓	**1.28**	1.10–1.51**	1.00	0.82–1.21	**1.21**	1.05–1.40**	**0.73**	0.59–0.90**	**0.85**	0.74–0.98**
SS Africa	**1.26**	1.07–1.48**	1.00	0.80–1.25	0.99	0.89–1.10	**0.79**	0.65–0.96*	**0.86**	0.74–1.00*
Rest of World	**0.87**	0.77–1.00*	**0.73**	0.62–0.86**	0.94	0.86–1.03	**0.69**	0.60–0.80**	**0.71**	0.64–0.79**

Note. Baseline model adjusts for age (ref = 40–44) and immigrant regions of origin (ref = born in England and Wales). Intermediate model additionally adjusts marital status (ref = single), education (ref = degree +) and Carstairs deprivation index (ref = least deprived). US … NZ = United States, Canada, Australia and New Zealand; Pak & Bang = Pakistan and Bangladesh. ✓ = health mortality paradox found in this group. Source: authors' own calculations based upon the Office for National Statistics Longitudinal Study (ONS LS). Bold significant are the results of 0.01* or 0.05*.

Abbreviations: CIs, confidence intervals; LLTI, limiting long-term illness; OR, odds ratio.

$^{**}p < 0.01$.

$^{*}p < 0.05$.

$^{\dagger}p < 0.10$.

women from India, Pakistan and Bangladesh, Caribbean, and Sub-Saharan Africa have an LLTI at ages 40–65 and 65+ relative to England and Wales-born. This contrasts with the lower proportions in the same groups having died. For example, the proportion of women from Pakistan and Bangladesh at ages 65+ in 2001 with an LLTI is 14 percentage points higher than the England and Wales-born, but the proportion having died is 19 percentage points lower. In general, immigrants tend to be as, if not more, highly qualified than native-born; particularly people from US … NZ, Europe (EU), and Sub-Saharan Africa. Exceptions are immigrants from India and Pakistan and Bangladesh in 1991 (with the upward shift in 2001 largely attributed to highly skilled intercensal arrivals and people who moved for education completing their studies) and Caribbean men (in 1991 and 2001). Immigrants from India, Pakistan and Bangladesh, and the Caribbean have much higher proportions across all age groups living in deprived areas. Indeed, the proportions for Pakistan and Bangladesh are more than *double* that of England and Wales-born. Finally, we find much lower proportions of immigrants from India and Pakistan and Bangladesh not married compared with other groups. Such differences demonstrate the need to adjust for these factors in the subsequent analyses.

Table 3 presents ORs for female immigrants for the baseline and intermediate models for health and mortality. In each instance, the reference is people born in England and Wales. Full tables are available in the supplementary materials (Tables S1 and S3). In the baseline models for LLTI in 1991 and 2001, we find a health disadvantage for women from India, Pakistan and Bangladesh, the Caribbean, and Sub-Saharan Africa (latter group 1991 only). For women from India, Pakistan and Bangladesh, and the Caribbean, the disadvantages are particularly pronounced (OR > 1.50). On the contrary, we observe a health advantage among women from the US … NZ and Europe (EU) in both 1991 and 2001. For Ireland, Europe (non-EU), and the Rest of the World, we do not observe any differences relative to native-born. In the intermediate model, adjusting for differences in education level, deprivation, and marital status reduces the size of observed differences, but they remain significantly different from

TABLE 4 Odds ratios for limiting long-term illness and all-cause mortality among immigrants relative to England and Wales-born, men

Male	LLTI 1991		Mortality 1991–2001		LLTI 2001		Mortality 2001–2011		Mortality 1991–2011	
	OR	95% CIs	OR	95% CIs	OR	95% CIs	OR	95% CIs	OR	95% CIs
Reference group = born in England and Wales										
Model 1 (baseline)										
Ireland	1.09	0.98–1.21	1.09	0.99–1.19†	1.04	0.94–1.16	**1.13**	1.02–1.25*	**1.11**	1.03–1.18**
US…NZ	**0.60**	0.47–0.77**	0.88	0.72–1.09	**0.53**	0.43–0.65**	0.89	0.72–1.10	0.90	0.77–1.04
Europe (EU)	**0.79**	0.67–0.94**	0.89	0.75–1.05	0.83	0.72–0.95**	**0.76**	0.64–0.91**	**0.83**	0.74–0.94**
Europe (nEU)	0.95	0.84–1.08	0.95	0.86–1.05	1.08	0.94–1.24	0.97	0.87–1.10	0.97	0.90–1.05
India ✓	**1.12**	1.01–1.25*	**0.89**	0.79–1.00*	**1.13**	1.04–1.24**	**0.83**	0.74–0.92**	**0.85**	0.79–0.92**
Pak & Bang ✓	**1.81**	1.60–2.05**	0.97	0.82–1.15	**1.72**	1.57–1.88**	**0.72**	0.61–0.85**	**0.84**	0.73–0.95**
Caribbean	1.09	0.93–1.28	0.87	0.73–1.03	1.03	0.88–1.21	**0.78**	0.65–0.95**	**0.83**	0.73–0.95**
SS Africa	**0.80**	0.67–0.96*	0.89	0.72–1.11	**0.86**	0.77–0.97*	0.86	0.73–1.03†	**0.87**	0.76–1.00*
Rest of World	0.88	0.78–1.00†	**0.79**	0.68–0.90**	**0.90**	0.82–0.98*	**0.73**	0.64–0.83**	**0.76**	0.69–0.83**
Model 2 (intermediate)										
Ireland	0.90	0.81–1.00†	1.01	0.92–1.11	**0.88**	0.79–0.98*	1.04	0.94–1.15	1.03	0.96–1.10
US…NZ	**0.68**	0.53–0.88**	0.93	0.75–1.14	**0.63**	0.51–0.78**	0.96	0.77–1.19	0.95	0.82–1.11
Europe (EU)	**0.77**	0.65–0.92**	0.89	0.75–1.05	**0.83**	0.73–0.96**	**0.77**	0.65–0.92**	**0.83**	0.74–0.94**
Europe (nEU)	**0.84**	0.73–0.96**	**0.90**	0.81–1.00*	0.99	0.86–1.14	0.95	0.84–1.07	0.93	0.86–1.01†
India	1.04	0.93–1.16	**0.86**	0.77–0.97*	1.06	0.97–1.16	**0.82**	0.73–0.92**	**0.84**	0.77–0.91**
Pak & Bang ✓	**1.52**	1.34–1.73**	0.90	0.75–1.07	**1.44**	1.31–1.58**	**0.67**	0.57–0.79**	**0.78**	0.65–0.82**
Caribbean	**0.74**	0.62–0.87**	**0.74**	0.62–0.88**	**0.68**	0.58–0.80**	**0.65**	0.54–0.79**	**0.70**	0.62–0.80**
SS Africa	**0.77**	0.64–0.93**	0.88	0.71–1.09	**0.84**	0.74–0.94**	0.86	0.72–1.02†	**0.86**	0.75–0.99*
Rest of World	**0.86**	0.75–0.98*	**0.78**	0.68–0.90**	**0.87**	0.79–0.96**	**0.72**	0.63–0.83**	**0.75**	0.68–0.83**

Note. Baseline model adjusts for age (ref = 40–44) and immigrant regions of origin (ref = born in England and Wales). Intermediate model additionally adjusts marital status (ref = single), education (ref = degree +) and Carstairs deprivation index (ref = least deprived). US … NZ = United States, Canada, Australia and New Zealand; Pak & Bang = Pakistan and Bangladesh. ✓ = health mortality paradox found in this group. Source: authors' own calculations based upon the Office for National Statistics Longitudinal Study (ONS LS). Bold significant are the results of 0.01* or 0.05*.

Abbreviations: CIs, confidence intervals; LLTI, limiting long-term illness; OR, odds ratio.

$^{**}p < 0.01$.

$^{*}p < 0.05$.

$^{\dagger}p < 0.10$.

native-born. Moreover, a small health advantage emerges among women from Ireland in 1991 and 2001. In both periods, we find a consistency in the direction and the magnitude of ORs for LLTI according to region of origin.

In the baseline model for mortality, women from India, Pakistan and Bangladesh, Sub-Saharan Africa, and the Caribbean do not have an excess mortality compared with native-born *despite* their considerable health disadvantages in 1991 and 2001. Indeed, these groups have similar mortality to the native-born from 1991 to 2001 and, paradoxically, experience mortality advantages over them in 2001 to 2011 (some of which only emerge in the intermediate model after adjusting for differences in education, deprivation, and marital status). In the 20-year follow-up, all of these groups have a mortality advantage over native-born. Perhaps as paradoxical, despite recording sizeable health advantages over the native-born, women from the US … NZ only ever experience comparable mortality with them. Similarly, the small health advantages found among women from Ireland in the intermediate model do not translate into a mortality advantage. The ORs that we find for LLTI and mortality for the group Europe (EU) are strikingly consistent over time.

Table 4 presents ORs for men in the same way as for women, with full models available in the supplementary materials (Tables S2 and S4). We observe consistency between 1991 and 2001 in not only the direction but also in the magnitude of differences between immigrants and native-born. In both periods, we observe a health disadvantage among men from India and Pakistan and Bangladesh, which is fully attenuated in the intermediate model for the former group but not latter group. Conversely, we find health advantages among men from the US … NZ, Sub-Saharan Africa, Europe (EU), the Rest of the World and, after having adjusted individual differences in education level, deprivation, and marital status, the Caribbean and Ireland. The sizeable health advantage of Caribbean and Sub-Saharan African men contrasts with that of women from the same origin regions. More generally, in the context of the LLTI results among women, the observation of a health disadvantage is less pervasive for men and more often explained in the intermediate model.

In line with the health and mortality patterns of female immigrants, men from India and Pakistan and Bangladesh, despite experiencing health disadvantages at the start of the periods, paradoxically hold a mortality advantage over the England and Wales-born in 1991–2001, 2001–2011 and 1991–2011. Again, a health disadvantage does not translate into excess mortality. Also like women, men from US … NZ only have similar mortality to the England and Wales-born in both periods despite experiencing substantial health advantages over them in 1991 and 2001. Nonetheless, for the remaining immigrant groups, we observe a much greater consistency in health and mortality for male immigrants than we do for females. In both periods, the direction and magnitude of health and mortality differences for males (after adjusting for differences in education level, deprivation, and marital status) from the Caribbean, Sub-Saharan Africa, Europe (EU), Europe (non-EU), and Rest of the World are similar even if in some cases ORs are not significantly different.

In the final model, we study the links between health, mortality, and immigrant origins more formally. We do this by fitting an extension of the intermediate model (Model 2) that includes LLTI as an explanatory variable and interacts LLTI with country of origin group (Model 3). This allows us to compare mortality risk within health groups (i.e., no LLTI: India vs. native-born, LLTI: India vs. native-born) *and* country of origin groups (i.e., India: LLTI vs. no LLTI). This will yield more insight into possible explanations of the paradox. Predicted probabilities of death for country of origin by LLTI are in Figure 1. The full models are available in the supplementary materials for women and men in Table S5; the values behind the predicted probabilities in Figure 1 are available in the supplementary materials Table S6.

From Figure 1, we can identify several patterns. First, when comparing *within* the country of origin groups (i.e., vertically from square to circle), the predicted probabilities of death are systematically higher among the subgroup with an LLTI, in several cases more so among immigrants than native-born (see US … NZ across all time periods, e.g.). Second, when comparing across country of origin groups (i.e., horizontally from square to square, or circle to circle), we tend to see migrant mortality advantages in both the no LLTI and yes LLTI subgroups for many immigrant groups. This is reassuring, as it shows that the overall mortality advantage in previous models is not concentrated within a specific subgroup (especially the "yes" category which, in turn, would suggest some artefactual explanation). A good example of this is men from India. Their predicted probability of death is lower for the LLTI group (vs. the LLTI England and Wales-born) *and* the no LLTI group (vs. the no LLTI England and Wales-born) across all periods. However, we do note a change between 1991 and 2001 among women in LLTI subgroup. In the first period, immigrant women with an LLTI have a predicted probability of death similar to England and Wales-born. Conversely, in the second period, most female LLTI subgroups are now advantaged relative to LLTI England and Wales-born women but at least remain disadvantaged relative to women from the same origin country group without LLTI.

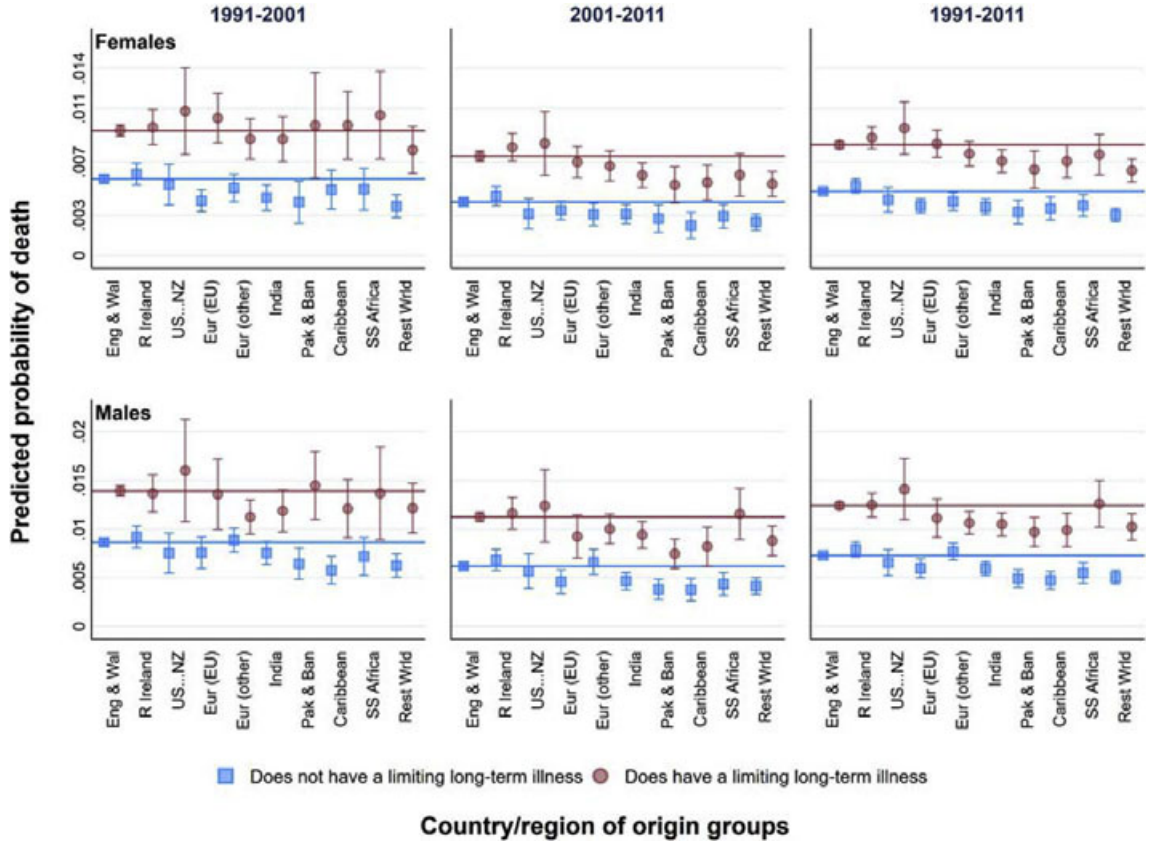

FIGURE 1 Predicted probabilities of death for immigrants by limiting long-term illness (LLTI) status from final model (Model 3). Source: authors' own calculations based upon the Office for National Statistics Longitudinal Study (ONS LS)

9 | DISCUSSION

Here, we have focused on the migrant health-mortality paradox in England and Wales, with the aim of determining how prevalent the combination of poorer health and lower mortality, was among major immigrant groups. The research was prompted by a small body of evidence on the paradox among Greeks and Italians in Australia (Kouris-Blazos, 2002; Kouris-Blazos & Itsiopoulos, 2014; Stanaway et al., 2020), Turks in Germany (Carnein et al., 2014), Indian and Pakistani ethnic groups in Scotland (Cezard, 2020; Cezard et al., 2020), and non-western immigrants in the Netherlands, Belgium and the United Kingdom (Reus-Pons et al., 2017). The major strengths of this study included the use of large-scale longitudinal data permitting a micro-level analysis of linked health and mortality outcomes for the same individuals, the inclusion of a large and diverse range of origin groups, a consideration of the role of socioeconomic characteristics in the paradox, and a formal investigation of the relationship between health status and mortality among immigrants.

To help achieve our aim, we posed four research questions. First, we asked whether we would find differences in the paradox between men and women; we found it to be more prevalent among women. This result mirrors the well-known gender paradox in health and mortality for which there is still no conclusive understanding (Di Lego, Di Giulio, & Luy, 2020). The body of work is dictated by two explanations. First, a combination of biological and social factors; women suffer from a greater number of conditions than men, but these conditions are less lethal (Di Lego et al., 2020). Second, that excess female morbidity is a consequence of reporting in survey data and differences in health that reflect subjective rather than objective differences. Given the overlap of these explanations with the ones proposed in the immigrant paradox literature, we wonder whether future work would benefit from leaning more explicitly into the longstanding gender paradox framework. Simultaneously, we are aware that although in the gender paradox literature there is a concrete understanding of what explains mortality differences between men and women, paradox aside, we are still trying to understand why immigrants have lower mortality than the native-born do.

Second, we asked whether the paradox would present across all immigrant groups. The paradox did not present in every origin group; it was concentrated among immigrants from India, Pakistan and Bangladesh, the Caribbean, and Sub-Saharan Africa (or more broadly low & middle-income groups). The paradox was not found among immigrants from Europe (EU), Europe (non-EU), the United States, Canada, Australia and New Zealand, and Ireland (or more broadly high-income origin groups). Such a finding is consistent with previous research that has found a paradox among Indian and Pakistani ethnic groups in Scotland (Cezard, 2020; Cezard et al., 2020), among non-western immigrants living in England and Wales (Reus-Pons et al., 2017), and Turks in Germany (Carnein et al., 2014). Although this suggests that the paradox is largely a feature of origin groups from lower & middle-income countries, we should be aware that the paradox has also been observed among Greeks and Italians in Australia (Kouris-Blazos, 2002; Kouris-Blazos & Itsiopoulos, 2014; Stanaway et al., 2020), both high-income to high-income migrant streams.

Third, for the groups in which we initially observed the paradox, we asked whether it would persist after adjusting for socio-economic factors that might explain health and mortality differences. Furthermore, we asked—in line with Stanaway et al. (2020)—whether the paradox would emerge among groups after adjusting for socio-economic factors, as it had among Italian men in Australia. We found that even after adjusting for differences in education level, deprivation, and marital status, a paradox persisted among men and women from Pakistan and Bangladesh and women from India and the Caribbean. For the groups in which the paradox disappeared, adjusting for socio-economic differences attenuated the initially higher ORs of LLTI, rather than explaining their lower mortality. We found no instances in which a paradox emerged in groups after adjusting for socio-economic factors.

In the final research question, we asked whether the patterns that we observed would give any indication as to what might explain the paradox. We believe that we can rule out many artefactual causes. Initially, the fact that we make comparisons using the same data for the same risk population rules out the idea that differences are generated by comparing work from previous studies. We also do not think that censoring bias can explain our findings. We accounted for unregistered emigration with a method devised by Wallace and Kulu (2014b) especially for the ONS LS, which identifies individuals who have made unregistered departures from England and Wales and exits them from risk. In their study, the effect of censoring bias on immigrant mortality was small, including for the same origin groups in which we found the health-mortality paradox (Wallace & Kulu, 2014b). Lastly, we believe that our study window was large enough to capture mortality given changes in health. We tracked individuals for 10 years in two different periods and fitted a longer model in which we tracked the mortality of groups for two decades. Previous work has found that, of those who reported LLTIs at census t, 37% died by census $t + 1$ (Norman & Bambra, 2007), a share that would only rise over the 20-year period mortality model that we fitted.

Regarding the causes of a genuine paradox, we do not think that the salmon bias effect can explain our results either. The core premise of this explanation is that the mortality advantage is generated entirely by the negative out-selection effect of ill people who return to their origin country to die. If this was the case, then in our final model (Model 3; Figure 1), we would only expect to see a mortality advantage among those immigrant subgroups who report an LLTI, who form part of the risk set liable to return to the origin country. However, we clearly see mortality advantages in subgroups from India, Pakistan and Bangladesh, and Caribbean that do not report an LLTI. Although previous research has found some evidence of a salmon bias effect among these three groups in England and Wales, the bias induced into their mortality rates was shown to be far too small to be able to explain their mortality advantage (Wallace & Kulu, 2018).

On the other hand, it *is* possible that our findings can be explained by selection. Model 3 (Figure 1) shows that even when

immigrants have an LLTI, they retain their mortality advantage relative native-born (with an LLTI). Additionally, the size of this advantage seems somewhat consistent with the advantage that immigrants without an LLTI have over native-born (without an LLTI). Under a selection framework, we could interpret this in two ways. First, at the *onset* of the LLTI, the chance of survival from the disease is the same for immigrants as native-born. However, the relative *overall* mortality risk of immigrants at the onset of LLTI is lower due to the presence of residual selection effects. Second, the similar conditions that lead to the onset of the same illnesses for immigrants and native-born mean that these groups have the same overall mortality risk at the onset of an LLTI. However, due to their selection, immigrants cope better as the LLTI develops and have a better chance of survival. Previous work shows that South Asians, once diagnosed with diabetes, CVDs or renal disease, survive longer than the White native-born population diagnosed with the same diseases, which feeds into this selection narrative (Bansal et al., 2013; Davis, Coleman, & Holman, 2014; Mathur, Dreyer, Yaqoob, & Hull, 2018). Further research with more appropriate data would be required in order to test these two hypotheses.

Broadly, cultural factors could also help us to explain the paradox. Specifically, the idea that changes in the health behaviours of immigrants—from those associated with the origin country to those of the host country—increases the risk of developing diseases to which they are susceptible (Spallek, Zeeb, & Razum, 2011). Considering the groups in which we find the paradox, and that it is more prevalent among women, one example might be diabetes. Previous research has found that South Asians and Afro-Caribbeans (notably women) have at least twice the risk of developing type 2 diabetes as the White British-born do. This is attributed, in part, to the idea that South Asians and Afro-Caribbeans have genes promoting carrying of excess fat and increased insulin resistance (Bhopal et al., 1999; Patel & Bhopal, 2007; Tillin et al., 2013) and to the idea that their risk is accelerated by adapting to a "western" lifestyle, which includes risk factors for diabetes (Spallek et al., 2011; Vandenheede et al., 2012). Taking inspiration from one of core explanations of the gender paradox, it could be that certain immigrant groups suffer from a greater number of conditions that than their native-born counterparts but that the conditions are less lethal. Future research could investigate this, making use of data with more fine-grained health information behind the reporting of an LLTI and on specific causes of death of immigrants and native-born.

Last of all, we think it is unlikely that our results are generated by variations in how immigrants from Indian, Pakistan and Bangladesh, and the Caribbean evaluate their own health. The results from Model 3 (Figure 1) are reassuring in that mortality in the three groups is always higher when an LLTI is reported than when it is not. Moreover, the size of the relative mortality difference in the no LLTI versus LLTI subgroups for these groups is at least as big as they are for native-born. Overall, the link between LLTI and mortality appears to be quite stable across all groups. This is in line with previous UK research that finds Indians, Pakistanis, Bangladeshis, and Caribbeans evaluate their health in a similar way to native-born (Chandola & Jenkinson, 2000). Nevertheless, it would only add to the small evidence base if future research were to look to investigate more objective health outcomes among immigrants, which is certainly something we encourage.

There are limitations to this study, which offer opportunities for further research. First, we combined many individual origin countries into broad country groups. Sample-size permitting, it would have been valuable to analyse the United Kingdom's immigrant populations to the full extent of their heterogeneity, rather than masking possible differences within these group averages. Second, we lacked detail in our education level variable. This was unavoidable and a direct result of the way the question was worded at the 1991 Census. Nonetheless, this meant that we had to combine a large and heterogeneous part of the educational distribution in which health and mortality undeniably vary. Last, and most important, we made the assumption (driven by the limits of the data) that individuals who belonged to a "yes" or "no" LLTI group at the start of a risk period, belonged to the same group 10 years later. Of course, health is dynamic and changes over time. On the one hand, we might have some people who suffer from an LLTI at the start of a period but not the end of it. More likely, we have people who answer no to this question at the start of a period but develop an LLTI at some point *during* the risk period.

Overall, we have found evidence of poor health coexisting with lower mortality among several immigrant groups in England and Wales. These findings reflect recent work on health, mortality, and ethnicity in Scotland, in which a similar paradox is found among women who have Indian, Pakistani and Bangladeshi ancestry (Cezard, 2020; Cezard et al., 2020), and more broadly, among "non-western" immigrants in England and Wales (Reus-Pons et al., 2017). Together, these findings form a convincing body of evidence suggest a need for UK-wide action. We recommend that national decision makers react to find out more about why certain groups are living longer in worse health and try to ensure that policies are employed to help preserve health and delay the onset of LLTIs and, thus, the emergence of a health mortality paradox. That similar outcomes have been found among immigrant groups in several other EU countries that include Germany (Carnein et al., 2014), the Netherlands, and Belgium (Reus-Pons et al., 2017) suggest the potential for EU-wide coordination on the issue of migration and health, an issue fast moving up the global agenda (Abubakar et al., 2018; Rechel et al., 2013).

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