

# An investigation of the healthy migrant hypothesis: Pre-emigration characteristics of those in the British 1946 birth cohort study

Esme Fuller-Thomson, PhD,<sup>1</sup> Sarah Brennenstuhl, PhD,<sup>2</sup> Rachel Cooper, PhD,<sup>3</sup> Diana Kuh, PhD, FMedSci<sup>3</sup>

## ABSTRACT

**OBJECTIVES:** The finding that migrants to high-income countries have lower rates of morbidity and mortality than non-migrants, controlling for socio-economic position, is often attributed to the “healthy migrant” hypothesis, which suggests that only the healthiest individuals choose to migrate. This prospective study investigates the healthy migrant hypothesis in a cohort of British emigrants using pre-migration health indicators. We also investigate how early-life health characteristics relate to age at emigration and whether or not the emigrant returned home.

**METHODS:** Data are from the Medical Research Council National Survey of Health and Development, a nationally representative cohort study of people born in England, Scotland or Wales in March 1946. Childhood socio-economic position, health and cognitive ability were compared between 4,378 non-emigrants and 984 emigrants. Of the emigrants, 427 emigrated before age 20 and 557 after that age; 602 emigrants remained abroad and 382 returned home.

**RESULTS:** Emigrants had better childhood health (especially greater height), higher childhood socio-economic position and better childhood cognitive ability at age 8 than non-emigrants. Return emigrants were very similar to emigrants who remained abroad.

**CONCLUSIONS:** We found support for the healthy migrant hypothesis in a cohort of British emigrants. Our findings improve an understanding of how health is distributed within and across nations.

**KEY WORDS:** The MRC National Survey of Health and Development; healthy migrants; healthy immigrants; life course; birth cohort

La traduction du résumé se trouve à la fin de l'article.

*Can J Public Health* 2015;106(8):e502–e508  
doi: 10.17269/CJPH.106.5218

Increasingly, studies on large immigrant-recipient countries, such as Canada,<sup>1,2</sup> the US<sup>3–5</sup> and Australia,<sup>6</sup> reveal that immigrants have better morbidity and mortality outcomes than non-immigrants, once adjustments have been made for socio-economic position (SEP). Researchers propose that this may be due to the “healthy migrant effect”: individuals who are in better health are more likely to choose to migrate (i.e., self-selection) and/or are given preference by receiving countries (i.e., external selection through health examinations of prospective immigrants). That is, factors contributing to the healthy immigrant effect may begin prior to migration itself.<sup>7</sup> This explanation is supported by research showing that immigrants have better health in their host countries than non-migrants in their countries of origin.<sup>5</sup> It is also consistent with evidence that positive health selection in migrant populations begins as far back as childhood. For example, several studies have shown that Mexican immigrants to the US are taller than their American-born counterparts<sup>8</sup> and their same-age counterparts who did not migrate or who migrated and then returned home.<sup>9</sup>

Often studied in the context of individuals migrating from lower- to higher-resource countries, the healthy migrant effect in those relocating from one high-resource country to another has been investigated in fewer studies (although there are exceptions<sup>4,6,10</sup>). Moreover, substantiating evidence of positive health selection, such as comparisons of pre-emigration health profiles with those of individuals remaining in the sending

country, is lacking, especially evidence based on prospective data from a country of origin. Studying the movement of individuals between high-resource countries is important for a better understanding of how health is distributed within and across nations. In the current study, we use the Medical Research Council National Survey of Health and Development (NSHD), the oldest British birth cohort study, started in 1946, to investigate the healthy migrant effect among those leaving Britain by comparing their childhood health with that of their contemporaries who stayed. The UK's long history of emigration makes it a good country to study health and migratory selection processes. Moreover, because many of its post-war emigrants would have migrated to other Commonwealth countries,<sup>11</sup> this cohort provides a good case study of the relationship between health and migration among higher-income countries. Canada has historically received large numbers of British emigrants.

### Author Affiliations

1. Factor-Inwentash Faculty of Social Work, University of Toronto, Toronto, ON
2. Lawrence Bloomberg Faculty of Nursing, University of Toronto, Toronto, ON
3. MRC Unit for Lifelong Health and Ageing at UCL, London, UK

**Correspondence:** Esme Fuller-Thomson, PhD, Factor Inwentash Faculty of Social Work & Institute for Life Course and Aging, University of Toronto, 246 Bloor St. W., Toronto, ON M6S 3W6, Tel: ☎416-978-3269, E-mail: esme.fuller.thomson@utoronto.ca

**Funding:** E. Fuller-Thomson is supported by the Sandra Rotman Chair in Social Work. R. Cooper and D. Kuh are supported by the UK Medical Research Council (Programme code: MC\_UU\_12019/1). The MRC National Survey of Health and Development is funded by the UK Medical Research Council.

**Conflict of Interest:** None to declare.

According to 2011 census data, approximately 5% of adults aged 65 and older living in Canada were born in the UK.<sup>12</sup>

A number of indicators of childhood health are associated with adult health outcomes, especially cardiovascular and metabolic health and, thus, may be associated with successful migration. For example, low SEP and poor material living conditions in childhood have been associated with increased risk of morbidity<sup>13</sup> and earlier mortality.<sup>14</sup> Nutritional factors, such as having been breastfed, are also associated with adult health status.<sup>15</sup> Greater height (an indicator of better nutrition, less illness and higher SEP in childhood) is related to lower risk of coronary heart disease, although it may be linked to higher risk of some cancers.<sup>16</sup> Low birth weight is associated with increased cardiovascular disease and type 2 diabetes.<sup>17</sup> Not surprisingly, poorer adult health status is predicted by having a serious illness in childhood.<sup>18</sup> In addition to predicting adult occupational prestige,<sup>19</sup> higher childhood cognitive ability is associated with improved longevity in adulthood.<sup>20</sup> Whether this is through socio-economic or biological pathways is a matter of debate.<sup>21</sup>

To further test the healthy migrant hypothesis, we also investigated age at immigration, which may play an important role in the healthy migrant effect. If self-selection is integral for determining the “hardiness” of those who migrate, adults who choose to emigrate under their own volition should have better health profiles than those who emigrate in their childhood. This speculation is supported for the outcomes of functional limitations<sup>3</sup> and cognitive decline<sup>22</sup> by studies of Mexicans migrating to the US; however, as far as we are aware, it has yet to be shown for those relocating between high-resource countries.

Finally, we explore another explanation for the unusually good health status of immigrants in host countries, called the “selective reverse migration hypothesis”. This hypothesis suggests that immigrants who develop a serious illness are more likely than healthy immigrants to return to their native country, thereby lowering the observed morbidity and mortality rates of immigrants in the host country. Again, this explanation has been investigated primarily in Hispanic populations in the US.<sup>3,8</sup> Moreover, evidence in favour of it has been mixed, only some studies finding support among Mexican Americans.<sup>3,8</sup> If the childhood health status of emigrants who remain abroad is better than that of emigrants who subsequently return to their native country, this would provide evidence of reverse migration bias. This may be particularly true for source countries, such as the UK, which provide universal health care.

Using the NSHD, the goal of the current study was to compare the childhood, pre-emigration characteristics of the following: non-emigrants with that of emigrants; those who emigrated before the age of 20 with those who emigrated after age 20; and emigrants who remained abroad with those who returned to live in their native country. To our knowledge, this is the first study of its kind.

## METHODS

### Study sample

The NSHD is based on a representative sample of 5,362 single, legitimate births in England, Scotland or Wales in March 1946. Subsequent waves of data collection have been conducted at

least every two years during childhood and at regular intervals during adulthood, the most recent being an ongoing series of data collections completed in 2006–2011, when study participants were aged 60–64 years.<sup>23,24</sup> For more information about study design, please see Wadsworth et al. and Kuh et al.<sup>23,24</sup>

### Measures

In each wave of the NSHD, if an individual was no longer available to be interviewed, information was recorded on whether the respondent had died, emigrated and/or was living abroad, refused to participate or could not be contacted. We classified all those who emigrated and/or were living abroad as “emigrants”. Those respondents who were interviewed in at least one wave after the first wave in which it was recorded that they had emigrated or were living abroad were classified as “return emigrants”.

The age at emigration was defined as the age of the birth cohort at the first wave of data collection in which the respondent was living abroad. For example, if the respondent had been interviewed in the UK in 1953 (at age 7) but had emigrated by the 1954 wave of data collection (at age 8), the respondent would have been classified as emigrating by age 8. Emigrants were divided into two groups: those who had emigrated before age 20 and those who had emigrated between ages 20 and 53. Age 53 was chosen as the upper limit in order to avoid post-retirement emigrants.

In total, there were 984 emigrants and 4,378 non-emigrants. Of the emigrants, 427 migrated before and 557 after age 20, 602 emigrants remained abroad, and 382 returned to Britain. The sample sizes varied slightly within waves of data collection as a result of non-response or missing data, and from wave to wave because of attrition.

We investigated a variety of variables known to influence adult health. Childhood SEP and material living conditions were assessed through six indicators ascertained in the early waves of data collection: father’s occupation, mother’s education, home ownership, housing quality, care of house and child, and parental involvement in child’s education. Father’s occupation, assessed when the respondent was aged 4, was categorized according to the UK Registrar General’s social classification into five levels (I or II professional and managerial, III non-manual, IIIIM skilled manual, IV manual partly skilled or V non-skilled; and father dead). Mother’s highest level of education assessed when study members were aged 6 was dichotomized into primary only versus higher than primary. Whether the respondent’s childhood home was owned by the parents was assessed at age 6. A score of housing quality (range 0–3) was ascertained when the respondent was aged 4; one point was allocated for each of the following: dwelling in very good repair, dwelling built since 1919 and no overcrowding ( $\leq 1.5$  persons per room). Scores were divided into best, intermediate and worst. Also at age 4, care of the house and child was assessed. One point was allocated for each of the following: very clean house, very clean child, at least adequate shoes, at least adequate clothes and mother coped well. Scores were divided into best, intermediate and worst. Parental interest in the study member’s education, based on comments made by class teachers when the child was aged 7 and on the records of the number of times parents visited

the primary school to discuss their child’s progress, distinguished parents with high, fair or low levels of interest.

Measures of childhood health included low birth weight, body mass index (BMI) at age 4, stunting at age 6 and having a serious childhood illness before the age of 5. Low birth weight was defined as <2.5 kilograms. Body mass index at age 4 was divided into three categories: low (<-2 standard deviations [SD] of the mean), normal (between -2 and +2 SD) and high (>2 SD). Individuals were defined as stunted in height at age 6 if their height was less than two SD of the average height of 6-year-olds based on 2007 World Health Organization measures.<sup>25,26</sup> Finally, if respondents had been hospitalized for a minimum of 28 days before the age of 5, they were classified as having had a serious childhood illness. We also measured whether the respondent had been breastfed according to mother’s reports of this at age 2. Finally, childhood cognitive ability was measured at age 8 using tests developed by the National Foundation for Educational

Research, which measured both verbal and nonverbal ability, including reading comprehension, word reading ability, vocabulary and picture intelligence.<sup>27</sup>

Data Analysis

Chi-squared tests were used to analyze categorical data and independent *t*-tests were used for continuous data. To adjust the analyses for other covariates, logistic regression was conducted. Statistical significance was set at *p* < 0.05. All analyses were undertaken using SPSS 21.

RESULTS

The results of the analysis testing the healthy migrant hypothesis are presented in Table 1. Note that the sample sizes varied slightly depending on the number of missing values in the measures used. Comparing the childhood characteristics of Britons who had *ever emigrated* with those who had *never emigrated* revealed that a

**Table 1.** Comparison of the childhood characteristics of Britons born in 1946 who never emigrated versus emigrants

	Never emigrated		Emigrated		p-value*
	N	% or mean (SD)	N	% or mean (SD)	
Sex					
Male	2286	52.2%	529	53.8%	0.38
Female	2092	47.8%	455	46.2%	
Socio-economic position & material living conditions					
Father's occupation					
Professional or zmanagerial	809	20.8%	201	30.0%	<0.001
Skilled non-manual	691	17.7%	133	19.8%	
Manual – skilled	1215	31.2%	206	30.7%	
Manual – partly or non-skilled	1126	28.9%	119	17.7%	
Father dead	56	1.4%	12	1.8%	
Mother's education					
Primary only	2417	65.1%	342	54.4%	<0.001
More than primary	1296	34.9%	287	45.6%	
Parents own home, age 6					
Not owner	2827	73.8%	429	66.7%	<0.001
Owner	1004	26.2%	214	33.3%	
Housing quality, age 4					
Best	1982	51.6%	409	59.4%	<0.001
Intermediate	1025	27.7%	162	23.5%	
Worst	835	21.7%	118	17.1%	
Care of house and child					
Best	1426	39.9%	311	48.7%	<0.001
Intermediate	939	26.2%	164	25.7%	
Worst	1213	33.9%	163	24.4%	
Parental interest in school progress					
Very interested	1481	41.7%	277	47.9%	<0.01
Average interest	1715	48.3%	264	45.7%	
Low interest	356	10.0%	37	6.4%	
Health indicators					
Serious illnesses					
No serious illness	3892	88.9%	706	5.0%	<0.001
Serious illness	486	11.1%	37	5.0%	
Height (cm), age 6	3480	113.9 (5.4)	581	115.1 (5.1)	<0.001
Stunted <sup>†</sup>					
Yes	204	5.9%	19	3.3%	<0.05
No	3276	94.1%	562	96.7%	
Birth weight (g)	4346	3372.8 (552.3)	981	3393.2 (489.8)	0.25
Low birth weight <sup>‡</sup>					
Yes	188	4.3%	28	2.9%	<0.05
No	4158	95.7%	953	97.1%	
Body mass index, age 4 <sup>§</sup>					
Low	37	1.0%	8	1.3%	=0.74
Medium	3383	95.1%	599	95.4%	
High	136	3.8%	21	3.3%	
Cognitive ability, age 8	3665	99.3 (15.0)	591	104.2 (14.5)	<0.001
Breastfed					
Yes	3037	75.7%	614	79.4%	<0.05
No	974	24.3%	159	20.6%	

SD, standard deviation.

\* *p* value derived from chi-squared tests for categorical variables and independent *t*-tests for continuous variables.

<sup>†</sup> Individuals were defined as stunted if their height was less than 2 SD of the average height of 6-year-olds based on 2007 World Health Organization measures.

<sup>‡</sup> Low birth weight was defined as <2.5 kilograms.

<sup>§</sup> Low body mass index was defined as <-2 SD of the mean, normal was between -2 and +2 SD, and high was >2 SD.

larger proportion of emigrants-to-be had a higher SEP (measured by father's occupation and mother's education), better material living conditions (measured by housing quality, home ownership and care of house and child) and greater parental interest in their education (each  $p < 0.01$ ). Also, a greater share of emigrants compared with non-emigrants were breastfed, not stunted and did not have a low birth weight or a serious illness in childhood (each  $p < 0.05$ ). Finally, emigrants were taller and had higher scores on cognition in childhood than non-emigrants (each  $p < 0.001$ ). The only childhood indicators that were not associated with emigration status were sex, BMI at age 4 and birth weight.

To further investigate the healthy migrant effect, we undertook a multivariable analysis with emigration status as the dependent variable. To avoid problems with multi-collinearity and to achieve parsimony in the final model we ran a preliminary model, which included the outcome and all six measures of childhood SEP and material living conditions, to determine which of the variables should be included in the final model. Only two variables remained statistically significant: father's occupation and housing quality. These variables were included in the final model, along with the variables most closely related to childhood health: low birth weight, having had a serious childhood illness by age 5, height at age 6 and cognitive ability at age 8. As shown in Table 2, when all factors were considered simultaneously, height at age 6, father's occupation, and cognitive ability at age 8 remained statistically significant. Specifically, the odds of emigration increased by 3% for every centimetre in height at age 6 ( $p < 0.01$ ) and 36% for every one SD increase in cognitive ability ( $p < 0.001$ ). Those with fathers who had an occupation in the professional or skilled manual labour categories had 56% and 34% higher odds respectively of emigrating than those whose fathers were partly or non-skilled manual labourers ( $p < 0.01$  and  $p < 0.05$ ). In short, both childhood socio-economic and health factors, when mutually adjusted, predicted emigration from the UK.

**Table 2.** Logistic regression of childhood characteristics of British emigrants born in 1946 versus their non-emigrating counterparts (sample with complete data on all covariates  $n = 3529$ )

	OR (95% CI)	p-value
<i>Socio-economic position &amp; material living conditions</i>		
Father's occupation		
Professional or managerial	1.56 (1.15, 2.12)	0.03
Skilled non-manual	1.19 (0.85, 1.65)	
Manual – skilled	1.34 (1.01, 1.78)	
Manual – partly or non-skilled	1.00 (Ref)	
Father dead	1.56 (0.63, 3.84)	
Housing quality, age 4		
Best	1.00 (Ref)	0.12
Intermediate	0.78 (0.61, 1.00)	
Worst	0.95 (0.72, 1.25)	
Health indicators		
Low birth weight*	0.68 (0.32, 1.42)	0.3
Serious illnesses before age 6	0.88 (0.56, 1.39)	0.59
Cognitive ability, age 8†	1.36 (1.20, 1.55)	<0.001
Height (cm), age 6	1.03 (1.01, 1.05)	<0.01
Nagelkerke R square	0.038	
– 2 Log likelihood	2696.4	

OR, odds ratio; CI, confidence interval.

\* Low birth weight was defined as <2.5 kilograms.

† Per 1 SD change.

Table 3 reports the results of the second descriptive analysis examining the hypothesis about age of migration. Comparison of the childhood characteristics of Britons who emigrated before and after age 20 revealed only one difference: Older emigrants had a marginally higher cognitive ability in childhood ( $p = 0.05$ ). All other measures of childhood SEP and health were comparable across older and younger emigrants and, thus, further multivariate analysis was not undertaken. In sum, we

**Table 3.** Comparison of the childhood characteristics of Britons born in 1946 who emigrated before age 20 versus age 20 or older

	Emigrant <20 years		Emigrant ≥20 years		p-value*
	N	% or mean (SD)	N	% or mean (SD)	
Sex					
Male	219	51.3%	310	55.7%	0.17
Female	208	48.7%	247	44.3%	
<i>Socio-economic position &amp; material living conditions</i>					
Father's occupation					
Professional or managerial	39	25.8%	162	31.2%	0.59
Skilled non-manual	34	22.5%	99	19.0%	
Manual – skilled	51	33.8%	155	29.8%	
Manual – partly or non-skilled	24	15.9%	95	18.3%	
Father dead	3	2.0%	9	1.7%	
Mother's education					
Primary only	61	50.8%	281	55.2%	0.39
More than primary	59	49.2%	228	44.8%	
Parents own home, age 6					
Not owner	85	67.5%	344	66.5%	0.84
Owner	41	32.5%	173	33.5%	
Housing quality, age 4					
Best	100	58.8%	309	59.5%	0.77
Intermediate	43	25.3%	119	22.9%	
Worst	27	15.9%	91	17.5%	
Care of house and child					
Best	76	50.0%	235	48.4%	0.57
Intermediate	42	27.6%	122	25.1%	
Worst	34	22.4%	129	26.5%	
Parental interest in school progress					
Very interested	38	42.2%	239	49.0%	0.23
Average interest	43	47.8%	221	45.3%	
Low interest	9	10.0%	28	5.7%	
<i>Health indicators</i>					
Serious illnesses					
No serious illness	178	95.7%	528	94.8%	0.62
Serious illnesses	8	4.8%	29	5.2%	
Height (cm), age 6	117	114.1 (4.9)	464	115.1 (5.2)	0.77
Stunted†					
Yes	2	1.7%	17	3.7%	0.29
No	115	98.3%	447	96.3%	
Birth weight (g)	426	3372.3 (497.8)	555	3409.3 (483.4)	0.24
Low birth weight‡					
Yes	16	3.8%	12	2.2%	0.14
No	410	96.2%	543	97.8%	
Weight, age 4§					
Low	2	1.3%	6	1.3%	0.28
Medium	148	97.4%	451	94.7%	
High	2	1.3%	19	4.0%	
Cognitive ability, age 8	90	101.4 (14.1)	501	104.6 (14.5)	0.05
Breastfed					
Yes	198	79.5%	416	79.4%	0.97
No	51	20.5%	108	20.6%	

SD, standard deviation.

\* p-value derived from chi-squared tests for categorical variables and independent t-tests for continuous variables.

† Individuals were defined as stunted if their height was less than 2 SD of the average height of 6-year-olds based on 2007 World Health Organization measures.

‡ Low birth weight was defined as <2.5 kilograms.

§ Low body mass index was defined as <-2 SD of the mean, normal was between -2 and +2 SD, and high was >2 SD.

found little evidence supporting the speculation that early-life characteristics relate to age at emigration.

The results of the third descriptive analysis investigating the selective reverse-migration hypothesis are presented in Table 4.

**Table 4.** Comparison of the childhood characteristics of British emigrants born in 1946 who stayed abroad versus emigrants who returned home

	Emigrants – stayed abroad		Emigrants – returned home		P-value*
	N	% or Mean (SD)	N	% or Mean (SD)	
Sex					
Male	334	55.5%	195	51.0%	0.17
Female	268	44.5%	187	49.0%	
<i>Socio-economic position &amp; material living conditions</i>					
Father's occupation					0.09
Professional or managerial	115	29.4%	86	30.7%	
Skilled non-manual	77	19.7%	56	20.0%	
Manual – skilled	130	33.2%	76	27.1%	
Manual – partly or non-skilled	66	16.9%	53	18.9%	
Father dead	3	0.8%	9	3.2%	
Mother's education					<0.05
Primary only	208	58.8%	134	48.7%	
More than primary	146	41.2%	141	51.3%	
Parents own home, age 6					0.76
Not owner	242	67.2%	187	66.1%	
Owner	118	32.8%	96	33.9%	
Housing quality, age 4					0.42
Best	231	59.4%	178	59.3%	
Intermediate	86	22.1%	76	25.3%	
Worst	72	18.5%	46	15.3%	
Care of house and child					0.13
Best	160	45.5%	151	52.8%	
Intermediate	100	28.4%	64	22.4%	
Worst	92	26.1%	71	24.8%	
Parental interest in school progress					0.54
Very interested	154	47.4%	123	48.6%	
Average interest	153	47.1%	111	43.9%	
Low interest	18	5.5%	19	7.5%	
<i>Health indicators</i>					
Serious illnesses					0.7
No serious illness	397	94.7%	309	95.4%	
Serious illness	22	5.3%	15	4.6%	
Height (cm), age 6	326	115.1 (5.2)	255	115.2 (5.0)	0.83
Stunted†					0.44
Yes	9	2.8%	10	3.9%	
No	317	97.2%	245	96.1%	
Birth weight (g)	599	3384.2 (479.2)	382	3407.3 (506.3)	0.48
Low birth weight‡					0.41
Yes	15	2.5%	13	3.4%	
No	584	97.5%	369	96.6%	
BMI, age 4§					0.8
Low	4	1.1%	4	1.4%	
Medium	332	95.1%	267	95.7%	
High	13	3.7%	8	2.9%	
Cognitive ability, age 8	332	104.7 (14.1)	259	103.5 (14.9)	0.34
Breastfed					0.88
Yes	355	79.2%	259	79.7%	
No	93	20.8%	66	20.3%	

SD, standard deviation.

\* p value derived from chi-squared tests for categorical variables and independent t-tests for continuous variables.

† Individuals were defined as stunted if their height was less than 2 SD of the average height of 6-year-olds based on 2007 World Health Organization measures.

‡ Low birth weight was defined as <2.5 kilograms.

§ Low body mass index was defined as <- 2 SD of the mean, normal was between -2 and +2 SD, and high was >2 SD.

Comparing return emigrants with those staying abroad shows that a greater share of returning Britons had a *higher* childhood SEP as measured by their mother's level of education ( $p < 0.05$ ). All other factors were comparable. Again, further multivariate analysis was not undertaken because we found little evidence suggesting that childhood characteristics were related to return migration.

## DISCUSSION

Consistent with the healthy migrant hypothesis, British emigrants born in 1946 had higher childhood SEP, better childhood health (indicated by height at age 6) and superior cognitive ability at age 8 than their counterparts who stayed in Britain. Moreover, each of these factors predicted emigration status, when all others had been controlled for. Our research adds to the literature on the healthy migrant effect in several important ways. First, we introduce support for the idea that the factors contributing to positive health selection in migrant populations begin as far back as childhood. Previous research has shown that Mexican immigrants are taller than their non-migrant counterparts and, thus, has implied that they also had better nutrition in childhood.<sup>8,9</sup> Our research is able to show this directly using prospective measures of childhood health. Second, we reveal that the healthy migrant effect can be found in a sample of those emigrating from a high-resource sending country. This finding suggests that positive health selection does not depend entirely on factors affecting individuals moving from a low- to a higher-income country.

Counter to the selective-reverse migration hypothesis, we found no evidence that emigrants with worse childhood health were more likely to return home. The only childhood indicator that differed between emigrants staying abroad and those returning home was mother's level of education, which was *higher* among return emigrants. This relationship was in the opposite direction than we had anticipated and was not corroborated by father's occupation, suggesting that it may have been a chance finding, especially given the multiple tests undertaken. However, it is also possible that higher maternal education is associated with greater perceived employment opportunities for the mother in her home country, especially if she had not been employed to her highest capabilities abroad. Further research is needed to explore this. The lack of support for selective-reverse migration is somewhat surprising given that returning emigrants would have regained access to the National Health Service, which is free for all British citizens. However, while this may have been an attractive option for some migrants who fell ill, it would not necessarily have made a difference for those ending up in Canada or another country with universal health care. That said, it is also possible that the original survey respondents would not have been quite old – or sick – enough to move back home for this reason.

The current study also reveals that age at emigration does not appear to matter with respect to the selection process for British emigrants, except when it comes to cognitive ability: Britons emigrating after age 20 had higher childhood cognitive ability at age 8. This finding deserves some attention. First, in contrast to what we had originally hypothesized it suggests that self-selection at the level of the parent may take into account the

health of children. That is, with the exception of some special cases, we suspect that parents from high-income countries, particularly those from countries with universal health care, are not likely to choose to emigrate if they have unhealthy children. Second, if all else is equal with respect to childhood health, it makes sense that childhood cognitive ability, which predicts adult occupational prestige,<sup>19</sup> would emerge as an important selective factor for successful immigration in adulthood. Cognitive ability is related not only to enhanced ability to adapt to a new environment but also to the type of opportunity for which an adult may move.<sup>28</sup> By the mid-1970s, countries receiving large numbers of British emigrants, such as Canada and Australia, were increasingly focused on attracting the most skilled migrants (a policy that continues until today).<sup>29</sup> Immigration policies favouring highly skilled workers, therefore, would have further contributed to selection based on cognitive ability for at least some of the NSHD emigrants.

There are several study limitations that should be considered when interpreting our results. First, we lacked data on where Britons emigrated to or why, and so we cannot fully specify the selection process behind the healthy migrant effect observed in our data. Second, it is possible we misclassified some of those who could not be contacted or refused to participate as “non-emigrants” when they may have subsequently emigrated. Such an error would bias the results towards the null, rendering our results more conservative. Third, because factors underlying migratory selection processes are likely to vary according to the historical time period and regions of the world between which migrants are moving, our findings should not be generalized to other birth cohorts or sending populations. For example, while many Britons born in 1946 would have moved to other wealthy, English-speaking countries, such as Canada, more recent British emigrants are increasingly moving within the European Union (EU).<sup>30</sup> This shift in receiving countries may affect the strength of selection effects, especially given the ease with which migration has been possible between nations of the EU. Also, the selection processes underlying the health profiles of migrants moving between wealthy countries likely differ from those of migrants moving from poorer areas of the world to more economically advantaged ones. The latter, who are the most common types of migrant today, may be more strongly selected for their health because of the need to find work.<sup>31</sup>

Our finding that the childhood health of return migrants was similar to those who stayed abroad provides no support for the selective reverse migration hypothesis. Future research could more definitively test this hypothesis by also gathering data about the adult health of migrants and non-migrants. Finally, the sample sizes used for tests of the selective reverse-migration and age of migration hypotheses were relatively small. Consequently, these migrant-based analyses would have had less power to detect significant differences (especially for the categorical variables) than the main analysis using the full sample, although in many cases the direction of the observed association was opposite to that hypothesized.

In conclusion, using pre-emigration prospective data, we found evidence of a healthy migrant effect among Britons born in 1946. Moreover, differences found in the childhood characteristics of emigrants and non-emigrants suggest that the underlying

selection processes likely began in childhood. In particular, British emigrants had higher childhood SEP, better childhood health (as indicated by greater height at age 6) and better cognitive ability at age 8 than their counterparts who stayed at home. We also found some evidence that adult emigrants were more strongly selected for cognitive ability at age 8 than those who emigrated before age 20. More research using prospective birth cohort data and a range of wealthy and less economically advantaged sending nations is needed to more fully understand the selection processes that underlie the healthy migrant effect.

## REFERENCES

1. Ng E. The healthy immigrant effect and mortality rates. *Health Rep* 2011;22(4):C1–C9. PMID: 22352149.
2. McDonald J, Kennedy S. Insights into the ‘healthy immigrant effect’: Health status and health service use of immigrants to Canada. *Soc Sci Med* 2004;59(8):1613–27. PMID: 15279920. doi: 10.1016/j.socscimed.2004.02.004.
3. Fuller-Thomson E, Nuru-Jeter A, Richardson D, Raza F, Minkler M. The Hispanic paradox and older adults’ disabilities: Is there a healthy migrant effect? *Int J Environ Res Public Health* 2013;10(5):1786–814. PMID: 23644828. doi: 10.3390/ijerph10051786.
4. Huang C, Mehta NK, Elo IT, Cunningham SA, Stephenson R, Williamson DF, et al. Region of birth and disability among recent US immigrants: Evidence from the 2000 census. *Popul Res Policy Rev* 2011;30(3):399–418. PMID: 21666828. doi: 10.1007/s11113-010-9194-x.
5. Argeseanu Cunningham S, Ruben JD, Narayan KMV. Health of foreign-born people in the United States: A review. *Health Place* 2008;14(4):623–35. PMID: 18242116. doi: 10.1016/j.healthplace.2007.12.002.
6. Guo S, Lucas RM, Joshy G, Banks E. Cardiovascular disease risk factor profiles of 263,356 older Australians according to region of birth and acculturation, with a focus on migrants born in Asia. *Plos One* 2015;10(2): e0115627. PMID: 25695771. doi: 10.1371/journal.pone.0115627.
7. Franzini L, Ribble JC, Keddie AM. Understanding the Hispanic paradox. *Ethn Dis* 2001;11(3):496–518. PMID: 11572416.
8. Riosmena F, Wong R, Palloni A. Migration selection, protection, and acculturation in health: A binational perspective on older adults. *Demography* 2013;50(3):1039–64. PMID: 23192395. doi: 10.1007/s13524-012-0178-9.
9. Crimmins EM, Soldo BJ, Kim JK, Alley DE. Using anthropometric indicators for Mexicans in the United States and Mexico to understand the selection of migrants and the “Hispanic paradox”. *Soc Biol* 2005; 52(3/4):164–77. PMID: 17619609.
10. Kennedy S, McDonald JT, Biddle N. The Healthy Immigrant Effect and Immigrant Selection: Evidence from Four Countries, 2006; SEDAP Research Paper No. 164. Available at: <https://ideas.repec.org/p/mcm/sedapp/164.html> (Accessed July 13, 2015).
11. Constantine S. British emigration to the empire-commonwealth since 1880: From overseas settlement to diaspora? In: Fedorowich K (Ed), *The British World: Diaspora, Culture, and Identity*. London: Frank Cass, 2003;16–35.
12. Statistics Canada. National Household Survey. Statistics Canada Catalogue no.99-010-X2011026, 2011.
13. Strand BH, Murray ET, Guralnik J, Hardy R, Kuh D. Childhood social class and adult adiposity and blood-pressure trajectories 36–53 years: Gender-specific results from a British birth cohort. *J Epidemiol Community Health* 2012;66(6):512–18. doi: 10.1136/jech.2010.115220.
14. Kuh D, Hardy R, Langenberg C, Richards M, Wadsworth MEJ. Mortality in adults aged 26–54 years related to socioeconomic conditions in childhood and adulthood: Post war birth cohort study. *BMJ* 2002;325(7372):1076–80. PMID: 12424168. doi: 10.1136/bmj.325.7372.1076.
15. Parikh NI, Hwang S, Ingelsson E, Benjamin EJ, Fox CS, Vasan RS, et al. Breastfeeding in infancy and adult cardiovascular disease risk factors. *Am J Med* 2009;122(7):656–80. PMID: 19559168. doi: 10.1016/j.amjmed.2008.11.034.
16. Batty GD, Shipley MJ, Gunnell D, Huxley R, Kivimaki M, Woodward M, et al. Height, wealth, and health: An overview with new data from three longitudinal studies. *Econ Hum Biol* 2009;7(2):137–52. PMID: 19628438. doi: 10.1016/j.ehb.2009.06.004.
17. Barker DJ. The developmental origins of well-being. *Philos Trans R Soc Lond B Biol Sci* 2004;359(1449):1359–66. PMID: 15347527. doi: 10.1098/rstb.2004.1518.
18. Kuh D, Wadsworth M, Yusuf E. Burden of disability in a post war birth cohort in the UK. *J Epidemiol Community Health* 1994;48(3):262–69.
19. Cheng H, Furnham A. Childhood cognitive ability, education, and personality traits predict attainment in adult occupational prestige over 17 years. *J Vocat Behav* 2012;81(2):218–26. doi: 10.1016/j.jvb.2012.07.005.
20. Batty GD, Deary IJ, Gottfredson LS. Premorbid (early life) IQ and later mortality risk: Systematic review. *Ann Epidemiol* 2007;17(4):278–88. PMID: 17174570. doi: 10.1016/j.jannepidem.2006.07.010.

21. Kuh D, Shah I, Richards M, Mishra G, Wadsworth M, Hardy R. Do childhood cognitive ability or smoking behaviour explain the influence of lifetime socio-economic conditions on premature adult mortality in a British post war birth cohort? *Soc Sci Med* 2009;68(9):1565–73. PMID: 19269077. doi: 10.1016/j.socscimed.2009.02.006.
22. Hill T, Angel J, Balistreri K. Does the “healthy immigrant effect” extend to cognitive aging? In: Angel JL, Torres-Gil F, Markides K (Eds), *Aging, Health, and Longevity in the Mexican-Origin Population*. New York: Springer US, 2012; 19–33.
23. Wadsworth M, Kuh D, Richards M, Hardy R. Cohort profile: The 1946 national birth cohort (MRC National Survey of Health and Development). *Int J Epidemiol* 2006;35(1):49–54. doi: 10.1093/ije/dyi201.
24. Kuh D, Pierce M, Adams J, Deanfield J, Ekelund U, Friberg P, et al. Cohort profile: Updating the cohort profile for the MRC National Survey of Health and Development: A new clinic-based data collection for ageing research. *Int J Epidemiol* 2011;40(1):e1–9. PMID: 21345808. doi: 10.1093/ije/dyq231.
25. Ong KK, Hardy R, Shah I, Kuh D. National Survey of Health and Development Scientific and Data, Collection Teams. Childhood stunting and mortality between 36 and 64 years: The British 1946 birth cohort study. *J Clin Endocrinol Metab* 2013;98(5):2070–77. PMID: 23533234. doi: 10.1210/jc.2012-3595.
26. World Health Organization. Growth Reference 5–19 years, 2013. Available at: [http://www.who.int/growthref/who2007\\_height\\_for\\_age/en/index.html](http://www.who.int/growthref/who2007_height_for_age/en/index.html) (Accessed July 13, 2015).
27. Pigeon DA. Tests used in the 1954 and 1957 surveys (appendix 1). In: Douglas JWB (Ed), *The Home and the School*. London: Macgibbon & Kee, 1964.
28. Lu Y. Test of the ‘healthy migrant hypothesis’: A longitudinal analysis of health selectivity of internal migration in Indonesia. *Soc Sci Med* 2008;67(8):1331–39. PMID: 18639967. doi: 10.1016/j.socscimed.2008.06.017.
29. Khoo S, Hugo G, McDonald P. Skilled migration from Europe to Australia. *Population Space and Place* 2011;17(5):550–66. doi: 10.1002/psp.651.
30. Hawkins O. Migration Statistics, 2013. Available at: <http://www.parliament.uk/briefing-papers/SN06077> (Accessed July 13, 2015).
31. Malmusi D, Borrell C, Benach J. Migration-related health inequalities: Showing the complex interactions between gender, social class and place of origin. *Soc Sci Med* 2010;71(9):1610–19. PMID: 20869798. doi: 10.1016/j.socscimed.2010.07.043.

Received: July 13, 2015

Accepted: September 27, 2015

## RÉSUMÉ

**OBJECTIFS :** La constatation selon laquelle les migrants vers les pays à revenu élevé ont des taux de morbidité et de mortalité inférieurs à ceux des non-migrants, en tenant compte des effets du statut socioéconomique, est souvent imputée à l’hypothèse du « migrant en bonne santé », qui suggère que seules les personnes dont la santé est la meilleure choisissent d’émigrer. Notre étude prospective teste l’hypothèse du migrant en bonne santé dans une cohorte d’émigrants britanniques à l’aide d’indicateurs sanitaires avant la migration. Nous enquêtons aussi sur les liens entre les caractéristiques de santé en bas âge et l’âge au moment de l’émigration, et sur le retour ou non de l’émigrant dans son pays natal.

**MÉTHODE :** Nos données proviennent de la National Survey of Health and Development du Medical Research Council, une étude de cohorte représentative à l’échelle nationale des personnes nées en Angleterre, en Écosse ou au pays de Galles en mars 1946. Nous avons comparé le statut socioéconomique, la santé et les capacités cognitives durant l’enfance de 4378 non-émigrants et de 984 émigrants. Parmi les émigrants, 427 ont émigré avant l’âge de 20 ans et 557 après cet âge; 602 émigrants sont restés à l’étranger et 382 sont retournés dans leur pays natal.

**RÉSULTATS :** Les émigrants avaient eu une meilleure santé durant l’enfance (en particulier, ils étaient de taille plus grande), un statut socioéconomique plus élevé durant l’enfance et de meilleures capacités cognitives durant l’enfance, à l’âge de 8 ans, que les non-émigrants. Les émigrants de retour étaient très semblables aux émigrants restés à l’étranger.

**CONCLUSIONS :** Nous avons trouvé des preuves à l’appui de l’hypothèse du migrant en bonne santé dans une cohorte d’émigrants britanniques. Nos constatations permettent de mieux comprendre comment la santé est répartie à l’intérieur des pays et d’un pays à l’autre.

**MOTS CLÉS :** National Survey of Health and Development (enquête du MRC); migrants en bonne santé; immigrants en bonne santé; parcours de vie; cohorte de naissance