# COUNTRY OF BIRTH, COUNTRY OF RESIDENCE AND MULTIMORBIDITY

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# SUMMARY

Chronic diseases tend to accumulate into multimorbidity, with severe implications for health care needs, costs, and economic productivity, as well as for quality and duration of life. The accumulation of diseases may result from exposures and experiences concurrently and earlier in life. Objectives: We investigated multimorbidity among immigrant and native-born people across Europe, examining the importance of country of birth and country of residence for multimorbidity. Methods: We used the Survey of Health, Aging, and Retirement in Europe (SHARE), a cross-national, multidisciplinary panel survey representative of older adults in Europe (n=112,612 native-born and 11,266 foreign-born in 2002-2017). Self-reported chronic conditions used to define multimorbidity were: heart attack, high blood pressure, high blood cholesterol, stroke, diabetes, chronic lung disease, cancer, stomach ulcer, Parkinson's disease, cataracts, and hip fracture. We used multinomial logistic regression to identify patterns of multimorbidity and assessed interaction between country of birth and of residence. Results: More than a third of people living in Europe had multimorbidity, including 37.7% of migrants and 35.1% of native-born individuals. People living in Eastern Europe had the highest prevalence of multimorbidity. Across countries, compared to native-born people, multimorbidity was higher among migrants from Eastern Europe (OR:1.41) and Central and West Asia (OR:1.16), and lower among migrants from Asia (OR:0.66). Country of birth modified associations between county of residence and multimorbidity. Discussion: Country of birth and country of residence are each associated with multimorbidity, suggesting that early-life conditions can have different implications for health depending on later-life.


***Keywords:*** *migration, health, multimorbidity, environment*

# INTRODUCTION AND LITERATURE REVIEW

Multimorbidity, indicating that a person has multiple chronic conditions, is a global concern and is expected to increase due to population aging and changing lifestyles (Calderón-Larrañaga et al., 2017; Fortin et al., 2012; Kudesia et al., 2021; Palladino et al., 2016). It represents the progression and accumulation of chronic diseases across the lifespan, often leading to disability, high medical costs, and poor quality of life (Kudesia et al., 2021). The prevalence of multimorbidity increases with age and is higher among women and people with low socioeconomic status (Diaz, et al., 2015; Marengoni et al., 2011; Violan et al., 2014).

International migrants tend to be a healthy group in most populations, but limited access to care (ref) and repeated stressful exposures may leave migrants at risk of developing multimorbidity. Indeed, their health tends to worsen with time after migration, and health problems eventually resemble or even exceed those of the general population in their country of resettlement (De Maio, 2010; Diaz, Kumar, et al., 2015; Gimeno-Feliu et al., 2017; Gimeno-Feliu et al., 2020; Rechel et al., 2012). The process of migration can have both positive and negative implications for health: it can lead people to environments with lower risks of infectious diseases and better quality of living conditions and health care (Spallek et al., 2011); at the same time, it may also lead them to environments conducive to chronic disease due to eating patterns, smoking, and physical inactivity (Spallek et al., 2011).

Measuring multimorbidity among international migrants can also provide insights into how place affects health: if health varies with place of origin, then we may emphasize the importance of the long arm of childhood exposures, and habits, diets, and preferences developed early in life, affect us throughout our lives, regardless of migrant status. On the other hand, if health varies with place of current residence, then current exposures and behaviours may be most important for chronic disease trajectories, rather than occurrences and exposures earlier in life. If there is an interaction between current residence and place of birth, then early life exposures operate differently according to current exposures and thus some current circumstances can be expected to be more harmful for some people than for others; some people will be more vulnerable to current environments and behaviours than others. Using a large cross-national study that includes multiple measures of health across foreign-born and native-born people across Europe, we attempt to disentangle these associations between the role of places and the development of multiple chronic conditions. We characterize the prevalence of multimorbidity among foreign-born people across Europe and determine the importance of place of origin and place of resettlement in shaping risks for chronic disease.

# RESEARCH METHODOLOGY

### *Data Sources and Study Design*

The Survey of Health, Ageing and Retirement in Europe (SHARE) is a cross-national household-based panel survey that measures health, socio-economic status, and social and family networks (Börsch-Supan et al., 2013). SHARE has collected 7 waves of data on 140,000 individuals and covers 27 European countries and Israel. *easy*SHARE is a simplified version of the SHARE dataset that contains the same number of observations as the main release of SHARE, simplified data structure, and a selection of central SHARE variables.

In 2004-6, the first wave of SHARE was fielded in 11 countries: Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Greece, Italy, the Netherlands, Sweden, and Israel. In wave 2 (2006-2007), Czech Republic and Poland were added. Wave 3 was fielded in 2008-2011 and wave 4 in 2010-2012, adding Estonia, Hungary, Portugal and Slovenia. Wave 5 was fielded in 2013, adding Luxembourg, wave 6 in 2015, adding Croatia, and wave 7 in 2017 adding Finland, Lithuania, Latvia, Slovakia, Romania, Bulgaria, Malta and Cyprus; thus, all continental EU Member States were represented in wave 7.

SHARE represents people aged 50 and older living in Europe who have their regular domicile in the respective SHARE country. People who are incarcerated, hospitalized, out of the country during the entire survey period, unable to speak the country's languages. SHARE produces similar distributions of employment, income, education, and health with three other prominent European surveys: European Union Labour Force Survey (EU-LFS), the European Community Household Panel (ECHP), and the European Social Survey (ESS) (Brugiavini et al., 2005).

All SHARE respondents who were interviewed in any previous wave are part of the longitudinal sample, therefore all countries were used in the analysis. If they have a new co-residing partner, the partner is eligible as well, regardless of age. Proxy respondents are allowed for family, financial or household matters if physical or cognitive limitations make it too difficult for a respondent to complete the interview independently, as well as for end-of-life interviews. Age-eligible respondents are traced and re-interviewed if they move within the country.

Trained interviewers conduct face-to-face interviews in respondent's homes using a laptop with computer-assisted personal interviewing (CAPI). Interviews consist of questionnaires and physical exams. SHARE uses ex-ante harmonisation, with one common questionnaire translated and used throughout.

### *Variables*

The main independent variable in this study is country of birth, collapsed into geographic regions. Country of birth was recorded by asking the respondent "In which country were you born? Please name the country that your birthplace belonged to at the time of your birth". The countries were classified based on the ISO (International Organization for Standardization) country codes created by the United Nations Statistics Division (UNSD), which also provides codes for countries that no longer exist (UNSD). Using UNSD categorizations, country of birth was categorized into regions using the UNSD classifications (UNSD; Walkden et al., 2018): (1) Western, Northern, & Southern Europe, (2) Eastern Europe, (3) Latin America & the Caribbean, (4) Central & West Asia, (5) Southeast, South, & East Asia, (6) Africa, and (7) North America & Oceania. Appendix Table 1 describes the ISO classifications used to categorize country of birth and country of residence and the countries contained in each category.

Respondents were asked, "Do you currently have any of the conditions on this card? With this we mean that a doctor has told you that you have this condition, and that you are either currently being treated for or bothered by this condition". The 11 conditions used for analysis were (1) heart attack, (2) high blood pressure or hypertension, (3) high blood cholesterol, (4) stroke or cerebrovascular disease, (5) diabetes or high blood sugar, (6) chronic lung disease, (7) cancer or malignant tumour, (8) stomach or duodenal ulcer, peptic ulcer (9) Parkinson disease, (10) cataracts, and (11) hip fracture or femoral fracture. We defined multimorbidity as the presence of 2 or more of these conditions, coding health as: 0 chronic diseases, 1 chronic disease, and 2 chronic diseases (multimorbidity). Variables analysed as possible confounders were age, sex, country of residence, education, working status, and household income. Country of residence was coded as the country where the interview took place and categorized into regions: Western Europe, Northern Europe, Southern Europe, and Eastern Europe. Education was a generated variable created with country-specific measurements and ex-post harmonization (Brothers et al., 2014); which we categorized into the 3-level variable, following previous studies that used SHARE: None or primary, Secondary, Post-secondary (includes still in school and other) (Walkden et al., 2018). Working status captured if respondents were retired, employed or self-employed (including working for family business), unemployed, permanently sick or disabled, homemaker, and others. For analysis, this was condensed into five categories: retired, employed, unemployed, permanently sick, and homemaker/other (Bono & Matranga, 2019). Household income was measured by asking the participant, "Thinking of your household's total monthly income, would you say that your household is able to make ends meet..." with the responses: with great difficulty, with some difficulty, fairly easily, or easily. These categorizations were used for analysis.

### *Statistical Analyses*

The *easy*SHARE data are stored in long format, where one data line represents one wave in which each respondent participated. In order to capture each respondent once for a cross-sectional analysis, we restricted to the last (most recent) observation for each respondent. Additionally, we restricted the captured waves to 1, 2, 4, 5, 6, and 7, as wave 3 did not collect prospective data. We restricted ages to older than 50 years old at the time of interview, which excludes partners who were younger than 50 years old.

All analyses were conducted using SAS 9.1 using the *easy*SHARE dataset, which does not include survey weights.

The demographic and socioeconomic characteristics of the SHARE study in 2002-2017 are presented in Tables 1 and 2. Multinomial logistic regression was used to estimate association between country of birth and multimorbidity, with odds ratios and 95% confidence interval presented in Table 3. Respondents who reported 0 chronic diseases were treated as the reference category and were compared to respondents who reported 1 chronic disease and 2+ chronic diseases. For the minimally adjusted model, we controlled for age and sex. For the fully adjusted model, we additionally controlled for country of residence, education, working status, and household income. We tested for interaction between country of birth and residence country, with total effects presented in Table 4. We used the joint test, for an effect that all the parameters associated with that effect are zero, and Wald Chi p-value to assess the significance of the interaction term.

# RESULTS

Characteristics of participants by country of birth are shown in Table 1. In the SHARE study, 9.09% of participants were born in a country other than their current country of residence. 54.98% were women and the mean age was 68 years. 73.62% of foreign-born people were born in Europe, with 41.91% in Eastern Europe and 31.71% Northern, Western, and Southern Europe. The largest number of foreign-born individuals resided in Western Europe (40.05%) and Northern Europe (25.65%). Foreign-born people had similar education levels to native-born, but were less often retired, and were more likely to report household income struggles. Foreign-born individuals born in Africa and Central & West Asia reported the lowest education levels and worst income struggles, while those from North America & Oceania reported the highest education levels and were least likely to report income struggles. Although foreign-born individuals born in Northern, Southern, and Western Europe and foreign-born individuals born in Eastern Europe both reported high education and high retirement levels, foreign-born individuals born in Eastern Europe were more likely to report income struggles than foreign-born individuals born in Northern, Southern, and Western Europe.

## *Table 1*

*Sample Characteristics of Survey of Health of Aging and Retirement in Europe (SHARE), aged 50 years and old, by Migrant Status as characterized by Country of Birth Geographic Region (N=123,878)*

| | Migrant Status | | Country of Birth | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Native-born | Foreign-born (All) | N, S, & W Europe | E Europe | LAC | Central & W Asia | SE, S, & E Asia | Africa | N America |
| **Sex, %** | | | | | | | | | |
| *Female* | 54.89 | 55.84 | 55.92 | 58.03 | 59.08 | 50.21 | 52.96 | 50.82 | 59.66 |
| *Male* | 45.11 | 44.16 | 44.08 | 41.97 | 40.92 | 49.79 | 47.04 | 49.18 | 40.34 |
| **Age, %** | | | | | | | | | |
| *Mean (SD)* | 68.21 (10.22) | 68.02 (10.40) | 68.33 (10.23) | 69.35 (10.44) | 63.68 (9.14) | 66.92 (11.03) | 64.42 (9.50) | 65.63 (9.89) | 65.27 (10.23) |
| *50-59* | 21.53 | 23.83 | 22.61 | 19.46 | 38.62 | 30.58 | 35.48 | 30.58 | 32.77 |
| *60-69* | 34.60 | 32.31 | 31.51 | 32.11 | 35.73 | 26.79 | 35.99 | 35.57 | 36.97 |
| *70-79* | 26.88 | 26.58 | 29.58 | 27.09 | 18.16 | 25.95 | 20.57 | 22.24 | 15.97 |
| *80+* | 16.99 | 17.27 | 16.29 | 21.35 | 7.49 | 16.69 | 7.97 | 11.62 | 14.29 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Number of Chronic Diseases[a], %** | | | | | | | | | |
| *0* | 34.96 | 32.82 | 34.73 | 27.53 | 44.96 | 33.52 | 48.07 | 36.71 | 50.42 |
| *1* | 29.95 | 29.52 | 30.87 | 29.39 | 28.53 | 26.79 | 27.51 | 29.22 | 23.53 |
| *≥ 2* | 35.10 | 37.65 | 34.40 | 43.07 | 26.51 | 39.69 | 24.42 | 34.07 | 26.05 |
| **Country of Residence, %** | | | | | | | | | |
| *Western Europe* | 32.07 | 40.05 | 73.24 | 10.31 | 35.16 | 34.36 | 59.90 | 53.74 | 45.38 |
| *Northern Eur& Baltics* | 19.11 | 25.65 | 13.49 | 45.34 | 7.78 | 17.81 | 14.91 | 2.14 | 21.01 |
| *Southern Europe* | 27.19 | 15.32 | 6.30 | 22.81 | 45.53 | 5.75 | 6.43 | 13.54 | 8.40 |
| *Eastern Europe* | 21.63 | 18.98 | 6.97 | 21.54 | 11.53 | 42.08 | 18.77 | 30.58 | 25.21 |
| **Highest Level of Education, %** | | | | | | | | | |
| *None or primary* | 22.78 | 21.13 | 25.50 | 10.78 | 17.87 | 33.24 | 16.97 | 42.05 | 5.04 |
| *Secondary* | 57.37 | 51.71 | 48.95 | 60.48 | 49.28 | 42.64 | 50.13 | 36.71 | 30.25 |
| *Post-secondary* | 19.85 | 27.15 | 25.55 | 28.74 | 32.85 | 24.12 | 32.90 | 21.24 | 64.71 |
| **Working Status, %** | | | | | | | | | |
| *Retired* | 60.61 | 55.88 | 60.12 | 62.85 | 34.29 | 42.92 | 37.53 | 40.20 | 36.97 |
| *Employed* | 23.50 | 24.99 | 22.19 | 23.38 | 42.36 | 27.63 | 37.79 | 26.59 | 45.38 |
| *Unemployed* | 2.33 | 4.01 | 2.85 | 3.75 | 4.90 | 6.03 | 2.57 | 7.06 | 3.36 |
| *Permanently sick* | 3.39 | 5.33 | 4.73 | 4.11 | 4.90 | 9.12 | 7.71 | 8.70 | 2.52 |
| *Homemaker / Other* | 10.17 | 9.80 | 10.10 | 5.91 | 13.54 | 14.31 | 14.40 | 17.46 | 11.76 |
| **Household Income, % - Is household able to make ends meet?** | | | | | | | | | |
| *Easily* | 29.72 | 23.97 | 38.79 | 13.66 | 22.77 | 17.81 | 30.85 | 19.67 | 57.14 |
| *Fairly easily* | 30.35 | 27.56 | 31.54 | 26.28 | 31.99 | 21.74 | 30.85 | 23.16 | 21.85 |
| *With some difficulty* | 28.09 | 32.15 | 21.77 | 40.36 | 28.82 | 36.33 | 24.42 | 33.14 | 15.97 |
| *With great difficulty* | 11.84 | 16.31 | 7.89 | 19.70 | 16.43 | 24.12 | 13.88 | 24.02 | 5.04 |
| **Sample Size [b]** | 112612 | 11266 | 3573 | 4722 | 347 | 713 | 389 | 1403 | 119 |

[a] *Number of Chronic Diseases is measured as 2+ of the following chronic diseases: heart attack, high blood pressure, high blood cholesterol, stroke, diabetes, chronic lung disease, cancer, stomach ulcer, Parkinson disease, cataracts, and hip fracture.*

[b] *Values are unweighted counts and unweighted percentages from SHARE Wave 1-7 (2002-2017).*
*Country of birth and country of residence regions were categorized based on the International Organization for Standardization (ISO) Geographic Region Classifications. Native-born refers to the country surveyed. Regions of birth are: Eastern Europe, Latina American and the Caribbean, Southeast, South, and East Asia, Africa, and North America.*

The distribution of the number of chronic diseases by sample characteristics, categorized as 0, 1, and 2+ diseases, is shown in Table 2. Men, older people, those with lower education status, those not working due to permanent sickness, and those with income struggles were more likely to report multimorbidity. 37.65% of foreign-born individuals and 35.10% of native-born individuals reported 2+ chronic diseases. Reporting 1 chronic disease did not differ largely between foreign and native-born individuals (29.52% versus 29.95% for foreign-born and native-born, respectively). Foreign-born individuals born in Eastern Europe had the highest levels of multimorbidity (43.07%), followed by foreign-born individuals born in Central and West Asia (39.69%). Foreign-born individuals born in Latin America and the Caribbean and Southeast, South, and East Asia were on average younger than other regions and reported the lowest multimorbidity levels at 26.72% and 24.40.

## Table 2

*Sample Characteristics of Survey of Health of Aging and Retirement in Europe (SHARE)a (N=123,878)*

| | Overall (%) | Number of Chronic Diseases [b] | | |
|---|---|---|---|---|
| | | *0* | *1* | *2+* |
| **Sample Size** | n=12,3878 | n=43,063 | n=37,050 | n=43,765 |
| **Sex** | | | | |
| *Female* | 68,107 (54.98) | 24,318 (56.47) | 20,268 (54.70) | 23,521 (53.74) |
| *Male* | 55,771 (45.02) | 18,745 (43.53) | 16,782 (45.30) | 20,244 (46.26) |
| **Age** | | | | |
| *Mean (SD)* | 68.19 (10.24) | 64.33 (9.59) | 68.31 (9.95) | 71.90 (9.68) |
| *50-59* | 26,935 (21.74) | 15,078 (35.01) | 7,313 (19.74) | 4,544 (10.38) |
| *60-69* | 42,602 (34.39) | 16,218 (37.66) | 13,540 (36.55) | 12,844 (29.35) |
| *70-79* | 33,260 (26.85) | 7,788 (18.09) | 10,186 (27.49) | 15,286 (34.93) |
| *80+* | 21,081 (17.02) | 3,979 (9.24) | 6,011 (16.22) | 11,091 (25.34) |
| **Country of Birth** | | | | |
| *Native-born* | 11,2612 (90.91) | 39,365 (91.41) | 33,724 (91.02) | 39,523 (90.31) |
| *West, North, South Europe* | 3,573 (2.88) | 1,241 (2.88) | 1,103 (2.98) | 1,229 (2.81) |
| *Eastern Europe* | 4,722 (3.81) | 1,300 (3.02) | 1,388 (3.75) | 2,034 (4.65) |
| *Latin America & Caribbean* | 347 (0.28) | 156 (0.36) | 99 (0.27) | 92 (0.21) |
| *Central & West Asia* | 713 (0.58) | 239 (0.56) | 191 (0.52) | 283 (0.65) |
| *SE, South, & East Asia* | 389 (0.31) | 187 (0.43) | 107 (0.29 | 95 (0.22) |
| *Africa* | 1,403 (1.13) | 515 (1.20) | 410 (1.11) | 478 (1.09) |
| *North America & Oceania* | 119 (0.1) | 60 (0.14) | 28 (0.08 | 31 (0.07) |
| **Country of Residence** | | | | |
| *Western Europe* | 40,629 (32.80) | 15,354 (35.65) | 12,437 (33.57) | 12,838 (29.33) |
| *Northern Europe* | 24,412 (19.71) | 8,509 (19.76) | 7,323 (19.77) | 8,580 (19.60) |
| *Southern Europe* | 32,342 (26.11) | 10,480 (24.34) | 9,797 (26.44) | 12,065 (27.57) |
| *Eastern Europe* | 26,495 (21.39) | 8,720 (20.25) | 7,493 (20.22) | 10,282 (23.49) |
| **Highest Level of Education** | | | | |
| *None or Primary* | 28,033 (22.63) | 7,092 (16.47) | 8,202 (22.14) | 12,739 (29.11) |
| *Secondary* | 70,433 (56.86) | 25,445 (59.09) | 21,099 (56.95) | 23,889 (54.58) |
| *Post-secondary* | 25,412 (20.51) | 10,526 (24.44) | 7,749 (20.91) | 7,137 (16.31) |
| **Working Status** | | | | |
| *Retired* | 74,547 (60.18) | 19,646 (45.62) | 22,930 (61.89) | 31,971 (73.05) |
| *Employed* | 29,280 (23.64) | 16,357 (37.98) | 8,363 (22.57) | 4,560 (10.42) |
| *Unemployed* | 3,078 (2.48) | 1,520 (3.53) | 852 (2.30) | 706 (1.61) |
| *Permanently sick* | 4,417 (3.57) | 1,032 (2.40) | 1,196 (3.23) | 2,189 (5.00) |
| *Homemaker /Other* | 12,556 (10.14) | 4,508 (10.47) | 3,709 (10.01) | 4,339 (9.91) |
| **Household Income - Is household able to make ends meet?** | | | | |
| *Easily* | 36,174 (29.20) | 14,196 (32.97) | 11,119 (30.01) | 10,859 (24.8) |
| *Fairly easily* | 37,279 (30.09) | 13,552 (31.47) | 11,320 (30.55) | 12,407 (28.35) |
| *With some difficulty* | 35,254 (28.46) | 11,166 (25.93) | 10,501 (28.34) | 13,587 (31.05) |
| *With great difficulty* | 15,171 (12.25) | 4,149 (9.63) | 4,110 (11.09) | 6,912 (15.79) |

[a] *Values are unweighted counts and unweighted percentages from SHARE Wave 1-7 (2002-2017).*

[b] *Number of Chronic Diseases is measured as 2+ of the following chronic diseases: heart attack, high blood pressure, high blood cholesterol, stroke, diabetes, chronic lung disease, cancer, stomach ulcer, Parkinson disease, cataracts, and hip fracture.*
*Country of birth and country of residence regions were categorized based on the International Organization for Standardization (ISO) Geographic Region Classifications. Native-born refers to the country surveyed.*

## Table 3

*Multinomial logistic regression models for predicting multimorbidity among migrants in Europe, controlling for selected characteristics*

| | One chronic disease | | Two or more chronic diseases | |
|---|---|---|---|---|
| | Reference: No chronic diseases | | | |
| **Country of Birth** (Native-born) | Minimally Adjusted OR (95% CI)[a] | Fully Adjusted OR (95% CI)[b] | Minimally Adjusted OR (95% CI)[a] | Fully Adjusted OR (95% CI)[b] |
| *West, Northern, Southern Europe* | 1.03 (0.95, 1.12) | 1.05 (0.96, 1.14) | 0.98 (0.90, 1.06) | 1.06 (0.97, 1.15) |
| *Eastern Europe* | 1.22 (1.13, 1.32)** | 1.20 (1.11, 1.30)** | 1.50 (1.39, 1.61)** | 1.41 (1.31, 1.52)** |
| *Latin America & Caribbean* | 0.88 (0.68, 1.13) | 0.90 (0.69, 1.16) | 0.81 (0.62, 1.06) | 0.89 (0.67, 1.17) |
| *Central & West Asia* | 1.01 (0.83, 1.23) | 0.99 (0.82, 1.21) | 1.33 (1.11, 1.60)** | 1.16 (0.96, 1.40)** |
| *Southeast, South, & East Asia* | 0.76 (0.59, 0.96)** | 0.78 (0.61, 0.99)** | 0.64 (0.50, 0.83)** | 0.66 (0.51, 0.87)** |
| *Africa* | 1.03 (0.90, 1.18) | 1.00 (0.88, 1.15) | 1.12 (0.98, 1.28) | 0.98 (0.85, 1.12) |
| *North America & Oceania* | 0.60 (0.38, 0.95)** | 0.69 (0.44, 1.09) | 0.61 (0.39, 0.97)** | 0.83 (0.52, 1.33) |
| **Sex** (Female) | | | | |
| *Male* | 1.07 (1.04, 1.10)** | 1.07 (1.04, 1.11)** | 1.12 (1.09, 1.15)** | 1.16 (1.13, 1.20)** |
| **Age** (continuous) | 1.05 (1.04, 1.05)** | 1.03 (1.03, 1.04)** | 1.08 (1.08, 1.08)** | 1.06 (1.06, 1.06)** |
| **Country of Residence** (Western Europe) | | | | |
| *Northern Europe* | | 1.04 (0.99, 1.08) | | 1.12 (1.08, 1.17)** |
| *Southern Europe* | | 1.03 (0.99, 1.07) | | 1.03 (0.99, 1.07) |
| *Eastern Europe* | | 1.01 (0.97, 1.05) | | 1.24 (1.19, 1.29)** |
| **Highest Level of Education** (Post-secondary) | | | | |
| *None or Primary* | | 1.11 (1.06, 1.16)** | | 1.34 (1.28, 1.41)** |
| *Secondary* | | 1.04 (1.00, 1.08)** | | 1.14 (1.10, 1.19)** |
| **Working Status** (Retired) | | | | |
| *Employed* | | 0.70 (0.67, 0.73)** | | 0.43 (0.41, 0.45)** |
| *Unemployed* | | 0.70 (0.64, 0.77)** | | 0.56 (0.51, 0.62)** |
| *Permanently sick* | | 1.35 (1.23, 1.47)** | | 2.14 (1.97, 2.32)** |
| *Homemaker / Other* | | 0.83 (0.79, 0.87)** | | 0.77 (0.73, 0.81)** |
| **Household Income** - Is household able to make ends meet? (Easily) | | | | |
| *With great difficulty* | | 1.25 (1.18, 1.32)** | | 1.97 (1.87, 2.08)** |
| *With some difficulty* | | 1.17 (1.13, 1.22)** | | 1.45 (1.39, 1.51)** |
| *Fairly easily* | | 1.04 (1.01, 1.08)** | | 1.12 (1.08, 1.16)** |

Note: Reference categories are shown in parentheses.

[a] *Minimally Adjusted Model: included country of birth, sex, age.*

[b] *Fully Adjusted Model: included country of birth, sex, age, country of residence, education, working status, and household income. Country of birth and country of residence regions were categorized based on the International Organization for Standardization (ISO) Geographic Region Classifications. Native-born refers to the country surveyed.*

***p<0.05*

Multinomial logistic regressions are shown in Table 3. After controlling for other characteristics, foreign-born individuals born in Eastern Europe (compared to native-born individuals) had significantly higher odds of reporting 1 chronic disease (OR: 1.20, 95% CI: 1.11, 1,30) and multimorbidity (2+ chronic diseases) (OR: 1.41, 95% CI: 1.31, 1.52) rather than no chronic conditions (Table 3). Foreign-born individuals born in Southeast, South, & East Asia were significantly less likely to report 1 chronic disease (OR: 0.78, 95% CI: 0.61, 0.99) or 2+ chronic diseases (OR: 0.66, 95% CI: 0.51, 0.87). While, in unadjusted models, foreign-born

individuals born in North America and Oceania were significantly less likely to report 1 chronic disease and 2+ chronic diseases, their odds for chronic conditions were similar to those of native-born people after adjusting for other characteristics. Foreign-born individuals from Central and West Asia were significantly more likely to report multimorbidity but not 1 single chronic disease. Foreign-born individuals born in Northern, Southern, and Western Europe, Latin America and the Caribbean, and Africa had similar chronic disease patterns to native-born people.

Even after controlling for place of birth, country of residence was associated with multimorbidity. Among both foreign and native-born individuals, those residing in Northern Europe and Eastern Europe, compared to Western Europe, had significantly higher odds of multimorbidity (OR: 1.12, 95% CI: 1.08, 1.17 (Northern Europe); OR: 1.24, 95% CI: 1.19, 1.29 (Eastern Europe). The total effect (OR and 95% CI) for the association between multimorbidity and country of birth and interaction between country of birth and country of residence are shown in Table 4. Interaction was observed with a p-value of 0.0002 under the joint test for the interaction effect. However, the individual total effects were not significant for any combination of country of birth and country of residence.

## *Table 4*

*Multinomial Logistic Regression Adjusted Odds Ratios (total effect) and 95% CI for predicting multimorbidity by country of birth modified by country of residence, controlling for selected characteristics* [a]

| | **Residence Region** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | *Western Europe* | | *Northern Europe* | | *Eastern Europe* | | *Southern Europe* | |
| **(Baseline: 0 CD)** | **1 CD** | **2+ CD** | **1 CD** | **2+ CD** | **1 CD** | **2+ CD** | **1 CD** | **2+ CD** |
| **Country of birth (Native-born ref)** | | | | | | | | |
| *Western, Northern, Southern Europe* | 1.08 (0.98, 1.19) | 1.04 (0.94, 1.15) | 0.95 (0.75, 1.20) | 1.14 (0.91, 1.43) | 0.84 (0.52, 1.34) | 1.24 (0.78, 1.97) | 0.74 (0.36, 1.51) | 1.36 (0.67, 2.74) |
| *Eastern Europe* | 1.16 (0.96, 1.42) | 1.09 (0.88, 1.33) | 0.87 (0.55, 1.38) | 1.15 (0.73, 1.81) | 0.65 (0.25, 1.66) | 1.22 (0.48, 3.07) | 0.48 (0.12, 2.02) | 1.29 (0.32, 5.29) |
| *Latin America & the Caribbean* | 1.26 (0.93, 1.69) | 1.13 (0.83, 1.54) | 0.79 (0.40, 1.59) | 1.16 (0.59, 2.29) | 0.50 (0.12, 2.06) | 1.20 (0.30, 4.80) | 0.32 (0.04, 2.72) | 1.23 (0.15, 10.27) |
| *Central & West Asia* | 1.36 (0.91, 2.01) | 1.18 (0.78, 1.78) | 0.72 (0.29, 1.83) | 1.18 (0.48, 2.91) | 0.39 (0.06, 2.55) | 1.18 (0.18, 7.51) | 0.21 (0.01, 3.67) | 1.17 (0.07, 19.95) |
| *SE, South, & East Asia* | 1.46 (0.89, 2.40) | 1.23 (0.74, 2.05) | 0.66 (0.21, 2.10) | 1.19 (0.38, 3.70) | 0.30 (0.03, 3.17) | 1.15 (0.11, 11.76) | 0.14 (0.00, 4.95) | 1.12 (0.03, 38.75) |
| *Africa* | 1.58 (0.87, 2.85) | 1.28 (0.69, 2.37) | 0.60 (0.15, 2.42) | 1.20 (0.31, 4.70) | 0.23 (0.01, 3.94) | 1.13 (0.07, 18.40) | 0.09 (0.00, 6.68) | 1.07 (0.02, 75.31) |
| *N. America & Oceania* | 1.70 (0.85, 3.40) | 1.33 (0.65, 2.73) | 0.55 (0.11, 2.79) | 1.22 (0.25, 5.97) | 0.18 (0.01, 4.89) | 1.11 (0.04, 28.80) | 0.06 (0.00, 9.00) | 1.02 (0.01, 146.4) |

*a Adjusted for age, sex, education, working status, and income level.*

*b Chronic disease abbreviated as 'CD'.*

*c Country of birth and country of residence regions were categorized based on the International Organization for Standardization (ISO) Geographic Region Classifications. Native-born refers to the country surveyed.*

***p<0.05*

# DISCUSSION

The goal of this study was to investigate whether multimorbidity is associated with country of birth among migrants aged 50 years and older residing in Europe, and whether this association is modified by country of residence. The findings suggest that the risk of multimorbidity is associated both with early life experiences in the country of origin and with the post-migration circumstances and lifestyle in the country of resettlement.

Individuals born in Southeast, South, and East Asia, and North America and Oceania had lower odds of reporting one chronic disease and multimorbidity compared to native-born individuals in the European country where they were residing. Such differences could originate from the impact of social and structural environment in which people grew up. They could also be a result of selective migration, whereby people who are in good health are more likely to resettle in a different country. At the same time, people born in Eastern Europe and Central and West Asia had a higher odds of reporting multiple conditions than native-born people in their country of residence. Thus, there is great variability in health among migrants, even after accounting for the country where they resettled and for personal characteristics. These differences in health among migrants may result from differences in early life environments, socio-cultural and behavioural patterns associated with country of origin. They could also result in part from differences in selection of people into migration, that is, the more difficult it is to migrate, the more those who do migrate are better health and socioeconomic position. These findings are consistent with previous literature, for example, a study using national registries in Norway reported Eastern European migrants have higher odds of multimorbidity compared to foreign-born individuals from Western Europe, North America, Asia, Africa and Latin America (Diaz, Kumar, et al., 2015).

After accounting for country of origin, country of residence was also associated with multimorbidity, highlighting the additional importance of current living environments. Both migrants and non-migrants residing in Northern and Eastern Europe had higher odds of multimorbidity than those living in Western Europe; those residing in Southern Europe had similar multi-morbidity patterns to those in Western Europe. These regional differences in the prevalence of multimorbidity may relate to differences in age distribution of the population, differences in diagnosis of chronic conditions, as well as to living environments, lifestyles, and healthcare systems.

Additionally, among foreign-born people residing in European countries, there were differences in multimorbidity depending on their country of origin. Studies using SHARE data have identified ecological associations with frailty and country of residence, where people who have lived in relatively resource-poor countries of Southern and Eastern Europe during their late adulthood are more likely to be frail than people in the relatively resource-rich countries of Northern and Western Europe (Brothers et al., 2014; Santos-Eggimann et al., 2009). These patterns suggest that early life conditions can have different implications for health depending on later life circumstances. Barker and colleagues proposed that a mismatch between early life programming and adult circumstances can entail a high risk for chronic diseases, and these findings based on migrant health lend support to this idea (Barker et al., 2002). Exposure to harsh environmental conditions in early life and in utero in the host country will have lasting effects on health before, during, and after migration to a new host country. Those who make it through natural selection of hazardous early life exposures may exhibit deleterious effects during the aging process, due to antagonistic pleiotropy (Tan et al., 2003).

An important limitation of this analysis is that, using *easy*SHARE, we were unable to use sampling weights to adjust for study design. Without these, we cannot generalize to the population of the participating countries (Börsch-Supan et al., 2013). Previous studies using SHARE for migration-related analyses have noted that SHARE excludes migrants whose permanent residence is not in the country of interview, for example, transient workers and asylum seekers (Walkden et al., 2018). Because these types of migrants may have poorer health than resettled migrants, the findings presented here may indicate better health among migrants in Europe than is actually the case. Southern Europe especially houses a large population of undocumented migrants (Carta et al., 2005; Walkden et al., 2018), and we did not find evidence of interactions between country of birth and residence in Southern Europe. A related limitation is that, in using *easy*SHARE, we were not able to control for citizenship status or length of stay in the country of residence, which could relate to social integration and healthcare access (Diaz, Kumar, et al., 2015; Gimeno-Feliu et al., 2017; Gimeno-Feliu et al., 2020; Prados-Torres et al., 2018).

The measures of multimorbidity presented here are based on respondents' reports of chronic diseases in the first wave. Future studies using the full SHARE dataset can expand these analyses to also include other fractures; Alzheimer's disease, dementia, and memory impairment; affective or emotional disorders; rheumatoid arthritis; osteoarthritis, and chronic kidney disease. Lastly, because only the count of the chronic disease(s) for each respondent was included in the dataset, we were not able to examine the prevalence of each individual chronic disease or examine chronic disease combinations.

# CONCLUSION

This study using a large multi-country dataset showed that there is heterogeneity in chronic disease multimorbidity across country of birth and country of residence. It also showed that the risks of multimorbidity are different for people born in one country according to which country they subsequently resettled. These findings have implications for our understanding of migrant health and resettlement programs. People resettling in the same environment may have different health vulnerabilities, of which they, and their healthcare providers, should be aware. These findings are also relevant to our understanding of how our living environments across life may contribute to health trajectories even for people who do not migrate. Because migrants are individuals who, by definition, have been exposed to multiple living environments, we can see from their health, as demonstrated here, that their early life and adult living environments each contribute individually to adult health, as well as interacting to create different health trajectories with changing living environments. Notably, changes in living environments can also occur in situ, with possible implications for migrants and non-migrants alike.

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# APPENDIX

*International Organization for Standardization (ISO) Geographic Region Classifications*

| Country of Residence | Country or Area |
|---|---|
| *Northern Europe* | Sweden, Denmark, Ireland, Estonia, Lithuania, Finland, Latvia |
| *Western Europe* | Austria, Germany, Netherlands, France, Switzerland, Belgium, Luxembourg |
| *Southern Europe* | Spain, Italy, Greece, Portugal, Slovenia, Croatia, Malta |
| *Eastern Europe* | Israel, Czech Republic, Poland, Hungary, Bulgaria, Cyprus, Romania, Slovakia |
| **Country of Birth** | |
| *Eastern Europe* | Bulgaria, Belarus, Chechnya, Cyprus, Czechoslovakia, Czech Republic, Hungary, Israel, Moldova, Republic of, Poland, Romania, Russian Federation, Slovakia, Ukraine, U.S.S.R. |
| *Northern, Western, and Southern Europe* | Albania, Austria, Belgium, Bosnia and Herzegovina, Croatia, Denmark, Estonia, Faroe Islands, Finland, France, Germany, Greece, Greenland, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, Netherlands Antilles, Norway, Portugal, Serbia, Slovenia, Spain, Sweden, Switzerland, Macedonia, The former Yugoslav Republic of, United Kingdom |
| *Latin America and the Caribbean* | Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Grenada, Guadeloupe, Haiti, Honduras, Martinique, Mexico, Curacao, Aruba, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela, Virgin Islands (U.S.) |
| *Central Asia and West Asia* | Afghanistan, Azerbaijan, Bangladesh, Armenia, Georgia, Palestinian Territory, occupied, Iraq, Kazakhstan, Jordan, Kyrgyzstan, Turkey, Syrian Arab Republic, Tajikistan, Turkmenistan, Uzbekistan, Yemen, Afghan-Turkish, Turkish-Kurdish, Minor Asia, Kurdistan (region) |
| *Southeast, South, & East Asia* | Bhutan, Cambodia, Sri Lanka, India, Indonesia, Iran (Islamic Republic of), Lao People‘s Democratic Republic, Malaysia, Pakistan, Philippines, Singapore, Viet Nam, Thailand, Borneo Island<br>China, Taiwan, Hong Kong, Japan, Korea, Republic of, Macau, Taiwan, Hong Kong, Japan, Korea, Republic of, Macau |
| *Africa* | Africa, Algeria, Angola, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Republic of, Congo, Democratic Republic of (was Zaire), Benin, Equatorial Guinea, Ethiopia (before Eritrea broke away), Ethiopia, Eritrea, Gabon, Gambia, Ghana, Guinea, Côte d‘Ivoire, Kenya, Lebanon, Liberia, Libyan Arab Jamahiriya, Madagascar, Mali, Mauritania, Mauritius, Morocco, Mozambique, Nigeria, Guinea-Bissau, Reunion, Rwanda, Sao Tome and Principe, Senegal, Somalia, South Africa, Zimbabwe, Sudan, Togo, Tunisia, Uganda, Egypt, Tanzania, United Republic of, Burkina Faso, Zambia, Congo (both), Former Protectorate of Northern Rhodesia |
| *North America and Oceania* | Canada, United States of America, Australia, French Polynesia, New Zealand |