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MULTIMORDBIDITY AMONG MIGRANTS IN EUROPE: ASSOCIATIONS WITH COUNTRY OF BIRTH AND COUNTRY OF RESIDENCE

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BACHELOR OF SCIENCE
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Abstract

Multimorbidity Among Migrants in Europe: Associations with Country of Birth and Country of Residence
By Meaghan Woody

Background: Migrants are a growing population in Europe; in 2016, foreign-born individuals accounted for 10.7% of the European Union population. To explain disease patterns in migrant populations, the contextual circumstances of life experiences pre- and post-migration should be understood. Multimorbidity, defined as the occurrence of two or more chronic diseases existing concurrently in the same individual, is a holistic approach to studying chronic disease to understand disease patterns that occur due to environmental, social, and personal risk factors.

Objective: This study aims to investigate if multimorbidity is associated with country of origin among migrants residing in Europe, and if this association is modified by country of residence.

Methods: We used the Survey of Health, Aging, and Retirement in Europe (SHARE), a cross-national, multidisciplinary panel survey representative of individuals aged 50 and older living in Europe. Examining 112,612 native-born and 11,266 migrants sampled in 2002-2017, we investigated cross-sectional associations between country of birth and multimorbidity. 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 examined whether associations differed by migrant's country of residence, compared to native-born individuals in the same residence. Multinomial logistic regression models were used to assess multimorbidity and adjust for potential confounders.

Results: 37.65% of migrants and 35.10% of native-born individuals reported having multimorbidity. Compared to the native-born population, multimorbidity was significantly higher among migrants born in Eastern Europe (OR: 1.41, 95% CI: 1.31, 1.52) and Central and West Asia (OR: 1.16, 95% CI: 0.96, 1.40), and lower among migrants born in Southeast, South, and East Asia (OR: 0.66, 95% CI: 0.51, 0.87). Results remained significant after adjusting for socioeconomic factors. In the overall association between country of birth and multimorbidity, significant interaction was observed between country of birth and country of residence.

Conclusion: Overall, country of birth and country of residence are each associated with multimorbidity. These results underscore the importance of monitoring migrant health in national and regional health surveys to better understand the needs of the population and inform migrant-inclusive policies.

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I. Introduction

Background

Multimorbidity, defined as the presence of two or more chronic diseases, is highly prevalent worldwide and is estimated to further increase due to the growing aging population, increased risk factors, and improvements in medical technology (1–3). Multimorbidity is associated with older age, female sex, and lower socioeconomic class, but is not exclusive to these groups (4–6).

Migrants, or foreign-born individuals, are a growing population in Europe; in 2016, foreign-born individuals accounted for 10.7% of the European Union (7–9). The migration experience is unique to an individual's reason for migration, geographic origin, immigration status, and life history, each of which have differential effects on one's health (6,8). Multimorbidity is a holistic measurement to studying the health of migrants, focusing on chronic diseases as the consequence of environmental, social, and personal risk factors that contribute to increased vulnerability to a wide range of illnesses (10–12).

Migrant populations are commonly compared to the native-born population in the respective host countries to test the healthy migrant effect, which elucidates that migrants are frequently healthier than native-born individuals on arrival to the host country (10,13,14). Although migrants represent a selected and healthier subgroup of their country of birth population, their health worsens quicker than the native-born population upon arrival to the host country (15,16). In addition to genetic and migration factors, this population comparison between migrants and native-born individuals is affected by host country integration policies, economic origin, and the prevalence of specific diseases from the origin country (6,8).

Objective and Research Question

Cross-sectional analyses comparing migrants, characterized by country of birth, and native-born individuals have led to a better understanding of public health priorities and have generated new questions for explanatory research (16–18).

Using data from a large European cross-national health survey, the Survey of Health, Aging, and Retirement in Europe (SHARE), our primary objective was to study the association between multimorbidity and migrant status as characterized by country of birth, accounting for known risk factors for multimorbidity. Our secondary objective was to determine whether the association between multimorbidity and country of birth is modified by country of residence. For this study, multimorbidity was defined as the presence of two or more of the following chronic conditions: (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 tumor, (8) stomach or duodenal ulcer, peptic ulcer (9) Parkinson disease, (10) cataracts, and (11) hip fracture or femoral fracture. This work builds upon existing cross-sectional studies of European migrant health using SHARE by incorporating both European country of residence and country of birth regions to study the heterogeneity of the health of migrants in Europe (6,8,15,19).

II. Literature Review

Defining Multimorbidity

Multimorbidity is defined as the occurrence of two or more chronic diseases existing concurrently in the same individual (4). Multimorbidity is commonly measured in research studies using three methods (4). First, by the number of chronic diseases an individual is experiencing, which is usually at least two or three diseases. Second, using cumulative indices that take into account the number and the severity of the diseases in an individual. The Charlson Comorbidity Index, Comorbidity Illness Rating Scale, and the Cumulative Illness Rating Scale are widely used multimorbidity indices (4,20). Third, multimorbidity can be defined as the cumulative presence of diseases, symptoms, and functional limitations.

All three methods described measure the number of chronic diseases in an individual in some capacity and each have strengths and limitations. One advantage is that we are measuring multimorbidity on an additive scale and are able to differentiate individuals into levels of morbidity (4). The disadvantage is that we are effectively weighting all diseases equally, which minimizes the severity of the combination of chronic diseases that are both important and variable in an individual (1). The third definition is the most holistic by taking into account not only diagnosed diseases, but symptoms, cognitive and physical dysfunction, and psychosocial impairment as well (4).

Multimorbidity in Europe

In a systematic review by Vetrano et al., the prevalence of multimorbidity has been reported to span from 2% to 70% across 48 studies conducted in Europe (n = 20), North America (n = 14), Asia (n = 8), South America (n = 5), and Australia (n = 1) (20). A review by Fortin et al., which gathered results from 21 studies, reported the prevalence range by age with the largest

ranges for those aged 75 in primary care (3.5% to 98.5%) and those aged 75 in the general population (13.1% to 71.8%) (3). These large ranges can be explained by the differences in the studies' choice of number of diseases ascertained, diagnosis criteria, and the multimorbidity definition used (4). It is suggested that ascertaining as low as 4 to 7 chronic diseases leads to underestimation and greater variation in prevalence estimates (3).

European Cross-Country Comparisons

Studies have harmonized datasets to compare and estimate the prevalence of multimorbidity in European countries using national and multinational population-based health surveys, namely Ageing Trajectories of Health: Longitudinal Opportunities and Synergies (ATHLOS), and Survey of Health, Aging, and Retirement in Europe (SHARE).

In a multiregional analysis using ATHLOS, European countries showed higher rates of multimorbidity in England and Southern Europe (21). Low to middle income countries (LMIC), Africa, China, and India, showed lower rates of multimorbidity compared with high-income countries (HIC), Russia, 11 European countries, and Israel.

The SHARE project has been a strong source for multiregional analyses on multimorbidity. Using cross-sectional data from wave 5 (2012-2013), Nielsen et. al found that multimorbidity was lowest in Northern Europe (26.2%), followed by Southern Europe (29.8%), and equally high in Central and Eastern Europe (34.8% and 35.2%, respectively) (22).

The prevalence of multimorbidity among older adults varies widely across Europe due to the differences in disease ascertainment and diagnosis technology and standards, region specific risk factors and environmental exposures, and underlying population characteristics in each country (23). In addition, the combinations of chronic diseases, commonly studied as multimorbidity group combinations or patterns, are not distributed evenly across European

countries. The regional distribution may also be linked to different stages of development and type of health care systems, and delivery of multimorbidity care.

European-based Multimorbidity Measurements

No standard approach exists for measuring multimorbidity. Selection and definition of chronic diseases is dependent on the data available. Using SHARE for a multiregional analysis, which surveys participants 50 years of age and older, Nielsen et. al included the 12 most disabling diseases out of 16 diseases queried in the survey (22). The diseases included in the multimorbidity measurement were: (1) high blood pressure or hypertension, (2) diabetes or high blood sugar, (3) osteoarthritis, (4) rheumatoid arthritis, (5) heart attack, including myocardial infarction or coronary thrombosis or any other heart problem including congestive heart failure, (6) stroke, (7) cancer or malignant tumor, including leukemia or lymphoma but excluding minor skin cancers, (8) chronic lung disease, (9) hip fracture or femoral fracture, (10) Parkinson's disease, (11) Alzheimer's diseases, dementia or senility, and (12) affective or emotional disorders. The diseases that were not included were high blood cholesterol, stomach or duodenal ulcer/peptic ulcer, cataracts, and other fractures.

On the other hand, the method can change drastically based on the type of data available. A popular method that has been used by Gimeno-Fleu's studies, who has published many studies on multimorbidity among immigrant populations using a common measurement (6,14,15). Using the National Population Register and the Norwegian Health Economics Administration database (HELFO) and EpiChron Cohort, which both use clinical and administrative medical records, medical records from primary health care services and used medical diagnosis based on the International Classification of Primary Care (ICPC-2) and uses up to 114 expanded chronic disease clusters. Among these 114 chronic disease clusters, the ten most frequent for migrant

females in 2011 in Spain were hypertension, dyslipidemia, varicose legs, arthropathy, depression, thyroid disease, osteoporosis, obesity, dermatitis, and diabetes (14). For men, the most prevalent chronic diseases were hypertension, dyslipidemia, diabetes, arthropathy, dermatitis, obesity, prostate hypertrophy, depression, lower back pain, and COPD. Although, this sample was aged 18 years and older, unlike SHARE which was 50 years and older.

Multimorbidity Risk Factors

Reviews have shown that multimorbidity in cross-sectional and longitudinal studies is associated with older age, low socioeconomic class, and female sex (4). Female sex as a risk factor has been disputed. However, these three variables are consistently controlled for or stratified by in multimorbidity studies.

Age

Many studies have shown that multimorbidity is strongly associated with age (4,24,25). The prevalence of multimorbidity has been seen to double for individuals aged over 65, while experiencing an average of five concurrent diseases (24). The linear growth of multimorbidity prevalence with increasing age can be seen in stratified age groups, such as one study which reported the prevalence at age ≥ 45 years at 58.9% and age ≥ 65 years at 75.6% (24). This association may be explained by a longer exposure and greater vulnerability to chronic disease risk factors as age increases (4).

Female Sex

Greater prevalence of multimorbidity among females compared to males has been both reported and disagreed with in literature. Previous studies by Violan and a review by Marengoni indicated that women had greater prevalence of multimorbidity compared to men (4,5). Laires et al. reported that women had a higher average number of chronic health conditions and among

participants aged between 65 and 69, women had one more illness than men in this study (24). However, this study did not report any gender difference in the adjusted risk of multimorbidity, which disagrees with Violan and Marengoni.

This inconsistency may be explained by selection bias as men tend to seek medical help less frequently and in poorer health states than women (26). Women's greater awareness of health status and higher use of medical appointments leads to higher self-reporting of morbidity compared to men (24). Social and economic disadvantage can also explain the underlying mechanism to the gender differences explained in these results.

Low Socioeconomic Status and Low Education

Many studies have shown an inverse association between multimorbidity and socioeconomic status measured through deprivation index, health insurance coverage, and education level (5). Reviews have reported multiple measures of associations comparing the lowest and highest socioeconomic status and occurrence of multimorbidity to be between 1.20 and 1.91 (5).

Low education on its own has been measured as a determinant as well. Using the Heidelberg, Germany cohort of the European Prospective Investigation into Cancer and Nutrition (EPIC), one study measured education using three educational degrees: primary school, less, or no degree (low), secondary school (middle), and grammar school (high) (27). When comparing multimorbidity in the lowest and highest education groups, the odds ratio was statistically significant at 1.43.

Using self-reported measures of chronic diseases to assess multimorbidity may overestimate the true prevalence among individuals of higher socioeconomic status and higher education, as individuals of both classes are more likely to report their chronic illness (3,23).

Migration and Chronic Disease

The impact of migration on health begins at the country of origin, continues through the migration journey, and persists for the entirety of time spent at the destination country (10). The health determinants and experiences across these time periods are complex and can be described by nine intersecting determinants, including reason for migration, length of stay or acculturation period, socioeconomic characteristics, social support, neighborhood characteristics, health status, health knowledge, health practices, and access to care (8). Migrant and non-migrant health differences can vary by host country, country of origin, economic origin, and country-specific migration health policies (8).

While most studies generally compare the health of migrants to native-born populations in the respective host country, comparisons between migrant groups from the same country of origin moving to different host countries can provide insights into the effect of health determinants specific to countries of destination (28). This method has been used to study circulatory disease mortality in Europe. Two studies have shown patterns of circulatory heart diseases differing by country of birth, showing both differences and similarities in mortality depending on the destination country among each country of origin (17,18).

Multimorbidity Among Migrants in Europe

Multimorbidity has been used as a general measure of health status of migrants to study chronic diseases impacted by migration and transition (10). The prevalence of multimorbidity in foreign-born populations has been reported to be both lower and higher than in native-born populations (13,14).

In Italy, which has one of the oldest populations in the world, immigrants were reported to have fewer diseases than Italian citizens (25). Immigrants were defined as those without stay

permits and multimorbidity was assessed using hospital discharge records. The prevalence of Italian citizens with multimorbidity was 14.4% and the prevalence of multimorbidity in immigrants was 15.0% and 9.3%, standardized by age and gender respectively. Similarly, the prevalence of multimorbidity in Spanish undocumented migrants was also shown the be lower than both documented migrants and Spanish nationals (14).

The risk of multimorbidity among foreign-born migrants compared to the native-born population has been vastly studied. The risk has been shown to be lower than that of native-born residents in Spain, as well as in a separate study on family reunification immigrants in Denmark (6,7). Many important variables can influence the health of migrants including length of stay and country of birth.

Multimorbidity and Length of Stay

Length of stay is an important predictor in migrant health outcomes and is associated with increased multimorbidity prevalence (10,14,15). In documented migrants in Aragon, Spain, length of stay was associated with a higher multimorbidity prevalence, with 28.13% at length of stay ≥ 5 years, and 17.16% length of stay < 5 years (14). Though, undocumented migrants did not show the same association with length of stay and increased multimorbidity prevalence in this study. The association was confirmed in another study on Norway immigrants, particularly examining labor immigrants (10).

This association can be described by the increase of the use of health services in the host country and the reduction in the use of health services in the country of origin, especially if multimorbidity is measured using hospital databases (10). The reduction in the salmon bias is also noted with this association, where migrants remigrate to their home country when they become ill (10,15).

Multimorbidity and Country of Birth

Additionally, the prevalence of multimorbidity among migrants can be characterized by area of origin or country of birth to recognize heterogeneity in the migrant population. Gimeno-Feliu et. al investigated the relationship between multimorbidity and length of stay by area of origin (15). Compared to migrants from the same origin who lived in Spain with length of stay < 5 years, migrants from Asia with length of stay ≥ 5 years had the greatest risk of multimorbidity, followed by Western Europe and North America, Africa, Eastern Europe, and Latin America. Moreover, the probability of experiencing multimorbidity was lowest for migrants from Asian, followed Eastern Europe, Africa, Latin America, and Western Europe and North America. Additionally, in a study comparing Norwegian-born individuals and immigrants, the multimorbidity rates were lowest for migrants from Eastern Europe, followed by Asia, Africa and Latin America, and Western Europe and North America (10).

Conceptual Framework

Multimorbidity is defined as the presence of two or more chronic conditions affecting the same individual, which largely results in low quality of life and high health care utilization (10). Understanding the trends in multimorbidity can inform policy decisions by identifying prevalent health outcomes and allocating resources to the specific health needs of the population (11). Many studies have shown there is limited information on the health of migrants, specifically those residing in European countries, which has resulted in the lack of monitoring to improve migrant health (11,29). For many countries, this has limited their efficiency in responding to the current needs of migrant populations and developing future policies (11).

To explain the disease patterns in migrant populations, the contextual circumstances of life experiences prior to migration should be understood. The impact of migration on health

begins in the country of origin, persists through the migration journey, and continues in the host country through the duration of the length of stay (10,30). A life course epidemiology approach is useful as well to understand the physical and social exposures and their timing, duration, and sequence (30). With emphasis on the timing, migration can be viewed as a health transition. For migrants who enter Europe from less developed countries of origin, they experience both positive and negative health outcomes. Some protective effects are experienced rapidly, which include a decrease in infectious disease mortality, maternal and child mortality, and improved health care, safe drinking water, and sanitation (30). The hazardous effects related to chronic disease may be experienced after a lag period. The chronic diseases of interest in this transition are cancer, cardiovascular disease, and diabetes, which are associated with lifestyle factors such as Western nutritional diets, smoking, and physical inactivity (30).

The goal of this study is to investigate whether multimorbidity is associated with country of origin among migrants aged 50 years and older residing in Europe, and whether this association is modified by country of residence. If migrants from the same country of origin share similar health characteristics, we are tackling the question of whether multimorbidity is affected by host countries' differential environmental and social determinants of health (17). If multimorbidity is similar across host countries, it suggests that the disease patterns are largely influenced by social, cultural, and genetic factors of the migrant population (17).

Cross-country comparisons to survey migrant health can be useful for designing policy interventions and reviewing the efficiency of existing health systems in place. These cross-country comparisons involve comparing multiple host countries by its population of migrants from the same country of origin, who likely share similar health characteristics (28).

III. Data and Methods

Data Source

The Survey of Health, Ageing and Retirement in Europe (SHARE) is a cross-national, multidisciplinary, household-based panel survey that assesses health, socio-economic status, and social and family networks (31). SHARE has collected 7 waves of data on 140,000 individuals and covers 27 European countries and Israel.

In 2004, the first wave of SHARE surveyed 11 countries including Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Greece, Italy, the Netherlands, Sweden, and Israel. Additional countries were added in later waves: Czech Republic and Poland in wave 2; Estonia, Hungary, Portugal and Slovenia in wave 4; Luxembourg in wave 5; Croatia in wave 6. In wave 7, Finland, Lithuania, Latvia, Slovakia, Romania, Bulgaria, Malta and Cyprus were included, allowing all continental EU Member States to be represented in SHARE.

SHARE represents the population of individuals aged 50 and older living in Europe. Comparisons with three prominent European surveys (European Union Labour Force Survey (EU-LFS), the European Community Household Panel (ECHP), and the European Social Survey (ESS)) have shown that SHARE produces similar distributions of employment, income, education, and health (32).

SHARE is a panel survey and all SHARE respondents who were interviewed in any previous wave are part of the longitudinal sample. The survey retention rates were lowest in the second wave, causing the R-indicator (representativeness to the target population) to drop in the second wave. Although, the R-indicator has stabilized in waves 3-6 as the composition of the sample was maintained with respect to individual and household characteristics (33).

EasySHARE is a simplified version of the SHARE dataset for student training and for researchers who have little experience with complex survey data. EasySHARE contains the same number of observations as the main release of SHARE, simplified data structure, and a selection of central SHARE variables. EasySHARE measures have been selected or recoded in mind to perform comparative analyses with the US Health and Retirement Study (HRS) (34).

Sample Population

The SHARE inclusion criteria are persons aged 50 years and over at the time of sampling who have their regular domicile in the respective SHARE country. Those excluded were incarcerated persons, hospitalized or out of the country during the entire survey period, unable to speak the country's language(s), or have moved to an unknown address.

All SHARE respondents who were interviewed in any previous wave are part of the longitudinal sample. If they have a new partner living in the household, the new partner is eligible for an interview as well, regardless of age. In addition to individual and partner respondents, other respondents may be surveyed on family, financial or household matters as well, regardless of age. A proxy respondent is used only if physical and/or cognitive limitations make it too difficult for a respondent to complete the interview on their own. These limitations may include hearing loss, speaking problems, Alzheimer's disease, and difficulties in concentrating for the whole interview time period. Proxy respondents are given end-of-life interviews regarding the respondents last year of life and the circumstance of their death.

Age eligible respondents who participated are traced and re-interviewed if they move within the country and end-of-life interviews are conducted if they are deceased. Younger partners, new partners, and partners who never participated in SHARE will not be traced if they move and are not eligible for an end-of-life interview.

Data Collection

SHARE data collection is performed by computer-assisted personal interviewing (CAPI). Interviewers conduct face-to-face interviews using a laptop on which the CAPI instrument is installed. In addition to verbal questionnaires, physical exams are performed, making face-to-face interviews necessary. Interviews were conducted in respondents' homes by trained lay interviewers from professional survey agencies.

SHARE uses ex-ante harmonisation, where there is one common generic questionnaire that is translated into the national language, which may be multiple languages depending on the country. The survey is inputted into an internet-based translation tool and processed automatically in a CAPI instrument.

SHARE first conducted surveys in wave 1 in 2004-6, and has since conducted wave 2 (2006-2007), wave 3 (2008-2011), wave 4 (2010-2012), wave 5 (2013), wave 6 (2015), and wave 7 (2017). The time period and length of interviewing varies by country performing surveys. The SHARE surveys are prospective and ask respondents about their current circumstances recalling the past two years. Special life course surveys were also conducted on retrospective data solely in wave 3 (SHARELIFE) and partially in wave 7. This study excluded wave 3 to only capture prospective survey responses.

Variables

Main Exposure of Interest

The independent variable in this study is country of birth, collapsed into large 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 (35). If the respondent answered they were born in the USSR, it would be coded as USSR. If they answered "Russia", it would be coded as "Russia", even if the country was USSR when the respondent was born. Appendix Table 1 describes the ISO classifications used to categorize country of birth and country of residence and the countries contained in each category.

Country of birth was categorized into regions using the UNSD classifications (8,35). The geographical regions are based on continental regions and subdivided into small regions by the UNSD to account for homogeneity in sizes of population, demographic circumstances and accuracy of demographic statistics. Each country or small area is shown in one region only. The countries of birth that were reported by respondents and the countries of residence categorization are described in Table 1.

For country of birth, we used the regions (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.

Control variables

Additional demographic and socioeconomic variables that were analyzed as possible confounders were age, sex, residence region, education, working status, and household income.

Sex was recorded by asking the interviewer to note sex of respondent from observation, and gender was categorized into male and female.

Age was recorded using date of birth. Age was categorized into ten-year groups for descriptive analysis (50-59, 60-69, 70-79, 80+) and was used as a continuous variable for logistic regression.

Country of residence was coded as the country the interview took place. Country of residence regions was also categorized using the UNSD classifications. The European residence countries were placed up into the regions: (1) Western Europe, (2) Northern Europe, (3) Southern Europe, and (4) Eastern Europe.

Education was a generated variable created with country-specific measurements and ex-post harmonization and standardized by ISCED (International Standard Classification of Education) and NACE (Nomenclature des Activités Économiques dans la Communauté Européenne) codes (19). The following 8-level ISCED categorization was coded by SHARE: Level 1: Primary education or first stage of basic education, Level 2: Lower secondary or second stage of basic education, Level 3: (Upper) secondary education, Level 4: Post-secondary non-tertiary education, Level 5: First stage of tertiary education, Level 6: Second stage of tertiary education, "still in school", and "none". We further condensed education into the 3-level variable referencing previous studies that used SHARE data: None or primary, Secondary, Post-secondary (includes still in school and other) (8).

Working status or current job situation was measured by asking the respondents, "In general, how would you describe your current situation?", where they answered retired, employed or self-employed (including working for family business), unemployed, permanently sick or disabled, homemaker, and other. Working status was condensed into five categories: retired, employed, unemployed, permanently sick, and homemaker/other (36).

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 unchanged for analysis.

Dependent variables

Chronic diseases and conditions were assessed with the question, “Has a doctor ever told you that you had/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”. This question was asked in wave 1, 2, 4, 5, 6, and 7. The conditions surveyed were modified between waves, therefore only conditions that were surveyed in all six waves will be analyzed. 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 tumor, (8) stomach or duodenal ulcer, peptic ulcer (9) Parkinson disease, (10) cataracts, and (11) hip fracture or femoral fracture.

The number of chronic diseases variable which counts the number of chronic diseases each respondent indicated they had was provided by easySHARE. To analyze multimorbidity, the three-level categorical variable was created, whereas individuals were coded as 0 (with zero chronic diseases), 1 (with one chronic disease), and 2 (with ≥ 2 chronic diseases, or multimorbidity).

Data Preparation

Sample Creation

The easySHARE data is stored in the long format, where one data line represents one wave in which the 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 and children of respondents who were younger than 50 years old.

Data Cleaning and Coding

Missing Data

Each variable was cleaned for missing value codes. The responses that were coded as missing for analysis were: -3: "implausible value/suspected wrong", -7: "not yet coded", -9: "not applicable filtered", -12: "don't know / refusal", -13: "not asked in this wave", -14: "not asked in this country", -15: "no information", and -16: "no drop-off (information in drop-off in this wave)". Univariate analyses were used to identify missing values and to confirm the values were properly cleaned.

Table 1 represents the summary statistics of variables and missingness. The sample size was 131,219 before listwise deletion. Observations had missing data on migrant status (809, 0.62%), number of chronic diseases (1,046, 0.80%), county of birth (2,415, 1.84%), education (1,417, 1.08%), working status (2,646, 2.02%), and household income (3,923, 2.99%). Listwise deletion was performed in SAS to omit observations with missing data, resulting in the analytic sample size of 123,878.

Creation of the Foreign-Born Variable

We created a new variable called "mod1", which indicates whether or not respondents were born in the country of interview at their first wave interview. We also created a variable called "mod2", which indicates whether or not respondents were born in the country of interview at the last wave interview. This is to account for respondents who entered or left the study at wave 3, where a demographic survey was not conducted.

We then created a variable called “mod”, indicating whether the respondent was born in the country of interview at the last wave interviewed. If we did not have valid data for “mod”, we used data from the first wave interviewed. If we still had a value of -13 (not asked at this wave), we compared the country of interview with the country of birth to determine whether they were foreign-born or native-born. We then used "mod" to create a binary variable called "foreign_born", where foreign_born = 0 if respondent is native-born and foreign_born = 1 if respondent is foreign-born.

Creation of the Migration Trajectory Variable

An 8-level categorical variable was created to compare the migration path of respondents of foreign-born and native-born respondents, using the responses from the country of birth variable. The categories were coded as: 0: did not migrate (native-born), 1: migrated within Northern, Southern, & Western Europe to elsewhere in Europe, 2: migrated from Eastern Europe to elsewhere to Europe, 3: migrated from Latin America and the Caribbean to Europe, 4: migrated from Central & Western Asia to Europe, 5: migrated from Southeast, South, & East Asia to Europe, 6: migrated from Africa to Europe, and 7: migrated from North America/Oceania to Europe.

Statistical Analysis

All analyses were conducted using SAS 9.1. This analysis and the easySHARE dataset do not include survey weights. This study is representative of the population of individuals aged 50 and older living in Europe (32).

Descriptive Analyses

First, descriptive analyses were conducted to describe the distribution of the covariates among the number of chronic diseases categories and country of birth categories (Table 1 and Table 2, respectively) using cross tabulations.

Modeling

Multinomial logistic regression was used to assess the association between country of birth and multimorbidity, characterized by the number of chronic diseases, and minimally and fully adjusted by confounders. Odds ratios and their 95% confidence interval through multinomial logistic regression are presented in Table 3. Respondents who reported 0 chronic diseases were treated as the baseline outcome 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 controlled for age, sex, and socioeconomic variables (education, working status, and household income).

Additionally, we tested for interaction between country of birth and residence country in the fully adjusted model to quantify how much the odds of multimorbidity increases or decreases for respondents from a particular country of birth, given where they are now residing in Europe. 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.

In the models below, the outcome G has three categories, which refer to 0 chronic diseases, 1 chronic disease, and 2+ chronic diseases. The lowercase g (1,2) subscript refers to the specific comparison being made to the reference category. The α_g term represents the intercept. The β_{g1} term represents the regression coefficient for the main exposure (country of birth). The γ_{g1} terms represent confounders that are adjusted for in the model.

Minimally Adjusted Model:

$$ln\left[\frac{P(G=g|CBirth)}{P(G=g|CBirth)}\right] = \alpha_g + \beta_{g1} * CBirth + \gamma_{g1} * Age + \gamma_{g2} * Sex$$

Tests the association between the 3-level outcome G (2 chronic diseases and 1 chronic disease vs. 0 chronic diseases) and the main exposure country of birth, adjusting for age and sex.

Fully Adjusted Model:

$$ln\left[\frac{P(G=g|CBirth)}{P(G=g|CBirth)}\right] = \alpha_g + \beta_{g1} * CBirth + \gamma_{g1} * Age + \gamma_{g2} * Sex + \gamma_{g3} * Residence + \gamma_{g4} * Education + \gamma_{g5} * WorkingStatus + \gamma_{g6} * Income$$

Tests the association between the 3-level outcome G (2 chronic diseases and 1 chronic disease vs. 0 chronic diseases) and the main exposure country of birth, adjusting for age, sex, and country of residence.

Fully Adjusted Model with Interaction:

$$ln\left[\frac{P(G=g|CBirth)}{P(G=g|CBirth)}\right] = \alpha_g + \beta_{g1} * CBirth + \gamma_{g1} * Age + \gamma_{g2} * Sex + \gamma_{g3} * Residence + \gamma_{g4} * Education + \gamma_{g5} * WorkingStatus + \gamma_{g6} * Income + \delta_{g1} CBirth * Residence$$

Tests the association between the 3-level outcome G (2 chronic diseases and 1 chronic disease vs. 0 chronic diseases) and the main exposure country of birth and the interaction between country of birth and country of residence, adjusting for age, sex, and country of residence.

IV. Results

Descriptive Results of Study Population

The demographic and socioeconomic characteristics of the unweighted SHARE study population surveyed in 2002-2017 are presented in Table 1 and 2. The study population included a total of 123,878 SHARE respondents with 112,612 (90.91%) native-born status and 11,266 (9.09%) migrant status. 54.98% of the entire sample was female and the mean age was 68.19, with similar age distribution categories across the migrant and native-born samples. The distribution of the SHARE sample population by migrant status, characterized by geographic country of birth (regionally), is shown in Table 1. By country of birth, the two largest regions that migrants were born in were Eastern Europe (41.91%) and Northern, Western, and Southern Europe (31.71%), with the five remaining regions outside of Europe represented at much smaller percentages. The country of residence region that housed the most migrants was Western Europe (40.05%), followed by Northern Europe (25.65%). The percentage of migrants living in each country of residence varied widely by country of origin. Full descriptive analyses by migrant status are shown in Table 1.

Socioeconomic characteristics were also assessed, which showed that compared to native-born respondents, migrants had similar education levels, were less often retired from work at the time of interview, and were more likely to report household income struggles. Migrants born in Africa and Central & West Asia reported the lowest education levels and worst income struggles, while migrants from North America & Oceania reported the highest education levels and were least likely to report income struggles. Although migrants born in Northern, Southern, and Western Europe and migrants born in Eastern Europe both reported high education and high

retirement levels, migrants born in Eastern Europe were more likely to report worse income struggles than migrants born in Northern, Southern, and Western Europe.

The distribution of number of chronic diseases by sample characteristics, categorized as 0, 1, and 2+ diseases, was assessed in Table 2. 37.65% of all migrants and 35.10% of all native-born individuals reported 2+ chronic diseases. Reporting 1 chronic disease did not differ largely between migrants and native-born individuals (29.52% versus 29.95% for migrants and native-born, respectively). Full descriptive analyses by chronic disease outcome status are shown in Table 2.

Migrants born in Eastern Europe had the highest levels of self-reported multimorbidity (43.07%), followed by migrants born in Central and West Asia (39.69%). Migrants born in Latin America and the Caribbean and Southeast, South, and East Asia were on average younger than other countries of birth regions; these two countries of birth regions also reported the two lowest multimorbidity levels (26.72% and 24.40%, respectively), which aligns with our understanding that multimorbidity increases with age.

Multivariate Logistic Regression Models for Multimorbidity

Multivariate logistic regression was performed to test the association between multimorbidity, characterized by the 3-level number of chronic disease variable (0 chronic diseases, 1 chronic disease, 2+ chronic diseases), and country of birth. The minimally adjusted model controlled for age and sex. The fully adjusted model additionally controlled for country of residence, working status, education level, and household income. Full listings of odds ratios and 95% Confidence Intervals (CIs) for the multinomial logistic regression analyses are shown in Table 3.

For countries of birth, migrants 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 2+ chronic diseases (OR: 1.41, 95% CI: 1.31, 1.52). Migrants born in Southeast, South, & East Asia were significantly less likely to report 1 chronic disease (OR: 0.78, 95% CI: 0.61, 0.99) and 2+ chronic diseases (OR: 0.66, 95% CI: 0.51, 0.87).

Migrants born in North America and Oceania were significantly less likely to report 1 chronic disease and 2+ chronic diseases, but this association was no longer significant in the fully adjusted model including socioeconomic status variables. Migrants born in Central and West Asia were significantly more likely to report 2+ chronic diseases, but showed no significance in reporting 1 chronic disease. Migrants born in Northern, Southern, and Western Europe, Latin America and the Caribbean, and Africa were not significantly associated with reporting number of chronic diseases.

Among both migrants and native-born individuals, residing in Northern Europe and Eastern Europe (compared to Western Europe) was significantly associated with higher odds of reporting 2+ chronic diseases (OR: 1.12, 95% CI: 1.08, 1.17 (Northern Europe); OR: 1.24, 95% CI: 1.19, 1.29 (Eastern Europe)). Residing in Southern Europe did not have a significant effect on chronic disease reporting.

Additionally, among both migrants and native-born individuals, sex, age, education level, working status, and household income were associated with reporting both 1 chronic disease and 2+ chronic diseases compared to 0 chronic diseases. Male sex, older age, lower education status, not working due to permanent sickness, and having incomes struggles were associated with higher multimorbidity reporting.

Interaction was assessed for two variables: country of birth and country of residence for the association between country of birth and multimorbidity. Significant interaction was observed with an interaction p-value of 0.0002 under the joint test for the interaction effect, elucidating that some of the country of birth and country of residence combinations are significant, though complex to interpret. Table 4 shows the significant Maximum Likelihood Estimates (including beta estimates and standard errors) for the association between multimorbidity and country of birth modified by country of residence, compared to reference levels.

We found four significant combinations in the association of country of birth and multimorbidity modified by country of residence: (1) migrants born in Africa residing in Northern Europe for 1 chronic disease and 2+ chronic diseases compared to 0 chronic diseases, (2) migrants born in Western, Northern, and Southern Europe residing in Northern Europe for 2+ chronic diseases, (3) migrants born in Western, Northern, and Southern Europe residing in Eastern Europe for 2+ chronic diseases, and (4) migrants born in Eastern Europe residing in Eastern Europe. Full interactions results (including beta estimates and standard errors) are shown in Table 4.

V. Discussion

Main Findings

In a large European dataset, we investigated whether multimorbidity is associated with migration status as characterized by country of birth, controlling for country of residence and socioeconomic characteristics. Overall, our results show that country of birth and current European country of residence is associated with reported multimorbidity, defined as two or more chronic diseases. We observed heterogeneity by European country of residence in the association between country of birth and multimorbidity reporting.

The odds of reporting multimorbidity differed by country of birth and country of residence. There were consistently lower odds of reporting one chronic disease and multimorbidity for migrants from Southeast, South, and East Asia, and North America and Oceania, and higher odds for migrants from Eastern Europe and Central and West Asia. Studies comparing the reason for migration among migrants residing in Norway have also shown that Eastern European refugees have higher odds of multimorbidity compared to migrants from Western Europe, North America, Asia, Africa and Latin America, though Eastern European migrants had the lowest odds of multimorbidity among all labor migrants in Norway (10). A possible explanation to this may be attributed to the heterogeneity of health status, cultural diversity, medical care, and hegemony of the country of origin among the group of Eastern European migrants, particularly those from Poland, Bosnia, and Kosovo (10).

The association between country of birth and multimorbidity reporting differed by country of residence. In Northern and Eastern Europe, participants residing in these areas demonstrated higher odds of multimorbidity in comparison to participants living in Western Europe. No difference was seen in participants residing in Southern Europe. 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 (19,37). However, this association has not been explained in Southern Europe alone, which may be attributed to greater health selection effect for those individuals who choose to migrate to Southern Europe for the reasons of fleeing conflict, war and economic crises (19).

Several risk factors have been linked to multimorbidity by previous studies, such as age, sex, and socioeconomic status. Consistent with previous literature, sex, age, education level, working status, and household income were all associated with reporting both one chronic disease and multimorbidity (5). In our study, males had greater odds of reporting multimorbidity compared to females.

We found evidence of significant interaction in the association between reported multimorbidity and country of birth modified by European country of residence. A similar significant interaction association has also been reported for migration status, characterized as migrants and native-born, and frailty, modified by country of residence using SHARE data (8,19). The interaction effect has not yet been studied using the measures for migrant status as characterized geographic country of origin and geographic country of residence and using SHARE data.

Strengths and Limitations

There were limitations in our analysis due to using easySHARE instead of the complete SHARE dataset. Foremost, the absence of sampling design weights to compensate for unequal selection probability among the SHARE interview countries. Without these sampling design

weights, it is not possible to obtain unbiased estimates of population parameters (31) Additionally, SHARE was not designed to examine migration patterns in Europe, nor does it claim to be representative of migrant populations in the respective interview country (19).

Studies using SHARE for migration-specific analyses have noted that SHARE excludes a large population of migrants whose permanent residence is not in the country of interview, as this is an inclusion criterion (8). Migrants who do not have a permanent residence represent transient workers, trafficked persons, refugees, and asylum seekers. The underrepresentation of these migrants in SHARE may have biased the multimorbidity associations towards the null, as these groups experience greater vulnerability and experience negative health outcomes (8). Southern Europe houses a large population of undocumented migrants due to its culture, history, and geography (8,38). This may explain why we did not find associations in the interaction between country of birth and Southern Europe residence. While this limitation biases our results, it is standard for studies not to be generalizable to undocumented migrants and individuals without permanent residences.

Moreover, this study did not include citizenship status, which could explain barriers to healthcare access and health insurance and can influence the number of chronic diseases reported. Additionally, we were not able to include length of stay in our analysis, which also influences multimorbidity among the migrant population and some studies deem essential to account for (10,14,15,29). The full SHARE dataset captures both citizenship status and length of stay, though easySHARE does not.

To assess multimorbidity in our analysis, we could only capture chronic diseases that respondents were asked to report in each wave conducted. EasySHARE did not capture the chronic diseases added in subsequent waves. The list of chronic diseases that were captured in

each wave included: heart attack, high blood pressure, high blood cholesterol, stroke, diabetes, chronic lung disease, cancer, stomach ulcer, Parkinson disease, cataracts, and hip fracture. The following conditions were not included in this study's analyses: other fractures, Alzheimer's disease, dementia, or any other serious memory impairment, other affective or emotional disorders, including anxiety, nervous or psychiatric problems, Rheumatoid Arthritis, Osteoarthritis, or chronic kidney disease. Because many other published studies have used the complete SHARE dataset, we may have undercounted the number of chronic diseases an individual reported in comparison to these studies and biased our results towards the null. Lastly, we were not able to examine individual chronic diseases or chronic disease combinations. Due to easySHARE restrictions, only the count of the chronic disease(s) for each respondent was included in the dataset.

The limitations described due to using easySHARE should be assessed in future studies by replicating the analysis using the full SHARE dataset and enhancing the data with cross-section weights and the variables for citizenship status, length of stay, and individual chronic diseases. This recommendation comes directly from the SHARE Project User Support Team.

This is a large study including 123,878 respondents, which allowed us to look for heterogeneity by country of residence, country of birth, and interaction between country of birth and country of residence. This study combined previously used measures for geographic country of birth and geographic country of residence to study differences between migrants and native-born populations in Europe. This approach adds to the growing literature of multimorbidity using a large cross-country comparison survey and can be used to help inform future studies.

Conclusion

Overall, our results show that migrant status characterized by country of birth and country of residence are associated with reported multimorbidity. This study has highlighted the differences in the burden of multimorbidity among countries of origin and country of residence. These differences remain significant after accounting for post-migration experiences, including working status and household income, and emphasize the importance of the heterogeneity in the migrant population. Our data limitations and the European Union's lack of organizational and regulatory effort to monitor migrant health imply that migration specific surveys must be established or included in existing national and regional data collection projects. The migration experience must be better captured to include variables on pre-migration experience and post-migration acculturation, which can provide evidence to support migrant-inclusive policies that promote healthcare and citizenship rights to improve the overall health of migrants in their respective host country.

VI. Data Acknowledgements

This paper uses data from SHARE Waves 1, 2, 3, 4, 5, 6, 7 and 8 (DOIs: 10.6103/SHARE.w1.710, 10.6103/SHARE.w2.710, 10.6103/SHARE.w3.710, 10.6103/SHARE.w4.710, 10.6103/SHARE.w5.710, 10.6103/SHARE.w6.710, 10.6103/SHARE.w7.711, 10.6103/SHARE.w8cabeta.001), see Börsch-Supan et al. (2013) for methodological details (31).

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This paper uses data from the generated easySHARE data set (DOI: 10.6103/SHARE.easy.710), see Gruber et al. (2014) for methodological details. The easySHARE release 7.1.0 is based on SHARE Waves 1, 2, 3, 4, 5, 6 and 7 (DOIs: 10.6103/SHARE.w1.710, 10.6103/SHARE.w2.710, 10.6103/SHARE.w3.710, 10.6103/SHARE.w4.710, 10.6103/SHARE.w5.710, 10.6103/SHARE.w6.710, 10.6103/SHARE.w7.710) (34).

VII. References

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VIII. Tables and Figures

Table 1. Sample Characteristics of Survey of Health of Aging and Retirement in Europe (SHARE) by Migrant Status as characterized by Country of Birth Geographic Region (N=123,878)

	Migrant Status		**Country of Birth**						
	Native-born	*Migrants (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 Europe	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.

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=123878	n=43063	n=37050	n=43765
Sex				
Female	68107 (54.98)	24318 (56.47)	20268 (54.70)	23521 (53.74)
Male	55771 (45.02)	18745 (43.53)	16782 (45.30)	20244 (46.26)
Age				
Mean (SD)	68.19 (10.24)	64.33 (9.59)	68.31 (9.95)	71.90 (9.68)
50-59	26935 (21.74)	15078 (35.01)	7313 (19.74)	4544 (10.38)
60-69	42602 (34.39)	16218 (37.66)	13540 (36.55)	12844 (29.35)
70-79	33260 (26.85)	7788 (18.09)	10186 (27.49)	15286 (34.93)
80+	21081 (17.02)	3979 (9.24)	6011 (16.22)	11091 (25.34)
Country of Birth				
Native-born	112612 (90.91)	39365 (91.41)	33724 (91.02)	39523 (90.31)
Western, Northern, Southern Europe	3573 (2.88)	1241 (2.88)	1103 (2.98)	1229 (2.81)
Eastern Europe	4722 (3.81)	1300 (3.02)	1388 (3.75)	2034 (4.65)
Latin America & the Caribbean (LAC)	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)
Southeast, South, & East Asia	389 (0.31)	187 (0.43)	107 (0.29	95 (0.22)
Africa	1403 (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	40629 (32.80)	15354 (35.65)	12437 (33.57)	12838 (29.33)
Northern Europe	24412 (19.71)	8509 (19.76)	7323 (19.77)	8580 (19.60)
Southern Europe	32342 (26.11)	10480 (24.34)	9797 (26.44)	12065 (27.57)
Eastern Europe	26495 (21.39)	8720 (20.25)	7493 (20.22)	10282 (23.49)
Highest Level of Education				
None or Primary	28033 (22.63)	7092 (16.47)	8202 (22.14)	12739 (29.11)

Secondary	70433 (56.86)	25445 (59.09)	21099 (56.95)	23889 (54.58)
Post-secondary	25412 (20.51)	10526 (24.44)	7749 (20.91)	7137 (16.31)
Working Status				
Retired	74547 (60.18)	19646 (45.62)	22930 (61.89)	31971 (73.05)
Employed	29280 (23.64)	16357 (37.98)	8363 (22.57)	4560 (10.42)
Unemployed	3078 (2.48)	1520 (3.53)	852 (2.30)	706 (1.61)
Permanently sick	4417 (3.57)	1032 (2.40)	1196 (3.23)	2189 (5.00)
Homemaker /Other	12556 (10.14)	4508 (10.47)	3709 (10.01)	4339 (9.91)
Household Income - Is household able to make ends meet?				
Easily	36174 (29.20)	14196 (32.97)	11119 (30.01)	10859 (24.8)
Fairly easily	37279 (30.09)	13552 (31.47)	11320 (30.55)	12407 (28.35)
With some difficulty	35254 (28.46)	11166 (25.93)	10501 (28.34)	13587 (31.05)
With great difficulty	15171 (12.25)	4149 (9.63)	4110 (11.09)	6912 (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.

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	
	Baseline: 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]**
Western, 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 & the 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.
** Significant at the 0.05 level.

Table 4. Multinomial Logistic Regression Adjusted Beta Estimates and Standard Errors for predicting multimorbidity by country of birth modified by country of residence, controlling for selected characteristics[a]

	Country of Residence							
	Western Europe		**Northern Europe**		**Eastern Europe**		**Southern Europe**	
(Baseline: 0 CD)[b]	**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				0.31 (0.18)*		0.52 (0.18)**		
Eastern Europe						0.53 (0.15)**		
Latin America & the Caribbean								
Central & West Asia								
Southeast, South, & East Asia								
Africa			-0.41 (0.20)**	-0.52 (0.21)**				
North America & Oceania								

[a]Fully adjusted model controlled for age, sex, country of residence, education, working status, and household income.
[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.
** Significant at the 0.05 level.
* Significant at the 0.10 level.

IX. Appendices

Table 1. 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 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

Table 2. Descriptive Summary Statistics of Variables and Missingness for Survey of Health of Aging and Retirement in Europe (SHARE) 2002-2017 (N = 131,219)

Variable	Mean (SD)	Range	Missing (%)*
Migrant Status			809 (0.62)
Sex			0
Age (years)	68.48 (10.42)	50.1 - 111.6	0
Number of Chronic Diseases	1.26 (1.28)	0 - 9	1046 (0.80)
County of Birth			2415 (1.84)
Country of Residence			0
Highest Level of Education			1417 (1.08)
Working Status			2646 (2.02)
Household Income - Is household able to make ends meet?			3923 (2.99)

*Participants were coded as missing for the responses: don’t know / refusal, not asked in this wave, and no information.