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Cardiovascular Disease
and Risk Factors

The Prevalence of Multimorbidity among Foreign-born Adults in the United States

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Objective: We examined multimorbidity among foreign-born adults in the United States. This population may be particularly affected by chronic conditions and limited health care access.

Design: Longitudinal cohort.

Setting: United States.

Participants: Foreign-born adults at the point of legal permanent residency.

Methods: We estimated the prevalence of multimorbidity and patterns over time. Data are from the New Immigrant Survey (NIS), a nationally representative study of adult immigrants at green card status in 2003 (N=8,174) and reinterview in 2008.

Main Outcome Measures: Multimorbidity defined as two or more of eight chronic conditions (hypertension, diabetes, obesity, arthritis, stroke, cancer, chronic lung disease, and heart problems).

Results: The prevalence of multimorbidity was 6% in 2003, and 12% in 2008. The most common condition dyad at both time points was hypertension-obesity; the largest increase over time was in combinations that included hypertension, diabetes, and obesity. The odds of having multimorbidity compared to no chronic conditions were higher among older immigrants and those who had seen a doctor in the past year. The odds of gaining one chronic condition over a 5-year period increased with age; 45-65 years: OR 2.8[CI 2.3,3.5]; aged ≥65 years: OR 3.2 CI[2.2,4.7].

Conclusions: The prevalence of multimorbidity among immigrants was lower than the prevalence in the overall US population of the same age, consistent with studies showing an immigrant health advantage. *Ethn Dis*. 2022;32(3):213-222; doi:10.18865/ed.32.3.213

Keywords: Migration; Chronic Disease; Cardiometabolic Disease

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Introduction

The prevalence of chronic diseases is high in the United States; 42% of the nation's adults have obesity, 12% have diabetes, 15% have chronic kidney disease, 48% have cardiovascular diseases, and 40% have been diagnosed with cancer sometime in their lifetime.[1-3] Many people suffer from multiple chronic conditions, particularly cardiometabolic diseases.[4] For example, 50% of people with diabetes also have hypertension and 18.5% of people with obesity have diabetes.[5] People with multiple chronic conditions are more likely to have functional limitations, disability and have higher health care needs and medical costs, and higher risks of premature mortality than people with just one condition.[6,7]

Some of the most commonly occurring disease clusters involve hypertension, diabetes, heart disease and depression.[4,8] Studies differ in the number and type of chronic conditions they use to define multimorbidity[4,9]; therefore, the estimated prevalence of multimorbidity varies across publications, with nationally representative estimates of the prevalence of multimorbidity for US adults ranging from 9% to 26%.[4,8]

Of the US adult population, 14.4% are foreign-born. Some research has found that foreign-born adults are less likely than native-born adults to suffer from heart disease, overweight, obesity, mental disorders, and several cancers.[10] However, several studies have also found that foreign-born people have worse cardio-metabolic health: cardiovascular disease, diabetes, and obesity. These conditions are generally less prevalent

in foreign-born people on arrival, but they increase disproportionally with time since arrival.[11] Some studies have hypothesized that foreign-born people resettling in the United States acculturate into obesogenic contexts, that is, they find themselves in food environments and built environments that are conducive to the development of chronic disease, and, with time, they adopt the risk inherent in these environments.[12-16]

Previous studies have reported on the prevalence of multimorbidity among foreign-born people.[17,18] In the United States, a cross-sectional study of Asian Indian, Chinese, and non-Hispanic Whites reported multimorbidity prevalence among foreign-born adults in these groups to be 26.5% during 2012-2017 (10 chronic conditions considered).[19] In Europe, the prevalence of multimorbidity of immigrants has been estimated at 9% to 38%, varying by region of origin, sex, and length of stay.[18,20,21] Among adult asylum seekers in Switzerland, psychiatric conditions were especially prevalent in estimates of multimorbidity, where 20% had multimorbidity involving psychiatric conditions.[17] In Spain, multimorbidity prevalence was 14.2% among foreign-born adults (aged ≥15 years), with highest prevalence among those from Western Europe and North America (21.2%), followed by Latin America (18.5%), Africa (11.7%), Eastern Europe (10.4%), and Asia (10%).[20]

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In this study, we used data from the nationally representative New Immigrant Survey (NIS) to estimate the disease patterns and prevalence of multimorbidity over time among foreign-born adults at the point of receiving legal permanent residence and green cards in the US in 2003 and incident over the following five years. We identified the most common patterns of multimorbidity overall and by regions of origin and sex. Although this is primarily a descriptive study, we hypothesized that foreign-born adults from regions of origin closer in proximity (ie, Latin America and Caribbean) would have a higher prevalence of multimorbidity and individual conditions, based upon the increase in cardiometabolic disease in Latin American and Caribbean region over this same time period.[22] Secondly, due to the change in environment, we anticipated a higher incidence of multimorbidity and individual conditions than we would have anticipated based solely on aging. This study uses a longitudinal sample from a population in middle adulthood and thus, helps to fill in gaps related to the progression of multimorbidity in younger ages than is typically evaluated.

Methods

Setting and Sample

The New Immigrant Survey (NIS) is the only nationally representative survey of foreign-born adults in the United States. The sampling frame of the NIS was based on administrative records compiled by the United States Citizenship and Immigration Services (USCIS) and consisted of foreign-born adults admitted to lawful permanent residence between May and November 2003.[23] The sampling frame was stratified by four immigrant visa categories: employment principals, diversity principals, spouses of US citizens, and other immigrants. Individuals who were new arrivals to the United States, as well as those who were already in the United States with a temporary nonimmigrant visa and had adjusted to lawful permanent residency (LPR) were also included in the sample. Data collection was conducted in 2003-2004, in the language of the respondent's choice, as soon as possible after people were granted LPR.

A follow-up interview (wave two) was conducted from June 2007 to December 2009. Re-interview rate was 45.5% for adults resulting in a sample size of 3,902 with completed interviews. Between wave one and wave two, the context for interviewing immigrants had changed dramatically. The strongest predictors of being involved in wave two pertained to country of origin, years of education, and intention for future US residen-

cy.[24] Immigrants are by definition a mobile population, and with an average gap of around five years between the two waves, many original respondents had moved. The NIS created non-response weights for use with wave two to help mitigate the differences in the sample that answered wave one vs wave two. We used these weights for all wave two analyses and the design weights for both waves.

The NIS adult sample consisted of 8,573 respondents. We excluded observations missing data on chronic health conditions, for a final analytic sample at wave one of 8,174 and of 3,291 for wave two. The final sample includes 5,423 people with data only at wave one and 3,291 people with both wave one and wave two data. As a sensitivity analyses, we evaluated those with complete data for both waves (n=3,291). Our results were parallel to the full sample results when using the design weights and we present the full sample results (other results available upon request). All procedures were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all participants included in the study.

Variables

Multimorbidity was measured in terms of eight chronic conditions. NIS participants were asked "Has a doctor ever told you that you have/had… "high blood pressure or hypertension"; "a heart attack, coronary heart disease, angina, congestive heart failure, or other heart problems"; "stroke"; "chronic lung disease such as chronic bronchitis or emphysema"; "diabetes or high blood sugar"; "cancer or a malignant tumor, excluding minor skin cancers"; or "arthritis or rheumatism" We created the variable for obesity based on self-reported weight and height: underweight (BMI < 18.5 kg/m^2), normal weight (18.5 kg/m^2< BMI < 25 kg/m^2), overweight (25 kg/m^2 < BMI < 30 kg/m^2), and obesity (BMI > 30 kg/m^2). To account for implausible values, we excluded BMI values <10 or >60.

For each chronic condition, we created a dichotomous variable indicating the presence or absence of the condition. Individuals were considered to have multimorbidity if they had two or more of the eight chronic conditions: hypertension, heart problems, stroke, chronic lung disease, diabetes, cancer, arthritis, or obesity. At wave two, the same series of questions on chronic conditions were included and we created parallel dichotomous variables indicating the presence of conditions and multimorbidity at wave two. We also measured whether an individual gained a new chronic condition between wave one and wave two.

The independent variables of interest were: region of origin (Latin American and the Caribbean, East Asia, South Asia, and the Pacific, the Middle East and North Africa, Sub-Sahara Africa, Europe, Central Asia, and North America); age (18-44; 45-64; > 65); sex (men, women); years of education (< 12 years, ≥12 years); marital status (not married or living together, married or living together); length of stay in the United States (years since first migration [< five years, ≥ five years]); and health care utilization (yes; no). Health care utilization was from the following question: "Aside from any hospital stays, have you seen or talked to a medical doctor about your health, including emergency room or clinic visits in the last 12 months?" We did not include income or employment because they were both highly correlated with education.

Statistical Analysis

We conducted analyses using STATA15.1. We used sampling weights and non-response weights for wave two analyses. We ran bivariate analyses for each independent variable with the dependent variable. We used multinomial logistic regression to categorize multimorbidity severity by the number of chronic conditions, where the base reference category was "no chronic conditions." We used logistic regression to examine whether respondents gained a new chronic condition in wave two compared to no new conditions after wave one. Full models controlled for sex, age, region of origin, years of education, marital status, health care utilization, and length of stay in the United States.

Results

Among foreign-born adults at the time of green card receipt, 56.2% were women and more than 70% were aged <45 years (Table 1). They were most commonly from Latin America and the Caribbean (44.2%) and East Asia, South Asia, and the Pacific region (29.5%). The majority

Table 1. Baseline characteristics of foreign-born adults in the US, N=8,174, 2003

	Overall	No multimorbidity % (95% CI)	Multimorbidity [a] % (95% CI)	P
Sample size	N = 8,174	n = 7,706	n = 468	
Sex				<.05[d]
Men	43.8 (42.6-45.1)	44.1 (42.8-45.4)	39.1 (34.5-43.9)	
Women	56.2 (54.9-57.4)	55.9 (54.6-57.2)	61.0 (56.1-65.5)	
Age, years				<.001[b]
18-44	72.3 (71.2-73.3)	75.1 (74.0-76.1)	27.9 (23.5-32.6)	
45-64	21.3 (20.3-22.3)	20.0 (19.0-21.0)	42.7 (38.0-47.6)	
65 and above	6.4 (5.9-7.0)	5.0 (4.5-5.5)	29.4 (25.2-34.0)	
Region of origin				<.01[c]
Latin America & the Caribbean	44.2 (43.0-45.5)	43.7 (42.4-45.0)	52.7 (47.8-57.5)	
East Asia, South Asia, & the Pacific	29.5 (28.4-30.7)	29.8 (28.7-31.0)	24.6 (20.8-28.9)	
Sub-Saharan Africa	6.6 (6.0-7.2)	6.7 (6.1-7.3)	4.7 (3.0-7.4)	
Middle East & North Africa	4.4 (3.9-4.9)	4.4 (3.9-5.0)	3.3 (2.0-5.2)	
Europe, Central Asia & North America	15.3 (14.4-16.2)	15.3 (14.4-16.3)	14.7 (11.5-18.6)	
Highest level of education				<.001[b]
<12 years of education	35.9 (34.7-37.1)	34.4 (33.2-35.6)	59.0 (54.2-63.7)	
≥ 12 years of education	64.1 (62.9-65.3)	65.6 (64.3-66.8)	41.0 (36.3-45.8)	
Current marital status				<.001[b]
Married or living together	76.5 (75.5-77.5)	77.0 (76.0-78.0)	68.1 (63.5-72.3)	
Not married or living together	23.5 (22.5-24.5)	23.0 (22.0-24.0)	31.9 (27.7-36.5)	
Consulted with a doctor in the past year				<.01[c]
Yes	37.7 (36.5-38.9)	36.7 (25.4-37.9)	54.3 (49.5-59.2)	
No	62.3 (61.1-63.5)	63.3 (62.1-64.6)	45.6 (40.8-50.5)	
Length of stay in the US				>.05[d]
Less than 5 years	55.2 (53.9-56.5)	55.5 (54.1-56.8)	50.9 (45.8-56.0)	
5 years or more	44.8 (43.5-46.1)	44.5 (43.2-45.9)	49.0 (44.0-54.2)	

	Green card receipt (2003)	Five years after green card receipt (2007-09)
	Prevalence, % (95% CI)	
Number of chronic conditions		
None	75.5 (74.42,76.53)	64.1 (62.17,66.08)
One	18.6 (17.61,19.63)	23.6 (21.93,25.33)
Two	4.4 (3.91,4.92)	8.4 (7.38,9.59)
Three or more	1.5 (1.34,1.97)	3.8 (3.08,4.79)

Survey data are weighted; Source: New Immigrant Survey, 2003

a. To assess multimorbidity, following chronic conditions were included in the analyses: obesity, hypertension, arthritis, diabetes, heart problem, chronic lung disease, cancer, and stroke

b. P significant at the .001 level

c. P significant at the .01 level

d. P significant at the .05 level

had completed more than 12 years of education (64.1%), had not consulted a doctor in the past year (62.3%), and had been in the United States for less than five years (55.2%). Foreign-born adults without multimorbidity in wave one were more often women (55.9%) and came from Latin America and the Caribbean region (43.7%).People with multimorbidity more often had <12 years of education, were married, were in the 45-64 year-old age group, and had consulted a doctor in the past year (P<.001). In 2003, most foreign-born adults had no chronic conditions (75.5%); 18.6% had one chronic condition and 5.9% had more than one chronic condition. Five years after green card receipt (wave two), the percent of foreign-born adults who had no chronic conditions fell to 64.1%; 23.6% had one chronic condition and 12.2% had more than one chronic condition.

Table 2. Total prevalence of chronic conditions by region of origin among foreign-born adults in the United States, green card receipt, 2003, n=8174, Prevalence, % (95%CI)

Chronic Conditions	Total Prevalence	US Population[a]	Latin America & the Caribbean	East, South Asia & Pacific	Sub-Saharan Africa	Middle East & North Africa	Europe, Central Asia & North America
Obesity	12.7 (11.6,13.3)	13.5	19.7 (18.1,21.4)[c]	4.7 (3.8,5.8)[c]	11.4 (8.6,15.1)	14.1 (10.3,19.0)	9.3 (7.6,11.4)[c]
Hypertension	8.1 (7.0, 8.4)	13.8	8.5 (7.5,9.6)	8.7 (7.6,10.0)	6.1 (4.3,8.7)	3.8 (2.3,6.4)[c]	7.5 (6.0,9.3)
Arthritis	3.9 (3.2, 4.1)	7.0	3.7 (3.0,4.5)	4.1 (3.3,5.0)	2.8 (1.6,4.9)	3.7 (2.1,6.2)	4.5 (3.4,5.9)
Diabetes	3.1 (2.6, 3.5)	4.8	4.0 (3.3,4.7)[c]	2.9 (2.3,3.6)	2.3 (1.3,4.0)	4.3 (2.5,7.2)	1.2 (.7,1.9)*
Heart Problems	1.7 (1.3, 1.9)	3.1	1.3 (.9,1.8)[c]	2.1 (1.6,2.8)	.6 (.2,1.9)*	1.9 (.9,4.0)	2.7 (1.9,3.9)
Chronic Lung Disease	.6 (.4, .8)	.7	.6 (.4,.9)	.4 (.2,.8)	.3 (.1,1.1)	.5 (.1,2.0)	1.2 (.6,2.1)
Cancer	.5 (.4,.8)	1.0	.5 (.3-.9)	.6 (.3,1.1)	--[b]	.2 (.1,1.4)	.8 (.4,1.5)
Stroke	.4 (.3, .6)	.9	.4 (.3,.7)	.6 (.3,1.0)	.3 (.1,1.4)	.3 (.1,2.1)	.3 (.1,.8)
Multimorbidity	5.9 (5.4-6.5)	8.2	7.1 (6.2,8.1)[c]	5.0 (4.1,6.0)*	4.3 (2.7,6.7)	4.4 (2.8,7.1)	5.7 (4.4,7.3)

Notes: New Immigrant Survey, 2007-09; all data significant at the .05 level, compared to the overall prevalence; survey weighted and non-response weights
a. Age-standardized to 2000 US Census Population
b. Not enough data
c. P<.05

Prevalence of Chronic Conditions and Multimorbidity by Region of Origin

At the point of green card receipt, the most prevalent chronic condition in foreign-born adults was obesity (12.7%), followed by hypertension (8.1%) and arthritis (3.9%) (Table 2). Multimorbidity prevalence at the point of green card receipt was 5.9%. Obesity was highest among those from Latin America and the Caribbean (19.7%). People from East Asia, South Asia, and the Pacific had the highest prevalence of hypertension (8.7%) and stroke (.6%), while those from Europe, Central Asia, and North America had the highest prevalence of arthritis (4.5%), heart problem (2.7%), chronic lung disease (1.2%), and cancer (.8%). Respondents from countries in the Middle East and North African region had the highest prevalence of diabetes (4.3%). The prevalence of multimorbidity was highest among foreign-born adults from Latin America and the Caribbean (7.1%), followed by Europe, Central Asia, & North America (5.7%), and was lowest among those from Sub-Saharan Africa (4.3%). These estimates are lower than the US national average on individual chronic conditions in 2003, for example obesity prevalence was 32.2%.[25]

Five years later (wave two, Table 3), the 5-year cumulative incidence of multimorbidity was 8.2% and total prevalence of 12.3%. The gaining of a chronic condition (or even two) was largely driven by incident obesity (8.4%) and hypertension (9.0%). The most prevalent chronic condition was hypertension (18.7%), followed by obesity (16.1%) and arthritis (8.7%). Obesity was still highest among those from Latin America and the Caribbean (25.3%). People from East Asia, South Asia, and the Pacific had the highest prevalence of hypertension (21.9%), arthritis (10.0%) and stroke (1.2%). Those from Europe, Central Asia, and North America had the highest prevalence of heart problems (5.5%), chronic lung disease (1.5%), and cancer (2.7%). The prevalence of multimorbidity was highest among foreign-born adults from Latin America and the Caribbean (13.7%), followed closely by East Asia, South Asia and the Pacific (13.4%), and was lowest among those from Sub-Saharan Africa (6.6%). However, the prevalence of multimorbidity increased over the five-year study period for all regions of origin. (Table 3)

Prevalence of Dyads of Chronic Conditions

Figure 1 shows a heat map of the frequency of co-occurrence of each pair of eight conditions at the point of green card status and five years later separately (wave one and two). There was a considerable increase in dyads of chronic conditions over five years. Five dyads had above a 2% total population prevalence (hyperten-

Table 3. Total prevalence and five-year incidence of chronic conditions by region of origin among foreign-born adults in the United States, five years after green card receipt, 2007-09, n=3291, Prevalence, % (95%CI)

Chronic Conditions	5-yr Cumulative Incidence	Total Prevalence	US Population[a]	Latin America & the Caribbean	East, South Asia & Pacific	Sub-Saharan Africa	Middle East & North Africa	Europe, Central Asia & North America
Obesity	8.4 (7.18,9.71)	16.1 (14.5,17.8)	13.7	25.3 (22.4,28.5)[b]	5.9 (4.4,8.0)[b]	13.2 (9.2,18.0)	17.7 (10.6,28.2)	11.4 (8.1,15.7)[b]
Hypertension	9.0 (7.87,10.23)	18.7 (17.1,20.3)	14.5	19.1 (16.8,21.7)	21.9 (18.8,25.3)	15.6 (11.5,20.9)	9.4 (5.3,16.2)[b]	16.3 (13.1,20.2)
Arthritis	3.9 (3.16,4.69)	8.7 (7.6,10.0)	7.3	9.5 (7.7,11.7)	10.0 (8.0,12.6)	4.8 (2.3,9.7)	3.7 (1.7,7.6)[b]	8.0 (5.8,10.9)
Diabetes	3.8 (3.00,4.71)	7.7 (6.7,8.8)	5.1	9.4 (7.6,11.5)[b]	8.4 (6.7,10.5)	3.4 (1.8,6.5)	5.8 (3.0,10.9)	4.0 (2.6,6.0)
Heart Problems	1.6 (1.21,2.11)	3.4 (2.7,4.2)	3.2	1.9 (1.2,3.0)[b]	5.1 (3.6,7.2)	1.0 (.4,2.9)[b]	1.7 (.7,4.3)	5.5 (3.3,9.1)
Chronic Lung Disease	.04 (.005,.25)	.7 (.5, 1.2)	.7	.7 (.4,1.2)	.5 (.2,1.3)	.6 (.1,3.5)	.6 (.08,4.2)	1.5 (.6,4.2)
Cancer	.7 (.47,1.04)	1.1 (.8,1.5)	1.0	.6 (.3,1.2)	1.3 (.8,2.3)	.5 (.1,1.9)	.07 (.01,.5)	2.7 (1.7,4.2)[b]
Stroke	.4 (.19,1.02)	.8 (.5,1.3)	.9	.6 (.3,1.1)	1.2 (.4,3.2)	.2 (.02,1.2)	1.1 (.3,4.0)	.6 (.2,2.0)
Multimorbidity	8.2 (6.9,9.4)	12.3 (11.0,13.7)	10.7	13.7 (11.6,16.0)	13.4 (10.9,16.3)	6.6 (4.2,10.4)[b]	8.0 (4.2,14.7)[b]	10.3 (7.9,13.3)

Source: New Immigrant Survey, 2007-09; all data significant at the .05 level, compared to the overall prevalence; survey weighted and non-response weights.
a. Age-standardized to 2010 US Census Population
b. P<.05

sion-heart attack; obesity-diabetes; hypertension-diabetes; hypertension-arthritis; and hypertension-obesity).

Determinants of Multimorbidity

At the point of green card receipt (wave one), the odds of having multimorbidity were higher among those who were older: 45-64 years: 8.0 (6.0,10.5); ≥65 adults: 25.7 (18.1,36.4) (Table 4). Foreign-born adults from East Asia, South Asia and the Pacific had lower odds of having multimorbidity (Asia: .6 [.4,.8]) compared to foreign-born adults from Latin America and the Caribbean. Foreign-born adults with 12 or more years of education had lower odds of multimorbidity compared to those with no education (.6 [.4,.8]). Foreign-born adults who had lived in the United States for ≥5 years had higher odds of multimorbidity compared to those who had lived in the United States for <5 years (1.6 [1.02,2.0]). Foreign-born adults

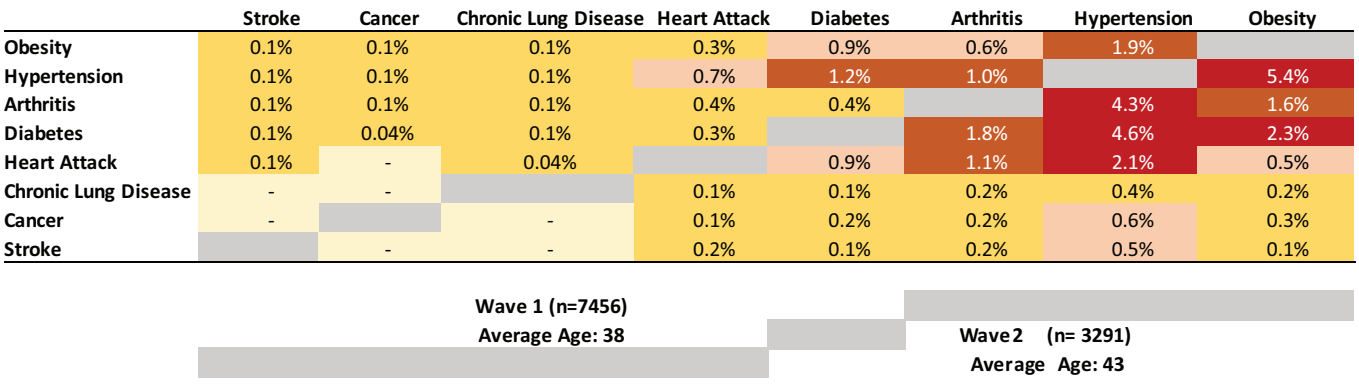

Figure 1. Prevalence of multimorbidity dyads among foreign-born adults in the US in 2003 and five years later
Heat Map of the burden of multimorbidity in terms of absolute frequency for Wave 1 and Wave 2. The number in each square is the percent of co-occurrence in the overall population (all ages and sex combined). The eight conditions are listed on the X and Y axes of both panels. Values for wave 2 are shown in the lower right triangle, and values for wave 1 are shown in the upper left triangle.
Prevalence Legend: light yellow: none; dark yellow: .1-.4%; light orange: .5-.9%; dark orange: 1.0-1.9%; red: ≥2.0%

Table 4. Odds of having one chronic condition and multimorbidity among foreign-born adults in the US between green card receipt (2003) and five years later (2007-09)

	Green card receipt - 2003		Five years after green card receipt, 2007 - 09		Five years after green card receipt 2007 - 09
	One chronic condition	Multimorbidity	One chronic condition	Multimorbidity	Gaining one chronic condition
	Reference: no chronic conditions		Reference: no chronic conditions		Reference: no change in number of conditions
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Sex (Men)					
Women	1.1 (.9,1.2)	1.1 (.9,1.4)	.8 (.6, .99)[a]	1.04 (.8,1.4)	.9 (.8,1.2)
Age, years (18-44 at baseline)					
45-64 at baseline	2.6 (2.2,3.0)[a]	8.0 (6.0,10.5)[a]	2.8 (2.2,3.6)[a]	9.4 (6.7,13.3)[a]	2.8 (2.2,3.5)[a]
65 and above at baseline	4.7 (3.7,6.0) [a]	25.7(18.1,36.4)[a]	7.7 (4.6,13.0)[a]	40.2(23.6,68.6)[a]	3.2 (2.2,4.7)[a]
Region of origin (Latin America & the Caribbean)					
East Asia, South Asia & the Pacific	.6 (.5,.7)[a]	.6 (.4,.8)[a]	.6 (.5,.8) [a]	.5 (.4,.9)[a]	.8 (.6,1.1)
Sub-Saharan Africa	.7 (.5,1.0)	.7 (.4,1.3)	.8 (.5,1.2)	.4 (.2,.8)[a]	.9 (.6,1.3)
Middle East & North Africa	.9 (.7,1.3)	.9 (.5,1.6)	.8 (.5,1.3)	.8 (.3,2.0)	.9 (.5,1.6)
Europe, Central Asia & North America	.7 (.6,.9)[a]	1.0 (.7,1.4)	.7 (.5,.9)[a]	.6 (.4, .99)[a]	.9 (.6,1.3)
Years of education (< 12 years of education)					
≥12 years of education	.8 (.7,.9)[a]	.6 (.4,.8)[a]	.9 (.7,1.1)	.9 (.5,1.2)	.8 (.6,1.1)
Current marital status (not married or living together)					
Married or living together	1.0 (.8,1.1)	.9 (.7,1.2)	1.2 (.9,1.5)	.9 (.7,1.3)	1.1 (.9,1.4)
Consulted with a doctor in the past year (No)					
Yes	1.2 (1.0,1.4)	2.4 (1.9,3.0)[a]	1.1 (.8,1.3)	1.6 (1.2,2.2)[a]	0.8 (.7,1.03)
Length of stay in the US (< 5 years)					
5 years or more	1.5 (1.3,1.8)[a]	1.6 (1.02,2.0)[a]	1.1 (.9,1.4)	1.3 (.9,1.8)	.9 (.7,1.2)

Source: New Immigrant Survey, 2003; 2007-09; Wave 1 (n=8,174); Wave 2 (n=3,291); Multivariate analysis was performed where each variable was adjusted for all other variables presented in the table; Reference categories are shown in parenthesis; Survey weighted and non-response weights for wave 2
a. P<.05

who had consulted with a doctor in the past year had higher odds of having multimorbidity (2.4 [1.9,3.0]).

Five years after green card receipt (wave two), foreign-born older adults had higher odds of multimorbidity with a gradient effect by increasing age and increasing number of conditions. Regional differences at wave one persisted in wave two. However, foreign-born adults from Sub-Saharan Africa had lower odds of having multimorbidity five years after green card receipt (.4 [.2,.8]). 22.5% of all foreign-born adults gained one new chronic condition between 2003 and 2008 (5 years; average 38 to 43 years). When exploring the determinants of adding one chronic condition compared to no change in number of conditions (Table 4, Column 5), older adults had higher odds of adding a chronic condition over five years (45-64 years: 2.8 [2.2,3.5]); (older adults: 3.2 [2.2,4.7]).

Discussion

In this study, we used data from the nationally representative New Immigrant Survey (NIS) to estimate

the patterns of chronic conditions and prevalence of multimorbidity at two time points among foreign-born adults (average age: 38 years). We identified the most common patterns of multimorbidity, and distinguished experiences with multimorbidity among people by regions of origin. The overall prevalence of multimorbidity, the presence of two or more chronic diseases in an individual, was approximately 6% in 2003 and more than 12% in 2008. The prevalence of multimorbidity was higher in women than men and was the highest among foreign-born people from Latin America and the Caribbean region at both time points, which is consistent with findings from previous studies.[18,21] The combination of hypertension with obesity, diabetes, and arthritis were the most commonly occurring disease pairs. Age, socioeconomic status, and length of stay in the United States were the most important measured predictors of the multimorbidity status in the study.

The overall prevalence of multimorbidity, the presence of two or more chronic diseases in an individual, was approximately 6% in 2003 and more than 12% in 2008.

The estimates in this study are relatively low compared to previous cross-sectional studies among foreign-born adults in Europe where multimorbidity estimates ranged from 9% to 35%.[18] The prevalence of multimorbidity was also lower in 2003 than in the total US population, which ranged from 9% to 26% in previous studies for a total of 9-10 disease count, but was within range by wave two.[4,8,26] Several factors might help explain the low prevalence of multimorbidity in this study, such as total disease count, the measure of multimorbidity, and the length of stay in the United States. This study included eight chronic conditions to assess multimorbidity as they were the most relevant in the published literature and were available in the NIS dataset.[8,26] The inclusion of eight conditions might result in a lower prevalence of multimorbidity in the study.[18,27,28] Some of the chronic conditions listed in other studies were sleep apnea, depression, anxiety, dementia, chronic pain, hyperlipidemia, hepatitis, human immunodeficiency virus (HIV), osteoporosis, gastrointestinal disease, and chronic kidney disease.[27,29] However, data on these chronic conditions listed in other studies, except for depression, were not available in the NIS. Depression is not commonly used in multimorbidity studies among migrant populations.[4,8,26] In addition, all chronic conditions in this study were self-reported, which can lead to a lower diagnosis of chronic diseases among foreign-born adults, resulting in lower multimorbidity prevalence. Literature has previously shown multimorbidity prevalence to increase substantially when chronic diseases were clinically measured compared to self-reported (eg, measured: 56.3% vs self-reported: 34.8%).[28] Although the prevalence of individual chronic conditions and multimorbidity was lower among foreign-born adults than the US national average, the increase in prevalence of individual conditions and five-year cumulative incidence was greater than seen among US national populations.[1,25]

Length of stay in the host country has also often been shown in the literature as a significant predictor of health-related outcomes.[20,29] Foreign-born adults are often healthier than their native counterparts on arrival to the host country.[18,20,29] However, with increasing length of stay, foreign-born adults often converge to the health status of the host population due to lifestyle changes, social, and other environmental factors.[30] As a result of these factors, foreign-born populations face increasing health risks, which often lead to risk factors for chronic diseases such as elevated blood pressure, high BMI, and increased glucose level.[31] The healthy migrant effect among foreign-born individuals might also partly explain the low multimorbidity prevalence in this study in 2003, as the majority of the study participants did not live in the United States long enough at the time of the data collection to experience a gradual decline in health.

The prevalence of individual chronic diseases and multimorbidity also varied by place of origin, consistent with previous studies.[20] The prevalence of obesity was highest among foreign-born adults from

the Latin American and Caribbean region, and the prevalence of hypertension was highest among those from East Asia, South Asia, and the Pacific region; these findings are compatible with prior studies.[32] The study also found that the odds of multimorbidity was lower among foreign-born adults from countries of origin geographically further from the United States. For example, the prevalence of multimorbidity was highest among those from Latin America and the Caribbean, followed by those from Europe, Central Asia, and North America, and lowest among East Asia, South Asia, and the Pacific. These findings are in agreement with previous literature which has shown long-distance migrants were less likely to suffer long-term illnesses, followed by short-distance and non-migrants.[33] Given that the majority of the study population had been in the United States for less than five years and became legal permanent residents at the time of data collection, this study confirms that this specific population of foreign-born adults who are in good health are often more likely to move long distance than those who are in poor health conditions.[34] Furthermore, the region including Latin America and the Caribbean has seen large increases in the prevalence of chronic diseases within this same time frame. For example, the prevalence of diabetes in Mexico increased by 22% between 1993 and 2000.[22]

Study Limitations

This study has several limitations. The NIS only samples immigrants with newly acquired legal permanent residence status, who may be different from immigrants without legal permanent residence status. This study was also a secondary analysis, and therefore there was no control over the data collection process. Chronic disease status to assess multimorbidity was self-reported, thereby leading to potential recall and misreporting bias. Lastly, our measurement of chronic disease is endogenous to being told by a doctor you have a disease, and therefore also tied to having gone to see a doctor. Furthermore, we do not have a comparison group of native-born adults. Moreover, all chronic disease variables used to assess multimorbidity were dichotomous variables. Because the data were not continuous, the severity of each chronic disease was not accounted for in the study.

Conclusion

This study demonstrates an increase in prevalence of multimorbidity within five years among a relatively young population typically hypothesized to be healthier than the native-born US population. More than half of the respondents had been in the United States for less than five years in 2003, typically cited as the healthiest time for immigrant populations.[11] Instead of diagnosing and treating chronic conditions individually, multimorbidity can represent a new approach and paradigm shift to understanding and clinically managing combined chronic conditions. Research should endeavor to further investigate sentinel conditions and the progression of multimorbidity more broadly. These findings provide important insights into the health care needs of the foreign-born adults and are expected to enhance the evidence base on co-occurring chronic conditions among this group.

Data Availability Statement

The data that support the findings of this study are openly available in Princeton Office of Population Research Archive at https://nis.princeton.edu/data.html

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Conflict of Interest

No conflicts of interest to report.

Author Contributions

Research concept and design: Jones, Tasnim, Cunningham; Acquisition of data: Jones, Tasnim; Data analysis and interpretation: Jones, Tasnim, Cunningham; Manuscript draft: Jones, Cunningham; Statistical expertise: Jones, Cunningham; Acquisition of funding: Jones; Administrative: Jones, Tasnim; Supervision: Cunningham

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