Are Immigrants Positively Selected on Genetic Predisposition to Better Health? Evidence for Cognition and Smoking from the Health and Retirement Study

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Abstract

The research offers an empirical test of the "health immigrant effect" hypothesis – the idea that better health outcomes of the foreign-born can be explained by the selective migration of healthier individuals. The paper uses genetic data (polygenic scores) from the 2006-2014 Health and Retirement Study (HRS) to evaluate whether immigrants have genotypes that predispose them to better health outcomes and behavior, focusing on general cognition and smoking. The results from the t-tests and OLS regressions point to a statistically significant immigrant advantage over the U.S.-born older adults with respect to genetic predisposition to higher cognition. The results for smoking are less conclusive. The foreign-born have a sizable advantage over the native-born in the predisposition to frequency of smoking, but not to smoking initiation. Selective immigration may play a role in explaining nativity effects in health and should be considered in future modelling of the effects of immigration on health.

Are Immigrants Positively Selected on Genetic Predisposition to Better Health? Evidence for Cognition and Smoking from the Health and Retirement Study

With 258 million of people currently living outside of their countries of birth, immigration has become a global phenomenon (UN 2017). The growing size and increased diversity of the foreign-born population raise concerns about immigrant integration outcomes and their impact on the economic, political and social fabric of the immigrant-receiving countries. Immigrants' health is of particular interests to researchers and policymakers (Castañeda et al., 2015). Do immigrants have better or worse health than non-immigrants? What individual, social and environmental factors explain immigrants' health (dis)advantage — i.e. what is the effect of selection and what is the treatment effect of migration, reception and integration itself? Despite extensive research on the topic, the answers to these questions remain incomplete. Even though many studies acknowledge possible influence of biological mechanisms on immigrants' health, relatively few test their importance empirically.

Research on immigrants' health has led to the suggestion of an "immigrant health paradox." Namely, the foreign-born have lower mortality than the native-born despite their disadvantaged socioeconomic status (R. J. Angel, Angel, Diaz Venegas, & Bonazzo, 2010; Borrell & Lancet, 2012; Elo, Turra, Kestenbaum, & Ferguson, 2004; Marc A Garcia, Garcia, Chiu, Raji, & Markides, 2018; Lariscy, Hummer, & Hayward, 2015; Mehta, Elo, Engelman, Lauderdale, & Kestenbaum, 2016). Although U.S.-based research originally focused on Latinx (or even more specifically, Mexican) immigrants (e.g., Markides & Coreil, 1986), similar results were reported for non-Latinx foreign-born in the U.S. (Cunningham et al., 2008; Elo, Mehta, & Huang, 2011; Huang et al., 2011; Mehta et al., 2016; Reynolds, Chernenko, & Read, 2016; Riosmena et al., 2017; Singh & Hiatt, 2006) and for immigrant populations in other countries (Shor, Roelfs, & Vang, 2017;

Vang, Sigouin, Flenon, & Gagnon, 2017).

Positive health selectivity or "healthy immigrant effect" is one of the popular explanations of the superior health of the foreign-born. Because healthy people are more likely to migrate, foreign-born are healthier than the average person in both the sending and receiving countries, at least when they arrive (Akresh & Frank, 2008; Jasso, Massey, Rosenzweig, & Smith, 2004; Palloni & Ewbank, 2004; Riosmena, Kuhn, & Jochem, 2017; Ro, Fleischer, & Blebu, 2016). Despite strong face validity of the theoretical argument and frequent use as the residual explanation of "unexplained" differences after all observed factors are taken into account, the positive health selectivity of the foreign-born is notoriously difficult to measure at an individual level unless one measures health repeatedly pre- and post-migration. (And even then, since health problems later in life may reflect the cumulative result of states that are subclinical earlier in the life course, even such a longitudinal approach has its limitations.)

In the present paper we address this question from a novel perspective. Namely, since genotypes are fixed at conception and do not vary over the life course, by examining the genotypes of immigrants vis-à-vis natives, we can take a first pass at answering the question of whether immigrants tend to be self-selected to have better health endowments over their entire life course as compared to their native-born counterparts. Specifically, the present study deploys genetic data (polygenic scores) from the 2006-2014 Health and Retirement Study (HRS) to test whether immigrants, on average, have genotypes that predispose them to better health outcome and superior health behavior, focusing on general cognition and smoking. The results show that there is a statistically significant immigrant advantage over the U.S.-born older adults with respect to genetic predisposition to higher cognition. On average, being a foreign-born is associated with 0.09 -0.19 SD higher mean cognition PGS compared to U.S.-born. The results for smoking are less conclusive. There are no statistical differences between the U.S.- and foreign-born older adults in the biological predisposition to smoking initiation. But the foreign-born have a sizable advantage over the native-born in the predisposition to frequency of smoking. Overall, the results provide first empirical evidence for the "health immigrant effect" with respect to genetic predisposition to develop certain health outcomes and engage in health risk behaviors.

BACKGROUND

Most research on immigrants' health is framed around the fairly consistent finding of an "immigrant health paradox." (Acevedo-Garcia & Bates, 2008; Cunningham, Ruben, & Narayan, 2008; Markides & Eschbach, 2005; Riosmena & Dennis, 2012) The foreign-born have lower mortality than the native-born, especially if measured soon after arrival and if socioeconomic differences are taken into account (R. J. Angel et al., 2010; Borrell & Lancet, 2012; Elo et al., 2004; Marc A Garcia et al., 2018; Lariscy et al., 2015; Mehta et al., 2016). However, findings on other health outcomes are more mixed and contingent on specific health measures, age, race/ethnicity, country of origin and number of years since migration. For example, older immigrants report worse self-rated health (J. L. Angel, Buckley, & Sakamoto, 2001; Wakabayashi, 2010) and have higher rates of disability (Hayward, Hummer, Chiu, González-González, & Wong, 2014; Markides, Eschbach, Ray, & Peek, 2007). On such measures as depression, chronic stress, emotional health and overall subjective well-being, older immigrants' health is no better (and sometimes worse) than the health of the native-born (e.g., Aguila, Escarce, Leng, & Morales, 2013; Ladin & Reinhold, 2013; Lum & Vanderaa, 2010; Swallen, 1997; Wakabayashi, 2010). Older foreign-born persons have better health risk behavior profiles with lower rates of obesity, smoking and alcohol consumption, but many lack health insurance and do not have access to regular preventative health care services (e.g., Blue & Fenelon, 2011; Derose, Escarce, & Lurie, 2007).

Although U.S.-based research on immigrant health originally focused on Latinx (or even more specifically, Mexican) immigrants (e.g., Markides & Coreil, 1986), similar results were reported for non-Latinx foreign-born in the U.S. (Cunningham et al., 2008; Elo, Mehta, & Huang, 2011; Huang et al., 2011; Mehta et al., 2016; Reynolds, Chernenko, & Read, 2016; Riosmena et al., 2017; Singh & Hiatt, 2006). The immigrant mortality advantage has also been documented in other countries with different immigrant populations (Shor, Roelfs, & Vang, 2017; Vang, Sigouin, Flenon, & Gagnon, 2017). These facts suggest that the immigrant health advantage is not unique to Latinx immigrants in the U.S.; it is more likely related to migration processes than to specific ethnicity or country of origin.

Differences in data and methodology limit the comparability of results across studies, and methodological challenges work against estimating the size and sorting out explanations for the immigrant health advantage (Acevedo-Garcia & Bates, 2008; Arias, Eschbach, Schauman, Backlund, & Sorlie, 2010; Palloni & Morenoff, 2001). The "healthy immigrant effect" points to positive health selection. Because healthy people are more likely to migrate, foreign-born are healthier than the average person in both the sending and receiving countries, at least when they arrive (Akresh & Frank, 2008; Jasso et al., 2004; Palloni & Ewbank, 2004; Riosmena et al., 2017; Ro et al., 2016). According to another argument, migrant culture – healthier diets, social support from family and kin, and risk-avoidant behavior – is protective of health and helps counterbalance negative influences, such as poor working conditions, lack of access to health care and discrimination. Still another explanation is related to selective return migration or the so-called "salmon bias." Selective out-migration of less healthy immigrants results in overly optimistic estimates of the health status of the foreign-born in the host countries (Abraído-Lanza, Dohrenwend, Ng-Mak, & Turner, 1999; Diaz, Koning, & Martinez-Donate, 2016; Palloni & Arias, 2004; Turra & Elo, 2008).

These explanations are not mutually exclusive and each has received some empirical support. While there are many studies focusing on both positive and negative social influences on immigrant health post migration and there are several creative research papers investigating the extent of “salmon bias” (Arenas, Goldman, Pebley, & Teruel, 2015; Diaz et al., 2016; Ullmann, Goldman, & Massey, 2011), immigrant health selectivity hypothesis remains understudied. Despite strong face validity of the theoretical argument and frequent use as the residual explanation of “unexplained” differences after all observed factors are taken into account, the empirical support for “healthy immigrant effect” is scant and inconsistent (Akresh & Frank, 2008; Bostean, 2013; Riosmena et al., 2017; Ro et al., 2016). Previous research found support for selectivity with respect to some observed factors such as education, smoking and anthropometric indicators (Beltrán-Sánchez, Palloni, Riosmena, & Wong, 2016; Crimmins, Kim, Alley, Karlamangla, & Seeman, 2007; Crimmins, Soldo, Ki Kim, & Alley, 2005; Feliciano, 2005; Fleischer, Ro, & Bostean, 2017). But because most immigrants are young and healthy when they arrive and panel data with measures of health pre- and post-migration are rarely available, immigrant health selectivity is notoriously difficult to measure at an individual level.

Using genotype data — which is, as mentioned above, unchanging over the life course — would provide a lever to better assess whether immigrants are positively (or negatively) selected as compared to the native population in their receiving countries. In this way, genetic data provide a unique opportunity to test directly the presence and the degree of immigrant health selectivity with respect to biological predisposition to certain health conditions and health behavior. To the degree that genetic factors predict longevity, physical and mental health outcomes (e.g., Ehret et al., 2011; Iachine et al., 2006; Sullivan, Neale, & Kendler, 2000), health risk behaviors, such as smoking (e.g., Domingue, Conley, Fletcher, & Boardman, 2016; Furberg et al., 2010), and social determinants of health, such as education (e.g., Branigan, McCallum, & Freese, 2013; Domingue, Belsky, Conley, Harris, & Boardman, 2015; Okbay et al., 2016), it is possible that immigrant health advantage is explained, at least partially, by selective migration of individuals with favorable genetic predisposition.

RESEARCH QUESTION

The paper tests whether there is immigrant health selectivity with respect to genetic predisposition to certain health conditions and health behavior as compared to a matched, native-born U.S. population by comparing their distributions of relevant polygenic scores for health and health-related phenotypes. Due to selective migration, do immigrants have genotypes, on average, that predispose them to better outcomes in the domains of physical health and health behavior?

In general, we expect that the foreign-born will have more favorable distributions of PGSs (higher means of the health-enhancing PGSs and lower means of the PGSs related to diseases and health risk factors). Previous research specifically points to smoking as one of the strongest predictors of mortality and a possible explanation of the immigrant health advantage in mortality (Blue & Fenelon, 2011; Fenelon, 2013; Fleischer et al., 2017; Lariscy et al., 2015; Riosmena et al., 2017). There is also evidence of positive immigrant selectivity relative to country of origin population not only with respect to actual educational attainment (Feliciano, 2005), but also with respect to genetic predisposition to education (Belsky et al., 2016). Given the strong association between cognition and education, we expect to find an immigrant advantage on this measure, although the evidence on the nativity differences in cognition are mixed (Marc A. Garcia et al., 2017; Hill, Angel, Balistreri, & Herrera, 2012).

Hypothesis 1a: Based on the theoretical argument and previous research that documents positive educational selectivity, we expect to find an immigrant advantage with respect to the PGS related to education and general cognition.

Hypothesis 1b: Based on the theoretical argument about immigrant selectivity and previous research that documents lower rates of smoking among the foreign-born compared to the U.S.-born, we expect to find an immigrant advantage in the PGS related to smoking.

DATA AND METHODS

The paper uses data from the 2006-2014 Health and Retirement Study (HRS). The HRS is a longitudinal population representative study of the US population age 50 and over (Servais, 2010). The data have been collected every two years since 1992 and include multiple indicators of health along with a number of demographic, socio-economic and family characteristics. In 2006, HRS initiated an Enhanced Face-to-Face Interview (EFTF) that included, among other things, collection of blood and saliva samples (Crimmins, Faul, Kim, et al 2013; Crimmins, Faul, Kim, Weir 2015) that were subsequently genotyped. Genetic data was prepared and released to public by HRS staff researchers. The most recent release of public use genetic data in April of 2018 included polygenic scores (PGS) for various phenotypes (Ware, Schmitz, Gard, Faul 2018). PGSs are increasingly widely used in genetics research as they use information from the entire genome and typically have good predictive accuracy (Belsky & Israel, 2014; Dudbridge, 2013).We focus on older adults of European ancestry. The 2006-2014 HRS subsample of adults of European descent with the available genetic data is 12,057. The subsample of foreign-born non-Latinx whites is 423[1] or 3.5%.

The analyses focus on PGS for general cognition, smoking initiation (e.g. life time probability of smoking) and smoking frequency to test whether there are differenced in genetic predisposition to cognitive decline and smoking between the U.S.-born and foreign-born older adults. One of the advantages of using PGSs is that they can be treated as a normally distributed continues variables. To the hypotheses, we will perform t-tests and report statistically significant differences for 1-tailed tests (since our hypotheses are signed) using conventional p-value thresholds ($p<0.001$, $p<0.01$, $p<0.05$). Then to account for possible unobservable differences in the subsamples of the native- and foreign-born (e.g., due to the differences in ethnic composition), we run OLS regression models with an indicator for being a foreign-born as the main predictor and up to five principal components variables as controls. To account for a correlated error structure in the data (e.g., due to spouses included in the sample), we use robust standard errors.

RESULTS

The box-plot in Figure 1 shows the distribution of the polygenic scores for general cognition among the U.S.-born and foreign-born non-Latinx whites age 50 and over in the Health and Retirement Study. The median polygenic score is around 0 for the U.S.-born subsample, but among the foreign-born, it is clearly above 0. Also, the range of values is smaller among the foreign-born subsample. Table 1 present the mean polygenic scores for the two subgroups.

[Table 1 about here]

[Figure 1 about here]

[1] For six respondents in the European ancestry sample the information about the place of birth is missing.

The t-statistic obtained for the one-tailed t-test for the differences between the means is -3.249 (p = 0.0006), indicating that the differences are statistically significant. The differences are also in the expected direction: the foreign-born non-Latinx whites age 50+ have, on average, higher PGS for general cognition that the U.S.-born non-Latinx whites age 50 and over.

[Figure 2 about here]

Contrary to our expectation, the mean PGS for “ever smoking” is higher for the foreign-born compared to the native-born. Figure 2 shows that the median PGS are very similar. The t-obtained for the one-tailed t-test for the differences between the means is -0.455 (p = 0.6754), indicating that the differences are not statistically significant. However, the difference in the mean PGS for smoking frequency is highly significant and in the expected direction. Figure 3 illustrtes both the lower median PGS and the smaller range of values among the foreign-born compared to U.S.-born older adults. The t-obtained for the one-tailed t-test is 5.488 (p<.0001), pointing to a sizable immigrant advantage in genetic predisposition to the average number of cigarettes smoked compared to the U.S.-born older adults, which is unlikely to happen by chance.

[Figure 3 about here]

Table 2 present the results from the ordinary least square regression models for general cognition. Model 1 replicates the findings from the t-test by including only one predictor – an indicator variable for being foreign-born. Model 2-6 add principle components variables to evaluate how the differences in the mean PGS may be affected by the differences in ethnic ancestry composition.

[Table 2 about here]

The results from the OLS regression models show that the immigrant advantage with respect to general cognition PGS is robust to the inclusion of the principle components variable. Although each principle component is statistically significant and either slightly attenuate or magnify the size of the coefficient for the foreign-born, it is statistically significant at $p<0.05$, $p<0.01$ or $p<0.001$ level in all models. On average, being a foreign-born is associated with 0.094 -0.185 higher mean cognition PGS compared to U.S.-born.

[Table 3 about here]

Table 3 present the results from the OLS regression for life time probability of smoking. Models 1 through 4 show that there is no immigrant health advantage or disadvantage in genetic predisposition to smoking. However, the coefficient changes its sign from positive to negative in Model 5 with the addition of the 4^{th} principle component and it becomes statistically significant ($p<0.05$) in Model 6 with the addition of the 5^{th} principle component. But there is a sizable and consistent immigrant advantage in genetic predisposition to frequency of smoking (Table 4). The coefficient for the foreign-born is statistically significant in all models at $p<.01$. On average, being a foreign-born is associated with 0.129 -0.271 lower mean smoking frequency PGS compared to U.S.-born.

[Table 4 about here]

DISCUSSION AND CONCLUSION

The results generally support the “healthy immigrant hypothesis.” That is, we do observe an immigrant advantage over the U.S.-born older adults with respect to genetic predisposition to having higher cognition — which is, in turn, highly associated with a wide variety of positive health outcomes. This advantage is robust to inclusion of the principle components variables accounting for ancestry heterogeneity. On average, being a foreign-born is associated with 0.09 -

0.19 SD higher mean cognition PGS compared to U.S.-born. The support for positive immigrant selectivity with respect to genetic predisposition to life-time smoking is more tentative. The t-test and the first five OLS regression models show that there is no statistically significant immigrant advantage in smoking initiation. However, a statistically significant immigrant advantage appears in the last OLS regression model that accounts for all first 5 principal components. There is also a strong support for “the healthy immigrant effect” if predisposition to smoking is measured as the number of cigarettes smoked. On average, being a foreign-born is associated with 0.129 -0.271 SD lower mean smoking frequency PGS compared to U.S.-born.

The results have important implications. First, research that aims at estimating the nativity differences should take into account genetic factors. Accounting for genetic predisposition can potentially explain, at least partially, “unexplained” nativity differences in health outcomes reported in the previous studies. Second, accounting for immigrant selectivity with respect to genetic predisposition to certain health condition and health behavior will help better estimate the effects of social and environmental factors on the health of older immigrants and on the health disparities by nativity. For example, the effect of social factors on cognitive decline among the foreign-born may be underestimated given their more favorable genetic predisposition to higher cognition compared to the U.S.-born adults. Finally, the healthy immigrant effect may not be present in for all health outcomes and health behavior. For example, this study points to a favorable genetic predisposition with respect to smoking frequency, but not smoking initiation. In other words, immigrants are no less genetically predispose to begin smoking that the U.S.-born, but it may be easier for them to quit smoking or to smoke less.

The research has several limitations. As the data are U.S.-based, we are only able to evaluate selectivity with respect to the U.S. population rather than with respect to the populations of immigrant sending countries. However, most prior research on immigrant health and mortality compares the foreign-born to the host country population, and our research makes an important contribution to this literature. The analyses are focused only on non-Latinx white U.S.-born and foreign-born older adults. Because many immigrants in the U.S. are not white, the results may not be extrapolated to all foreign-born in the U.S. Although this is clearly a limitation that should be addressed in the future once better data become available, there are also advantages of using non-Latinx white subsample. First, non-Latinx white constitute about 86% of the U.S.-born adults age 50 and over and about 33% of older foreign-born adults age 50 and over. These are sizable proportions of the both populations. Second, the PGSs have the highest sensitivity for the non-Latinx white subsample as most of them were derived from the GWAS of people of European descent. Finally, the results for the non-Latinx whites will help advance future research on other subgroups as it will provide a point of reference in theorizing how immigrants of Latinx, Asian or African American ancestry may differ from non-Latinx white foreign-born. Another limitation is that the ethnic ancestry composition of the U.S.-born and foreign-born non-Latinx whites may be different. Unfortunately, these differences are impossible to evaluate directly as the HRS does not include a question about ethnic ancestry of the U.S.-born adults. Our comparison of the countries of origin of the entire foreign-born subsample of the HRS (available from the codebook) and the distribution of the reported ancestry of the non-Latinx whites age 50 and over from the 2008 American Community Survey show many similarities in ethnic ancestry. The top countries of origin of the non-Latinx white foreign-born age 50 and over in both the HRS and ACS are Canada, Germany/Austria, Great Britain, Italy, former Soviet Union and Poland. The top first reported ancestry categories for the U.S.-born non-Latinx whites age 50 and over in the ACS are German, English, Irish, United States and Italian. The biggest difference, perhaps, is that the foreign-born subsample has a non-trivial number of immigrants from the Middle Eastern countries and a very few U.S.-born non-Latinx whites over age 50 trace their ancestry to this region. Also, due to intermarriage of the ascendants of the immigrants from different countries, U.S.-born non-Latinx whites are more likely to be of multiple and mixed ancestry (e.g., Dutch and German, Irish and Italian, etc.). Including the principle components variables in the analyses partially addresses this limitation. Despite these limitations, the HRS is still the best available data to study immigrant selectivity with respect to genetic predisposition to certain health conditions and health behavior.

In sum, the results from this research provide the first empirical evidence in support for the "healthy immigrant effect" with respect to genetic predisposition to develop certain health outcomes and engage in health risk behaviors. Future research should address the limitations of the current study and use other data sources to assess the immigrant advantage in genetic risk profiles. Additionally, scholars may want to perform analyses directly predicting health outcomes (and mortality) by nativity status and then add in the relevant PGS variables to see how much of the effect is explained by this confounding variable.

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Table 1: Mean PGSs by nativity

Group	Mean	St. dev.	St. err.	t-obtained	p (1-tailed)	N
	General cognition					
U.S.-born	-.006	.998	.009	-3.249	.0006	11,628
Foreign-born	.154	1.030	.050			423
	Ever smoking					
U.S.-born	-.000	.996	.009	-.455	0.6754	11,628
Foreign-born	.022	1.091	.053			423
	Smoking frequency					
U.S.-born	.010	.998	.009	5.488	<.0001	11,628
Foreign-born	-.261	1.051	.051			423

Table 2: OLS regression models predicting "general cognition" PGS (N = 12,051)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Foreign-born	0.161**	0.167***	0.152**	0.143**	0.185***	0.094*
	(0.051)	(0.050)	(0.050)	(0.050)	(0.047)	(0.045)
PC1_5A		14.668***	14.665***	14.667***	14.691***	14.727***
		(1.204)	(1.205)	(1.207)	(0.945)	(0.916)
PC1_5B			-5.282***	-5.299***	-5.214***	-5.320***
			(0.971)	(0.957)	(0.947)	(0.918)
PC1_5C				16.208***	16.200***	16.227***
				(0.972)	(0.944)	(0.915)
PC1_5D					28.736***	28.672***
					(0.945)	(0.916)
PC1_5E						-25.647***
						(0.919)
Constant	-0.006	-0.006	-0.006	-0.005	-0.007	-0.004
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
R-squared	0.001	0.019	0.021	0.043	0.111	0.165

*** p<0.001, ** p<0.01, * p<0.05. Robust standard errors in parentheses

Table 3: OLS regression models predicting "ever smoking" PGS (N = 12,051)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Foreign-born	0.023	0.019	0.053	0.050	-0.012	-0.091*
	(0.054)	(0.054)	(0.053)	(0.053)	(0.045)	(0.044)
PC1_5A		-7.486***	-7.480***	-7.479***	-7.515***	-7.484***
		(1.148)	(1.141)	(1.140)	(0.917)	(0.895)
PC1_5B			11.801***	11.796***	11.673***	11.580***
			(0.967)	(0.969)	(0.919)	(0.896)
PC1_5C				5.604***	5.615***	5.639***
				(0.988)	(0.916)	(0.894)
PC1_5D					-41.795***	-41.851***
					(0.917)	(0.894)
PC1_5E						-22.246***
						(0.897)
Constant	-0.000	-0.000	-0.002	-0.001	0.001	0.004
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)	(0.008)
R-squared	0.000	0.005	0.016	0.019	0.163	0.204

*** p<0.001, ** p<0.01, * p<0.05. Robust standard errors in parentheses

Table 4: OLS regression models predicting "smoking frequency" PGS (N = 12,051)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Foreign-born	-0.271***	-0.275***	-0.232***	-0.234***	-0.240***	-0.129**
	(0.052)	(0.052)	(0.051)	(0.050)	(0.049)	(0.047)
PC1_5A		-8.531***	-8.523***	-8.523***	-8.527***	-8.571***
		(1.345)	(1.348)	(1.344)	(0.988)	(0.946)
PC1_5B			15.294***	15.291***	15.277***	15.407***
			(0.959)	(0.959)	(0.990)	(0.948)
PC1_5C				3.156**	3.157**	3.124***
				(0.980)	(0.987)	(0.945)
PC1_5D					-4.677***	-4.598***
					(0.988)	(0.946)
PC1_5E						31.437***
						(0.948)
Constant	0.010	0.010	0.009	0.009	0.009	0.005
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
R-squared	0.002	0.008	0.028	0.029	0.030	0.111

*** p<0.001, ** p<0.01, * p<0.05. Robust standard errors in parentheses

Figure 1: Box-plots for "general cognition" PGS by nativity

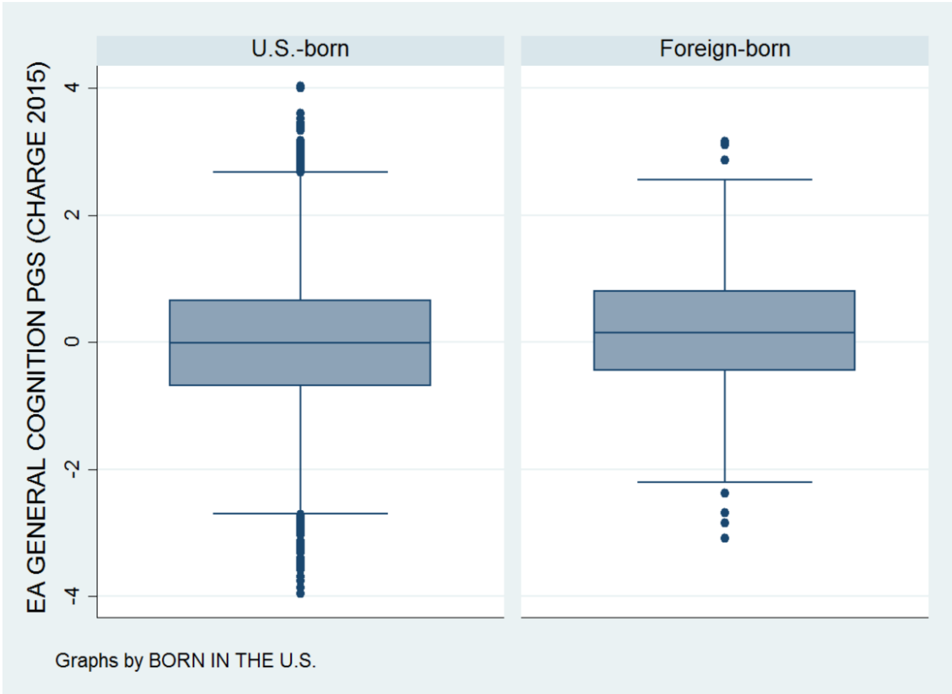

Figure 2: Box-plots for "ever smoking" PGS by nativity

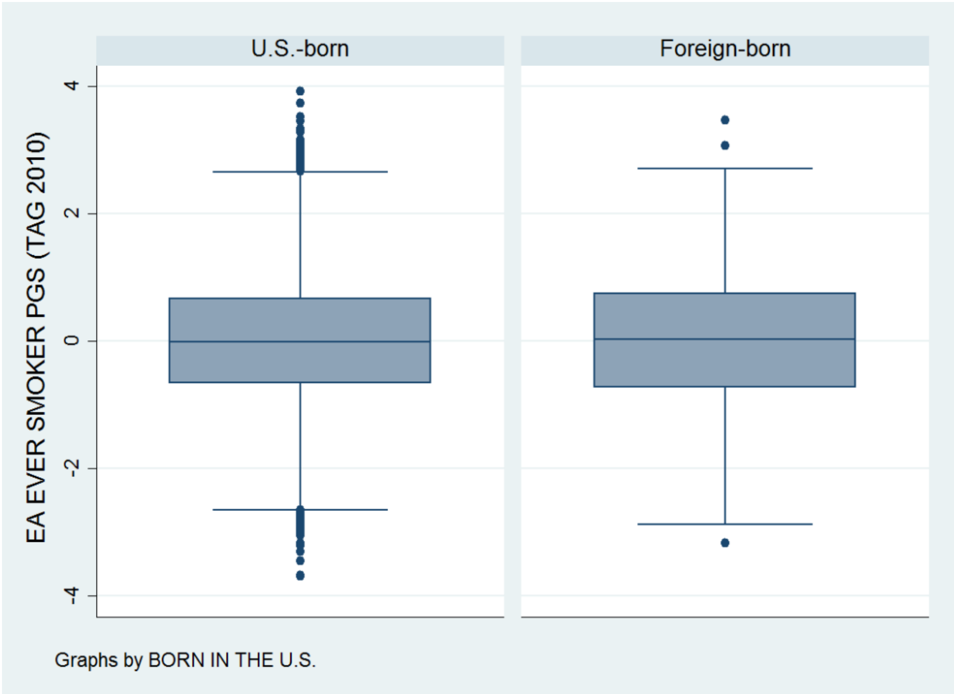

Figure 3: Box-plots for “smoking frequency” PGS by nativity