IMMIGRANTS' ACCULTURATION AND CHANGES IN BODY MASS INDEX

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ABSTRACT

We study Body Mass Index (BMI) changes among immigrants from Iran, Pakistan, Sri Lanka, Turkey, and Vietnam relative to native Norwegians in Oslo. We test a symmetric convergence hypothesis: irrespective of whether an immigrant's initial BMI is lower or higher than a native Norwegian, acculturation should make the difference in BMI between an immigrant and a native smaller. Convergence is driven by acculturation, which is measured by immigrants' language skills. Our data come from two surveys in Oslo 2000-2002. Weights and heights were measured at the surveys; participants were asked to recall weights when they were 25 years old. Norwegian language skills and various socio-economic data were collected. We use multivariate regression analysis. Our findings broadly support the symmetric convergence hypothesis. Proficiency in the Norwegian language tends to make immigrants' BMI, particularly among females, more equal to native Norwegians. Immigrants' time of residency has been found to have no impact on changes in BMI.

Introduction

Many studies have looked at obesity among immigrants. For example, in the United States, it has been found that obesity rates among immigrants rise over time. Healthy behaviors seem to decline, and risk factors seem to increase with acculturation; a convergence phenomenon has been noted. In this paper, we address the convergence hypothesis. Our study regards convergence in a symmetric way, so we hypothesize that acculturation may benefit or harm immigrants.

The data of our study come from two surveys conducted in Oslo, Norway in 2000-2002. Our study differs from others in a number of ways. First, we have immigrants in Oslo from five different countries: Iran, Pakistan, Sri Lanka, Turkey, and Vietnam. Second, we study their change in BMI between the time of surveys (in 2000 and 2001) and when they were 25 years old. Third, we compare the immigrants' BMI changes with those of native Norwegians.

The five groups of immigrants exhibit quite different degrees of obesity compared to Norwegians at the time of the surveys. In our sample, female Norwegians have a mean BMI of just under 25, while female immigrants from these five countries have BMIs ranging between just over 23 (Vietnam) to just over 30 (Turkey). For males, the mean Norwegian BMI is just over 26, and the immigrants' BMIs range between 24 (Vietnam) and under 28 (Turkey). More detailed descriptions are in Kumar et al (2006). Under the acculturation hypothesis, those immigrants with BMIs below Norwegians would have a higher increase over time, and vice versa for those with BMIs above Norwegians. The variations in BMIs among immigrants relative to natives provide an opportunity to test the acculturation hypothesis in a symmetric way.

It has been shown that acculturation affects obesity among immigrants (Kaplan et al., 2004; Goel et al., 2004; Lindström et al., 2005). The time of residency in the host country is often used as a proxy for acculturation. It is argued that as their time of residency in the host country increases, immigrants become more integrated with locals' lifestyle and eating habits. The longer they have stayed in the host country, the more likely the Body Mass Index (BMI) will converge to those of native residents. In our study, we use language skills as the measure of acculturation. This is arguably a better proxy than time of residency

because language skills directly are related to social interactions. We have found that immigrants' BMI changes are affected by acculturation as measured by language skills, and that these changes broadly are consistent with symmetric convergence. For our data we do not find that time of residency has an impact on immigrants' BMI changes.

Our results say that acculturation may result in better healthy behaviors and risk factors if immigrants have had a set of less favorable conditions before they come to the host country. In as much as immigrants' health status deteriorates when they move to a host country with unfavorable conditions, may their health improve when they move to more favorable environments?

Previous studies have pointed out the harmful effects of immigration on obesity. For example, Himmelgreen, et al., (2004) show that length of residency and language use have been associated with obesity in Puerto Rican women who have immigrated to the U.S. Goel et al (2004) report similar results on length of residency and obesity of many immigrant groups, as do Fuentes-Afflick et al (2008) on the effect of length of residency on Latina women.

While the literature has broadly documented the harmful effect on obesity from immigration, especially to the U.S., we contribute to the literature by showing that acculturation may have a protective effect against obesity. An immigrant who is overweight relative to natives may experience lesser weight gain compared to natives when possessing proficiency in the local language. Acculturation effects can be symmetric, and hence protective.

One may think that acculturation and language proficiency proxy social network effects. In fact, recent papers by McDonald and Kennedy (2005) and Christakis and Fowler (2007) point out the impact of social network on obesity. We suspect that such effects are present among immigrants in our study, but lack the data to document any.

Food prices likely are determinants to choices of diets. Relative prices between high-calorie and low-calorie foods in the origin countries and Norway may be very different. Immigrants therefore experience relative price changes when they move to Oslo. These may have an effect on their dietary

choices. The origin country variable likely captures some of these effects. If we were able to obtain information of relative prices of food over time, it would have been included in the analysis.

The rest of the paper is as follows. We first describe the study setting, the data and descriptive statistics. Next, we present the estimation method and empirical results. Finally, we discuss a number of issues on the limitation of our study and policy implications.

Data and descriptive statistics

Our study is based on two cross-sectional surveys of immigrants and native Norwegian residents in Oslo. The first data set is the Oslo Health Study (HUBRO), collaboration between the Norwegian Institute of Public Health, the University of Oslo, and the Municipality of Oslo. During 2000-2001, all residents of Oslo who were born in 1924, 1925, 1940, 1941, 1955, 1960 and 1970 were invited to participate in a survey, and 18,770 (46%) responded (Søgaard et al 2004). In addition, all those born in 1954 and 1969 were also invited towards the end of the study (although the invitation was not followed by further reminders). The second data set is the Oslo Immigrant Health Study, conducted by the Norwegian Institute of Public Health and the University of Oslo in 2002 with the same methodology as in HUBRO. In this study, Oslo residents who were born in Iran, Pakistan, Sri Lanka, Turkey, and Vietnam between 1942 and 1971 were invited, except those 800 individuals who already had been invited to participate in HUBRO. A total of 3019 (39.7%) responded to the invitation.

For each data set, we only use data on those individuals born between 1940 and 1971, and in Iran, Norway, Pakistan, Sri Lanka, Turkey, and Vietnam. Because we are interested in obesity among adults, individuals with birth years in this range would be between 30 and 60 years old at the time of the survey. Of a total of 17666 participants (Table 1), 1350 were excluded due to invalid height or weight measurements, or missing information of weight at age 25. There were then 16316 individuals left.

Table 1 describes the initial number of observations according respondents' places of birth in the Oslo Health Study and the Oslo Immigrant Health Study. More than 80 percent of the participants were from the Oslo Health Study, but immigrant respondents are in both data sets. In total 78 percent of the

respondents are born in Norway. Sri Lanka is the most prevalent foreign country, with 7 percent of the respondents born there.

Table 1

Information on age, gender and country of birth was provided by The Norwegian population register. For all participants not born in Norway, date of immigration was provided by Statistics Norway. All invited persons were asked to fill out the main questionnaire at home and to bring it to the screening station where this was checked by a nurse.

At the screening station, body weight (kg) and height (cm) were measured with an electronic height and weight scale with the participants wearing light clothing without shoes. Body mass index (BMI) was computed as weight divided by the square of height in meters (kg/m^2). Also, participants were asked to recall their body weight at age 25 and to report how many years of education they had completed. Finally, each participant was also given a supplementary questionnaire which could be completed at the screening site or sent back in a stamped, addressed envelope. In one of the questions applicable to immigrants they were asked "How good are your Norwegian language skills?" There were five possible responses, ranging from 'very good' to 'poor'. A substantial number of participants did not respond to the supplementary questionnaire, and of those who attended the study 50% of male immigrants and 53% of female immigrants did not respond to the language skill question.

Table 2 presents basic descriptive statistics according to gender and participants' countries of origin. First, due to missing information in some responses, the size of the data set is reduced from 16316 to 14208 here; there are 7711 men and 6497 women. While the proportion of Norwegians was 78 percent in the initial data set, it has increased to 90 percent in the data set used for the analyses. For the immigrant groups, the proportion from Sri Lanka has become smaller and the proportion of Iranians larger in the final data set than in Table 1. The proportion of males is 46 percent, both in the initial data set and in the final data set. Mean age is 43 years in the both data sets.

From Table 2 variables characterizing the prevalence of obesity vary considerably between men and women, and across countries of origin. While 47 percent of women from Turkey are obese (BMI>30), only 4 percent of women from Vietnam are. The variation in BMI (based on weight and height measured at the surveys) seems to be higher than BMI25, which is the respondent's BMI calculated from recalled weight at age 25. This likely is due to the fact that BMI of most people tends to increase as they age. The variation in obesity rates across countries of origin is smaller for men than women.

Table 2

We measure education by the dummy variable *%highereducation*, which is set to one if the number of school years is greater than twelve, and zero otherwise. According to Table 2, immigrant men generally have been in Norway longer than women. On average, immigrants have spent less than half of their lives in Norway. For Norwegians, we let the number of years they have lived in Norway equal their age.

Our key variable is *Norwegian language skills*, measured in an ordinal scale with five steps: *Poor, Rather poor, Medium, Good* and *Very good*. Native Norwegians were not asked this question, and we assume that their Norwegian language skills are in the *Very good* category. From Table 2, immigrant men generally have better Norwegian language skills than women, but there are considerable differences across countries of origin. For example, only 31 percent of women from Pakistan attain the Norwegian language at the good or very good levels, but 55 percent of Iranian women reported similar language skills. The variation across men seems to be somewhat smaller.

Language skill will be a main focus of our empirical study. As a substantial number of participants did not respond to this question, it is important to find out if there is any systematic difference between those who responded to the language skill question and those who did not. Weight change did not differ significantly between those who responded to the question on language skill compared to those

who did not in any gender and country specific group, except for Iranian men whose weight gain among responders was 2 kg more (p=0.035) than those who did not respond.

Table 3 describes weight change between the time of the surveys and the recalled weight at 25 years old, according to language skill, gender, and country of origin. We also present weight changes that are adjusted by ages (calculated by analysis of variance). Weight changes tend to be different between men and women. Among women from Iran, Pakistan, and Turkey, weight gains decline as their language skills become higher, while those women from Sri Lanka and Vietnam experience smaller weight changes over different levels of language skills. Among men, except for those from Vietnam, better language skills tend to be associated with more weight gains. Our multivariate analysis below will study these associations formally.

Table 3

Estimation and results

We study if acculturation tends to make immigrants' BMIs converge to native Norwegians'. Suppose that an ethnic immigrant has a BMI higher than a Norwegian at 25 years old. We hypothesize that between age 25 and the time of HUBRO and the Oslo Immigrant Study the immigrant will have a smaller weight increase than a Norwegian. Conversely, suppose that an ethnic immigrant has a BMI lower than a Norwegian at 25 years old, the immigrant will have a larger weight increase. Our dependent variable is an individual's change in BMI between the time of HUBRO/Oslo Immigrant Study and at 25 years old. The dependent variable is denoted by *dBMI*.

We use ordinary least squares regression on the dependent variable *dBMI*. Regressions on males and females are run separately. We use two groups of independent variables. The first group describes socio-demographic characteristics. This group includes *Age* and Age-squared (Age^2), to allow for non-

linear effects of age; a binary variable on *Education*, set to one if the individual has more than 12 years of schooling; a binary variable, West, set to one if an individual lives in the part of Oslo where socio-economic conditions are better.

The second group of independent variables includes individuals' countries of birth, and their Norwegian language skills. For simplicity, the level of Norwegian skills is treated as a scale variable, from 0 to 4 (0 for poor; 1 for rather poor; 2 for medium; 3 for good; 4 for very good), although it is an ordinal variable. We will show that our results do not rely on this simplification. Country of birth is also interacted with Norwegian language skills.

In our regressions the reference group is the native Norwegians, who are assumed to have very good language skills. In a supplementary regression we replace the Norwegian language skill variables by the number of years the immigrants have lived in Norway (Years) interacting with countries of origin. For Norwegians, we use their ages as the number of years they have lived in Norway.

Table 4

There are two key independent variables. The first is an immigrant's country of origin, and the second is the country of origin interacted with language skills. The acculturation hypothesis is empirically identified by the following predictions. For an immigrant whose BMI at 25 years old is higher than a native Norwegian, if the estimate of the country of origin variable is positive, then the country-of-origin-language-skill interaction term should be negative. Conversely, for an immigrant whose BMI at 25 years old is lower than a native, if the estimate of the country of origin variable is negative, then the country-of-origin-language-skill interaction term should be positive. In other words, controlling for country of origin, BMIs of immigrants should converge to that of natives, hence the opposite signs of the country of origin and language-skill interaction estimates.

Our key independent variable is the country of origin interacted with language skills. From the second column in Table 4, Turkish and Pakistani women have higher *dBMI* than Norwegians, but both

groups would experience smaller increases in BMI when their Norwegian language skills are better. These results support the acculturation hypothesis. The magnitude if this effect is considerable. For instance, each step of improved language skills has the effect of a reduction in *dBMI* of 0.71 kg/m^2 for Pakistani women. For a woman of height 1.57 meter (the mean height of Pakistani women) this effect corresponds to a weight reduction of about 2 kgs.

Language skills interacting with countries of origin do not exhibit significant effects on BMI increase for women from the other three countries. Nevertheless, Iranian women tend to have both higher BMI at 25 years old and higher *dBMI* than Norwegian, and the estimate of language skill interacting with country of origin shows a negative sign. From Table 4, *Age* and *Education* have the expected effects on women's *dBMI*. Since the maximum effect of age on *dBMI* occurs at 117.5 years of age, *dBMI* is increasing in age in practice. Living in *West*, where socioeconomic conditions are superior, contribute to a decline in weight increase.

From the fourth column of Table 4, men from Sri Lanka have lower *dBMI* than Norwegians, while the opposite is true for men from Vietnam. When Sri Lankan men have better language skills, their BMIs tend to increase more than Norwegians. This supports the acculturation hypothesis. When men from Vietnam have better language skills, their BMIs tend to increase less than Norwegians. Because Vietnamese men have BMIs lower than Norwegians, the acculturation hypothesis that better language skills should be associated with increases in BMIs higher than Norwegians, so the hypothesis is not consistent with the language skills estimate for Vietnamese men. We should, however, point out that many Vietnamese came as refugees with very low weights. As they faced a more agreeable environment, they became healthier. They started with low BMI, and their BMI rose faster than natives, but Norwegian language skills would reduce the BMI increase. For men from the other three countries, their BMIs are not significantly different from Norwegians, and language skills do not significantly affect changes in BMIs. Finally we note that *Age* has a positive and significant effect on men's increase in BMI, while *Education* has no effect.

In the third and fifth columns, we present regression results when language skills are replaced by the number of years since immigrants arrived in Norway. The number of years in Norway interacted with countries of origin does not have an impact on *dBMI* for any of the ethnic groups, for both men and women. To allow for nonlinear effects, in another set of regressions (not presented here), we also have included squares of the number of years in Norway, but results remain insignificant. Broadly, language skill is a better measure of acculturation than the amount of time spent in the host country.

We have performed several robustness checks. We have regarded Norwegian language skills as a scale, although it is an ordinal variable. In a supplementary regression, we collapse the language variable into a binary variable. This takes the value 1 if an individual commands the Norwegian language at the good or very good levels, and takes the value 0 otherwise. The effect of language skills is still negative and statistically significant for women from Turkey (p=0.002) and Pakistan (p=0.06).

In a second robustness check we exclude from our sample those who have birthdays in the latest 10-year period among all those in the data set. In this subsample, there are 5027 women, and 4110 men. Younger immigrants are perhaps different from the older ones, so this subsample will focus on whether acculturation has an effect on older immigrants. Now only the language skills among Pakistani women have a (marginally) statistically significant effect at a conventional level (coefficient = -0.76, p=0.053).

In our data set, about 90% of the individuals in the sample are Norwegians. To check that our results have not been driven by the high proportion of Norwegians, we rerun the regressions with only immigrants in the sample. The effect of language skills are still significant among Turkish women (coefficient = -0.70, p=0.025) and marginally significant among Pakistani women (coefficient = -0.63, p=0.055).

Discussion

We have analyzed the effects of acculturation on gains in BMI among immigrants. Our research is unique in that we allow for symmetry. Immigrants with BMIs lower than native when young are predicted to gain more weights than native; those with BMIs higher than native when young are predicted

to gain less weight. Put differently, we hypothesize that immigrants' BMI changes converge symmetrically to natives'. The empirical implementation uses immigrants' local language skills to measure the extent of acculturation, which drives the symmetric convergence. The regression analysis broadly supports our hypothesis of symmetric convergence. Unlike other studies, we do not find that the number of years since immigration have significant effects on changes in immigrants' BMI relative to natives.

Several issues are to be noted about our study. First, we can only ask subjects to recall their weights when they were 25 years old. Given that immigrants were not in Norway when they were 25 years old, this is the only feasible way to proceed. Information from recall can be unreliable. If the noise in recalling weights at 25 years old varies randomly among different ethnic groups and Norwegians, then our results are expected to be diluted .

Second, one may worry about a selection problem. Immigrants are seldom randomly selected individuals from their home countries. The effects of acculturation may not be applicable to the general population of the origin countries from which subjects of the surveys have immigrated. That is, a randomly chosen individual from Iran, for example, may experience a stronger or weaker effect due to acculturation if he or she were to immigrate to Norway, compared to an Iranian who was in our sample. However, it is unlikely that our results, which show broad support for the effect of acculturation, would be nullified by potential selection. Søgaard et al. (2004) found that attendance was positively associated with age, income, education, living in Outer West and Outer East. However, the impact of self-selection in the Oslo Health Study has been evaluated and the prevalence estimates of factors such as body mass index, smoking and self perceived health was found to be quite robust. Hence, one can interpret our results to apply to those individuals who have decided to immigrate to Norway. The relationship between acculturation and obesity is a moot issue for nonimmigrants.

Third, one should be cautious in drawing policy implications from the effect of acculturation on obesity. Integration of immigrants into host countries is a complex issue. Obesity is an undesirable outcome. Although obesity may be positively associated with acculturation from the convergence hypothesis (for someone with a low BMI immigrating to a host country with a population of high BMI), one must refrain from drawing the conclusion that the acquirement of the native language (which tends to accelerate acculturation) should be delayed. Often faster acculturation allows an immigrant to have better job opportunities, access to education and financial resources, and reduces stress due to adjustment. These benefits must be compared with the cost of obesity, and the comparison is far from easy.

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Table 1: Number of participants by countries of origin and surveys

Country of birth	Oslo Health Study	Oslo Immigrant Health Study	Sum (%)
Norway	13684	0	13684(78)
Turkey	132	418	550 (3)
Sri Lanka	185	987	1172 (7)
Iran	151	591	742 (4)
Pakistan	422	437	859 (5)
Vietnam	135	524	659 (4)
Sum	14709	2957	17666 (100)

Table 2: Descriptive statistics: means with standard deviations in parentheses

	Norway	Turkey	Sri Lanka	Iran	Pakistan	Vietnam
Females (n=7711)	n=7110	n=101	n=130	N=141	n=105	n=124
Height (cm)	167	157	156	158	157	153
Weight	68.9	73.7	64.3	65.0	71.3	54.5
Weight25	60.0	59.1	51.4	54.9	55.1	46.2
BMI	24.8 (4.3)	30.1 (6.0)	26.7 (4.1)	26.2 (4.3)	29.1 (5.0)	23.3 (3.3)
%overweight	39	76	64	57	82	27
%Obese	11	47	19	11	35	4
BMI25	21.5 (2.8)	24.0 (3.6)	21.2 (3.3)	22.0 (3.0)	22.4 (4.5)	19.7 (3.1)
Age	43.5 (10.8)	40.5 (7.2)	39.5 (8.0)	41.7 (7.6)	42.3 (8.7)	43.5 (7.5)
%highereducation	68	21	42	60	26	29
No. Years in Norway		15.2 (7.1)	10.5 (4.8)	10.6 (4.5)	16.1 (7.1)	14.1 (6.6)
Norwegian language skills						
%Poor		16	1	2	20	17
%Rather poor		12	8	6	16	17
%Medium		24	45	37	33	26
%Good		33	38	43	24	30
%Very good		15	8	12	7	10
Men (n=6497)	n=5678	n=137	n=193	N=200	n=171	n=118
Height (cm)	180	170	168	172	170.1	165
Weight	85.0	80.3	71.6	77.6	80.0	64.9
Weight25	75.6	68.9	62.1	67.0	67.6	55.2
BMI	26.3 (3.6)	27.7 (3.9)	25.4 (3.1)	26.4 (3.1)	27.5 (3.6)	24.0 (2.7)
%overweight	61	77	50	71	77	35
%Obese	14	23	6	13	25	3
BMI25	23.2 (2.7)	23.7 (2.6)	21.9 (3.7)	22.7	23.1 (2.9)	20.3 (2.4)
Age	43.6 (11.2)	42.6 (8.1)	40.2 (6.6)	41.6 (6.7)	43. (9.1)	43.5 (7.9)
%highereducation	70	26	49	65	33	43
No. Years in Norway		15.9 (8.5)	13.6 (4.0)	12.2 (4.1)	20.1 (9.2)	17.4 (5.6)
Norwegian language skills						
%Poor		5	1	4	4	5
%Rather poor		10	4	4	8	15
%Medium		28	38	23	35	36
%Good		42	50	48	35	35
%Very good		15	7	21	18	9

Table 3: Weight change, measured at survey less recalled weight at 25 years old, by language skill.

		Δ weight in kg (crude), by Norwegian language skills			Δ weight in kg (age adjusted), by Norwegian language skills		
Country of origin	N	Very good/good*	Average	Rather poor/poor*	Very good/good*	Average	Rather poor/poor*
women							
Turkey	105	10.5	14.4	20.6	12.0	14.8	19.2
Iran	150	9.5	10.9	13.7	9.7	10.5	13.8
Pakistan	115	12.4	15.5	19.5	14.0	14.9	17.9
Sri Lanka	139	13.1	13.4	12.4	13.7	14.7	11.2
Vietnam	138	7.9	8.7	8.0	7.9	7.4	6.0
men							
Turkey	142	11.9	11.1	11.9	12.0	11.1	11.1
Iran	213	10.6	11.2	7.1	10.9	10.9	6.1
Pakistan	188	12.9	12.2	10.6	12.7	11.6	9.7
Sri Lanka	210	10.1	8.1	9.7	10.7	8.4	9.5
Vietnam	129	7.9	8.2	15.5	7.9	7.8	15.2

*The two lowest and the two highest categories are merged.

Table 4: Effect of socio-demographic variables and ethnicity on BMI change since 25 years old (dBMI), estimated by OLS with Norwegians as reference

dBMI	Females		Males	
Age	0.47*** (0.03)	0.49*** (0.03)	0.36*** (0.03)	0.37*** (0.03)
Age^2	-0.004*** (0.0003)	-0.004*** (0.0003)	-0.003*** (0.0003)	-0.003*** (0.0003)
Education	-0.52*** (0.09)	-0.51*** (0.08)	-0.10 (0.08)	-0.14* (0.07)
Turkey	4.10*** (0.63)	2.47 (0.56)	0.81 (0.64)	0.28 (0.39)
Turkey*skills	-0.75*** (0.25)		0.02 (0.23)	
Turkey*years		-0.005 (0.03)		0.03 (0.02)
Pakistan	4.22*** (0.56)	3.57 (0.47)	0.32 (0.59)	1.03*** (0.35)
Pakistan*skills	-0.71*** (0.26)		0.29 (0.21)	
Pakistan*years		-0.04 (0.03)		-0.01 (0.02)
Iran	1.98** (0.85)	1.25*** (0.49)	-0.03 (0.61)	0.86* (0.49)
Iran*skills	-0.49 (0.31)		0.22 (0.21)	
Iran* years		-0.04 (0.04)		-0.06 (0.04)
Srilanka	1.19 (0.91)	1.57*** (0.46)	-1.56** (0.73)	0.25 (0.48)
Srilanka*skills	0.34 (0.36)		0.79*** (0.27)	
Srilanka*years		0.09** (0.04)		0.04(0.03)
Vietnam	-0.62 (0.54)	-0.73 (0.48)	2.08*** (0.64)	1.03 (0.63)
Vietnam*skills	0.15 (0.23)		-0.76*** (0.26)	
Vietnam*years		0.04 (0.03)		-0.05 (0.04)
West	-0.55*** (0.08)	-0.56*** (0.08)	-0.15* (0.08)	-0.16** (0.08)
Constant	-8.27 (0.73)	(2.15)	-6.26*** (0.71)	-6.43*** (0.70)
No. observ	7711	8396	6497	7289
Adj R^2	0.16	0.19	0.11	0.13

The symbols *, ** and *** denote statistical significance at 10, 5 and 1 percent, respectively.