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Immigrants' acculturation and changes in Body Mass Index☆

Tor Iversen [a], Ching-to Albert Ma [b,c,*], Haakon E. Meyer [d,e]

[a] Department of Health Management and Health Economics, Institute of Health and Society, University of Oslo, P.O. Box 1089 Blindern, NO-0317 Oslo, Norway
[b] Department of Economics, Boston University, Boston, MA, USA
[c] Department of Economics, University of Oslo, Oslo, Norway
[d] Department of Community Medicine, Institute of Health and Society, University of Oslo, Norway
[e] Norwegian Institute of Public Health, Oslo, Norway

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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 assess the effect of acculturation on BMI changes. We hypothesize that acculturation reduces the gap of BMIs between natives and immigrants. Acculturation 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 socio-economic data were collected. Our findings support our hypothesis. Acculturation, as measured by proficiency in the Norwegian language, has the predicted effects on BMI changes. We do not find any effect of immigrants' time of residency on BMI changes.

1. Introduction

Immigrants are exposed to new cultures when they arrive at their new country. It has been shown that acculturation affects obesity among immigrants (Kaplan et al., 2004; Goel et al., 2004; Lindström and Sundquist, 2005). 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 and Hessol (2008) on the effect of length of residency on Latina women.

In this paper we contribute to the literature by showing that acculturation may have a protective effect against obesity. New cultures need not always increase the incidence of obesity, and in fact can reduce it. Furthermore, unlike most other studies, we use language skills as the measure of acculturation. This is arguably a better proxy for acculturation than time of residency because language skills are directly related to social interaction and integration.

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. These five groups have different immigration histories. Most Pakistanis and Turks came to Norway as labor immigrants, and later their families reunited with them. Most immigrants from Iran, Sri Lanka and Vietnam experienced political unrest in their home countries, and came to Norway as asylum seekers and refugees. Second, we study their change in BMI between the time of surveys (in 2000 and 2001) and when they were

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* Corresponding author at: Department of Economics, Boston University, 270 Bay State Road, Boston, MA 02215, USA.
E-mail addresses: tor.iversen@medisin.uio.no (T. Iversen), ma@bu.edu (C.-t. A. Ma), h.e.meyer@medisin.uio.no (H.E. Meyer).

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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 Norwegian men, the mean BMI is just over 26, and for male immigrants, their mean BMIs range between 24 (Vietnam) and under 28 (Turkey). More detailed descriptions are in Kumar et al. (2006).

Our hypothesis is that acculturation reduces the gap of BMIs between Norwegians and immigrants. The variations in BMIs among immigrants relative to natives provide an opportunity to test the acculturation hypothesis in a symmetric fashion.

We have found that immigrants' BMI changes are affected by acculturation as measured by language skills. Consider two immigrants whose BMIs were higher than Norwegians' when they were 25 years old. Other things being equal, the immigrant whose Norwegian language is better has a lower rate of BMI increase. Conversely, consider two immigrants whose BMIs were lower than Norwegians' when they were 25 years old. Other things being equal, the immigrant whose Norwegian language is better has a higher rate of increase. Our data support that acculturation has a symmetric effect. The magnitude of the effect increases with language proficiency. For our data we do not find that time of residency has an impact on immigrants' BMI changes relative to natives'.

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.

2. Data and descriptive statistics

Our study is based on two cross-sectional surveys of immigrants and native residents in Oslo, Norway. The first data set is the Oslo Health Study (HUBRO), a collaboration between the Norwegian Institute of Public Health, the University of Oslo, and the Municipality of Oslo during 2000–2001. HUBRO did not have enough resources to survey the entire population of Oslo. Instead, HUBRO attempted to survey all residents in some selected birth cohorts. The selected cohorts were those born in 1924, 1925, 1940, 1941, 1955, 1960 and 1970; a total of 18,770 (46%) responded to the survey (Søgaard et al., 2004). Towards the end of the study HUBRO also invited all those born in 1954 and 1969 to participate in the survey (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. This uses the same methodology as HUBRO. The organizers of the Oslo Immigrant Health Study selected five of the largest non-western group of immigrants in Norway: Iran, Pakistan, Sri Lanka, Turkey, and Vietnam. Immigrants from these countries and born between 1942 and 1971 were invited, except those 800 individuals who already had been selected by HUBRO. A total of 3019 (39.7%) responded to the invitation.

We used the Norwegian Population Register to get participants' age, gender and country-of-birth information. For those participants born outside of Norway, we obtained their dates of immigration from Statistics Norway.

For each data set, we only use information of those individuals born between 1940 and 1971, and in Iran, Norway, Pakistan, Sri Lanka, Turkey, or Vietnam. Because we are interested in obesity among adults, these individuals would be between 30 and 60 years old at the time of the survey (2001). For some participants, their weight and height were measured under deviating conditions such as pregnancy, inability to fully extend torso, etc. We regard such measurements as invalid, and discarded these data points. We also discarded data from respondents who did not provide weight information from when they were 25 years old. From the total of 17,666 participants (Table 1), 1350 were excluded due to these criteria. There were then 16,316 individuals left.

Table 1 describes the initial number of observations according to respondents' places of birth in the Oslo Health Study and the Oslo Immigrant Health Study. More than 80% of the participants were from the Oslo Health Study, but immigrants are represented in both. In total, 78% of the respondents are born in Norway. Sri Lanka is the most prevalent foreign country, with 7% of the respondents born there.

In both studies, each participant was asked to fill out the main questionnaire at home and to bring it to the screening station. There, a nurse would check on the participant. In the questionnaire, participants were asked to recall their body weights when they were 25 years old, and to report how many years of education they had completed.

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 and without shoes. Body Mass Index (BMI) is the ratio of weight in kilograms to the square of height in meters (kg/m^2). Finally, each participant received a supplementary questionnaire. A participant could complete it at the screening site or mail it back in a stamped, addressed envelope. The supplementary questionnaire for immigrants has an extra section, in which the question "In your opinion, how good is your knowledge of Norwegian?" was asked. The five possible responses ranged from 'very good' to 'poor.'

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

Country of birth	Oslo Health Study	Oslo Immigrant Health Study	Sum (%)
Norway	13,684	0	13,684 (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	14,709	2957	17,666 (100)

The questionnaires were translated into Turkish, Farsi, Urdu, Tamil, and Vietnamese, except for the supplementary questionnaire in the Oslo Immigrant Health Study (which was only available in Norwegian and English). Field workers speaking the above five languages were available at the screening station. A substantial number of participants did not respond to the supplementary questionnaire, and of those who did, 50% of male immigrants and 53% of female immigrants did not answer the language skill question. Nevertheless, we have verified that the response rates of the supplementary questionnaire in HUBRO and the Oslo Immigrant Health Study were similar. Below we provide more information.

Table 2 presents basic descriptive statistics according to gender and participants' countries of origin. First, due to missing information in some responses, the number of participants left in the analysis was reduced from 16,316 to 14,208 (7711 men and 6497 women). While the proportion of Norwegians was 78% in the initial data set, it had increased to 90% in the data for analyses. For the immigrant groups, the proportion from Sri Lanka had become smaller and the proportion of Iranians larger than in Table 1. The proportion of males remains at 46%, while the average age also remains at 43 years old in the data set for analyses.

From Table 2, variables characterizing the prevalence of obesity vary considerably between men and women, and across countries of origin. While 47% of women from Turkey are obese (BMI $>$ 30), only 4% of women from Vietnam are. The variation in BMI (based on weight and height measured at the surveys) seems to be higher than in *BMI25*, which is the respondent's BMI calculated from recalled weight at 25 years old. The higher variation in BMI is likely because BMI tends to increase as people become older. Across countries of origin men have smaller obesity rate variations than women.

We measure education by the dummy variable *% higher education*, which is set to 1 if a respondent achieved more than 12 years of schooling, and 0 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, their years 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 immigrant women, but there are considerable differences across countries of origin. For example, only 31% Pakistani women reported speaking Norwegian at the *Good* or *Very good* levels, but 55% of Iranian women

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)
% higher education	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
	Norway	Turkey	Sri Lanka	Iran	Pakistan	Vietnam
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)
% higher education	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

reported similarly. Immigrant men seem to have less variations in language skills.

Language skill is a main focus of our empirical study. As we have discussed above, many participants did not respond to this question. We believe that selection bias is not so serious to hamper our analysis. First, as we have discussed, questionnaires were translated into immigrants' native languages, and field workers speaking these languages were on site. Second, we have verified that for all gender and country groups except Iranian men, weight changes did not differ significantly between respondents and nonrespondents. For Iranian men, weight gain among respondents was 2 kg more ($p = 0.035$) than nonrespondents. Other variables only show moderate differences between respondents and nonrespondents. Details can be found in the web page of "The Oslo Immigrant Health Study" residing in the web site of the Norwegian Institute of Public Health: http://www.fhi.no/eway/default.aspx?pid=233&trg=MainLeft_5669&MainLeft_5669=5544:53584::0:5667:2:::0:0.

Søgaard et al. (2004) find that attendance is positively associated with age, income, education, living in Outer East and Outer West (which, respectively, are more distant neighborhoods east and west of the city center). 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 has been found to be quite robust. (See also http://www.fhi.no/dav/C1E43891DD.pdf for more information.)

Table 3 describes changes in the participants' weights between the time of the surveys and when they were 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). Men and women experience different weight changes. Iranian, Pakistani, and Turkish women have weight gains that decline as their Norwegian language skills become better, while Sri Lankan and Vietnamese women have smaller weight changes over different levels of language skills. All immigrant men, except those from Vietnam, tend to have more weight gains when their Norwegian language skills are better. Our multivariate analysis below will study these associations formally.

3. Estimation and results

We study the effect of acculturation on immigrants' changes in BMI relative to native Norwegians. Suppose that at 25 years old an ethnic immigrant has a BMI higher than a Norwegian. Then acculturation leads to a smaller increase of the immigrant's BMI from 25 years old to the time of the HUBRO and the Oslo Immigrant Study. Conversely, suppose that at 25 years old an ethnic immigrant has a BMI lower than a Norwegian. Then acculturation leads to a larger increase of the immigrant's BMI. In other words, acculturation tends to reduce the gap between BMIs of immigrants and Norwegians.

The dependent variable is the change in a participant's BMI between the survey and 25 years old, and it is denoted by ΔBMI. We use ordinary least squares regression on the dependent variable ΔBMI. We run regressions on males and females separately. Each regression uses two sets of independent variables. The first 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 1 if the individual has more than 12 years of schooling; a binary variable, *West*, set to 1 if an individual lives in the part of Oslo where socio-economic conditions are more favorable.

The second set of independent variables includes individuals' countries of birth, and their Norwegian language skills. For simplicity, we treat the level of Norwegian skills 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 ordinal. We will show that our results do not rely on this simplification. We also interact country of birth with Norwegian language skills.

In our regressions we use native Norwegians as our reference group; naturally, we assume that they have very good Norwegian language skills. In a supplementary regression we replace the Norwegian language skill variables by how long immigrants have lived in Norway (*years*) interacting with countries of origin. For Norwegians, we use their ages as the numbers of years they have lived in Norway.

There are two key independent variables. The first is an immigrant's country of origin, and the second is the

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

Country of origin	n	Δ weight in kg (crude), by Norwegian language skills			Δ weight in kg (age adjusted), by Norwegian language skills		
		Very good/good[a]	Average	Rather poor/poor[a]	Very good/good[a]	Average	Rather poor/poor[a]
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

[a] The two lowest and the two highest categories are merged.

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, immigrants' changes in BMIs (ΔBMI) should get closer 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 Table 2, Turkish and Pakistani women have higher BMI than Norwegians at 25 years old. From the second column in Table 4, Turkish and Pakistani women have higher ΔBMI than Norwegians', but both groups would experience smaller increases in BMI when their Norwegian language skills are better. These results support the acculturation hypothesis since language skills reduce the gap of BMIs between natives and Turkish and Pakistani women. The magnitude of this effect is considerable. For instance, each step of improved language skills reduces ΔBMI by 0.71 kg/m^2 for Pakistani women. For a woman 1.57 m tall (the mean height of Pakistani women), this corresponds to a weight reduction of about 2 kg. Our hypothesis does not imply that BMIs of immigrants and native Norwegians must converge. It does imply that immigrants' BMI changes will be favorably affected by language skills.

Language skills interacting with countries of origin have no significant effects on BMI increase for women from the other three countries. Nevertheless, Iranian women tend to have both higher BMI when they were 25 years old and higher ΔBMI than Norwegians, and the estimate of language skill interacting with country of origin shows a negative sign. The more neutral result is to be expected. Compared to Pakistani and Turkish women, Sri Lankan, Vietnamese, and Iranian women have BMIs closer to Norwegian women at 25 years old, so the effect of language skill on ΔBMI should be smaller.

From Table 4, *Age* and *Education* have the expected effects on women's ΔBMI. According to the estimates, the maximum effect of age on ΔBMI occurs when age is at 117.5 years, so ΔBMI is increasing in age for the relevant range. Living in *West*, where socioeconomic conditions are superior, contributes to a decline in BMI increase.

According to the fourth column in Table 4 Sri Lankan men have lower ΔBMI than Norwegians' while the opposite is true for Vietnamese men. When Sri Lankan men have better language skills, their BMIs tend to increase more than Norwegians. This supports the acculturation hypothesis since at 25 years old, Sri Lankan men have lower BMI than Norwegian men. When Vietnamese men have better language skills, their BMIs tend to increase less than Norwegians. Since *BMI25* of Norwegian men is higher than Vietnamese men, the language skills estimate for Vietnamese men is inconsistent with the acculturation hypothesis. We should, however, point out that many Vietnamese came to Norway as refugees with very low weights. As they stayed in Norway and faced a more agreeable environment, they became healthier. They started with low BMIs, which rose faster than natives', but Norwegian language skills would reduce the BMI increase. For men from the other three countries, their ΔBMIs were not significantly different from Norwegians', and language skills did not significantly affect BMI changes. Finally we note that *Age* has a positive and significant effect on men's increase in BMI, while *Education* has no effect.

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

ΔBMI	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

* Statistical significance at 10%.
** Statistical significance at 5%.
*** Statistical significance at 1%.

In the third and fifth columns, we present regression results obtained from replacing language skills by immigrants' years of residency in Norway. Years of residency in Norway, interacted with countries of origin, does not have an impact on ΔBMI for any of the ethnic groups, for either men or women. To allow for nonlinear effects, in another set of regressions (not presented here), we also have included squares of years of residency in Norway, but results remain insignificant. We conclude that language skill is a better measure of acculturation than the length 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 0 otherwise. The effect of language skills remains negative and statistically significant for Turkish ($p = 0.002$) and Pakistani ($p = 0.06$) women.

In a second robustness check we exclude from our sample those who have birthdays in the last 10-year period of the data set. In this subsample of older participants, there are 5027 women, and 4110 men. Younger immigrants are perhaps different from the older ones, so here we assess whether acculturation works differently for older immigrants. Now only the language skills among Pakistani women have a marginally statistically significant effect (coefficient = -0.76, $p = 0.053$).

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

4. Discussion

We have analyzed the effects of acculturation on immigrants' BMI changes. Our research is unique in that we look for acculturation effects on immigrants who are either heavier or lighter than natives. According to our hypothesis, whether immigrants with BMIs lower or higher than natives, acculturation will contribute to reduce the BMI difference between immigrants and natives. The empirical implementation uses immigrants' local language skills to measure the extent of acculturation. Our regression analysis supports the hypothesis that acculturation is associated with immigrants' BMI changes being more similar to natives. Unlike other studies, we do not find that the number of years since immigration has significant effects on immigrants' BMI changes.

We now discuss several issues. First, subjects were asked to recall their weights when they were 25 years old. Recalled information may be unreliable. If the noise in recalling weights at 25 years old varies randomly among different ethnic groups and Norwegians, then our results may be diluted. Gorber et al. (2007) review the literature on bias in self-reported height and weight. Overall, their review shows under-reporting in weight. However, there were large variations in the bias among the reviewed studies. In our study, the respondents had to recall their weight at 25 years old. We have been unable to identify studies of recall bias in historic self-reported weights.

Second, 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 not of theoretical or policy interest to study the effect of acculturation on a randomly chosen individual. Such a scenario is irrelevant in practice. In any case, our results apply to those individuals who have decided to immigrate to Norway.

Third, 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 country-of-origin variable 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.

Fourth, individuals' food choices likely depend on their incomes. Unfortunately, our data set does not include income. We do have some socio-economic variables that are related to income. The variable *West* indicates whether the participant lives in a more affluent part of Oslo. Education usually is correlated with income. However, for immigrants, the correlation between income and education need not be very strong. This is because some educational or professional qualifications obtained in other countries may not be valid in Norway, and this adversely affects an individual's market opportunities. We have performed a robustness check by including a variable on an individual's employment status. An employed female immigrant tends to have a lower increase in BMI, and this effect is the same whether employment is full time or part time. Being employed has no effect on male immigrants. All other effects remain the same.

Fifth, 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.

Our study relates to a recent debate in Norway about its population's health. Contrary to the US, the policy concern is on immigrants' health when they are *less* integrated into the Norwegian society. The link between obesity, chronic diseases and ill health is now well documented; see, for example, OECD (2010). Obesity results in physical disability, mortality, increased use of health services, and economic loss from reduced labor market participation. In Norway, high obesity prevalence among immigrants from Turkey and Pakistan needs to be addressed. Our study shows that obesity among immigrants is related to lower

acculturation as manifested by poor language skills. The policy implication is that public measures that facilitate immigrants' acculturation may have beneficial effects on weight development.

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