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Original article

Obesity in the context of migration and socio-economic risk factors – a multivariate epidemiologic analysis

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ABSTRACT

Purpose: While the existence of a healthy migrant effect remains controversial, overweight and obesity are considered a global pandemic. Migrants seem to be affected more often, however most of the few existing studies did not differentiate a first-generation from a second-generation migration background and/or did not control common socio-demographic confounders. This study aims at examining the influence of first- and second-generation migration on body mass index (BMI) and obesity in Germany.
Subjects and Methods: We conducted a controlled observational study based on a survey of n = 64,089 participants of the German Socio-Economic-Panel. Missing values were multivariate imputed via chained equations (MICE). The influence of migration on BMI and obesity was assessed by comparing first-generation, second-generation and non-migrants to each other. Pairwise statistical testing was done by *t* tests and Fisher's exact tests. For the multivariate analysis, OLS and logistic regression models and its coefficients (beta, odds ratio) were used. Targeting multiple testing, Holm-correction was utilized.
Results: Within the bivariate analysis, all three group-specific mean BMI-values differ significantly from each other ($P < .001$). The pairwise differences regarding the obesity risk are also significant ($P < .001$). Within the multivariate analysis, only second-generation migration reveals an influence on BMI compared to first-generation migration (ß = 0.297; 97.5% CI: 0.127–0.467) and non-migrants (ß = 0.366; 98.33% CI: 0.103–0.628). This is equivalent to its influence on obesity versus first-generation (odds ratios = 1.220; 98.33% CI: 1.045–1.423) and non-migrants (odds ratios = 1.134; 97.5% CI: 1.018–1.262).
Conclusions: After controlling socio-demographic confounders, a second-generation migration background but not a first-generation migration background is associated with a higher BMI and obesity.

Background

Since 1967, there are international reports of healthy migrant effects describing a superior health and lower mortality of first-generation immigrants compared to the population of the host countries [1]. This advantage is oftentimes accompanied by a convergence effect leading to an adoption of the resident populations' health level and lifestyle manifesting itself at the latest in the second-generation [2]. Part of the healthy migrant effect is explainable via selection processes [3]. Basically, the probability of emigration is positively associated with the possible migrants' health status and income expectancies (if forced migration is left aside).

At least considering overweight, no protective effect of a migration background (MB) can be observed based on German data. According to the German Mikrozensus 2017, a MB is descriptively associated with a relatively increased body mass index (BMI) and overweight risk but a lesser obesity risk. Here, a MB is defined as being born or having at least one parent being born outside Germany. However, it must be kept in mind that the data is not adjusted to common confounders [4].

Based on the finding of the KiGGS-study of the German Robert-Koch-Institute (RKI), children with a one- or two-sided MB show a higher risk of overweight, and obesity compared to their Ger-

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man peers [5]. Moreover, there seem to be differences between first- and second-generation migrants which can be traced back to sex-spanning BMI increases with every additional year spent in Germany [6]. Analyses of epidemiologic data in the United States indicate that after migration, children of families with low socio-economic status are more likely to gain weight, especially if their country of origin is a low-income country [7].

In adults, obesity is persistent if the BMI is 30 kg/m^2 or more, overweight and pre-obesity up to a BMI of 25 kg/m2. Children and adolescents are overweight if their BMI is more than one standard deviation higher than the reference BMI and obese if their BMI deviates by more than two standard deviations [8]. According to the WHO Europe, there are three categories of obesity based on the BMI. Obesity class I for a BMI of 30.0–34.9, obesity class II for a BMI of 34.9–39.9 and obesity class III for a BMI above 40 [9]. Since overweight and obesity are increasing globally, they represent a global epidemic also known as "globesity." Considering social and psychological dimensions as well as the high prevalence and abundance of medical comorbidities, obesity represents one of today's most important public health problems [10].

Although industrial countries have already shown a constantly increasing high prevalence of obesity in the last decades, the increase of the prevalence is even more rapid in developing or middle-income countries. Currently, overweight is affecting approximately close to 2 billion and obesity more than 650 million adults, resulting in an overall prevalence of 39% and 13%, respectively.

While in many low- or middle-income countries there is a positive association between BMI and socioeconomic status, in most of the industrial countries the weight status tends to be inversely correlated with the socioeconomic status [11,2]. Epidemiologic research from the United States has shown an increased prevalence of obesity in youths as well as in adults with a low education and low income [12].

Other industrialized countries, including Germany, show similar observations. Also in Germany, obesity is affecting more often people with a low socioeconomic status. This effect is particularly observable in women and young people [13]. Here, current epidemiologic data show a prevalence of 67% in men and 53% in women regarding overweight. 23% of the male and 24% of the female population is obese [14]. On the other hand, people with a MB have a lower income as well as a lower level of education on average in Germany. These factors, in turn, are associated with an increased BMI [15,16].

The aim of the study at hand is to evaluate whether there is an influence of a first- and second-generation MB on BMI and the risk of obesity, which is independent of demographic and socio-economic factors, as well as to estimate its scope.

Materials and methods

This leads to the following hypotheses being tested for significance:

1. Compared to the German population without MB, a first-generation MB exerts an influence on BMI.
2. Compared to the German population without MB, a second-generation MB exerts an influence on BMI.
3. Compared to a first-generation MB, a second-generation MB exerts an influence on BMI.
4. Compared to the German population without MB, a first-generation MB exerts an influence on the risk of obesity.
5. Compared to the German population without MB, a second-generation mMB exerts an influence on the risk of obesity.
6. Compared to a first-generation MB, a second-generation MB exerts an influence on the risk of obesity.

Table 1
Included variables and their corresponding levels for the descriptive and multivariate analysis

BMI	Weight (kg)/(height (cm))^2
Migration background	None, first-generation migration background, second-generation migration background
Sex	Male, female
Education years	Years of education
Employment	Unemployed, employed
Marital status	Married, single, widowed, divorced, separated
Children	Count of children in household
Sporting activity	Every week, every month, less frequently, never
Income	Gross annual income in €
Age	Age in years
Speaking skills	Very good, good, fairly, poorly/not at all
Religion	Islamic, else

Adjusting to the multiple comparisons, only Bonferroni-Holm corrected *P*-values are reported [17] along with the test statistic's values and degrees of freedom (in brackets) while the significance level for statistical testing is set to $\alpha = 0.05$. The Bonferroni-Holm correction mentioned refers to the three-fold group difference tests (k = 3) as well as to the three dummy regression coefficients (k = 3) representing the absence of a MB, a first-generation MB and a second-generation MB. Since BMI and obesity are highly correlated, a further correction of multiple testing is not indicated. The same applies to the bi- and multivariate analyses, which are specifications of the same underlying hypothesis. Measures of effect size are accordingly reported with 98.33%, 97.5%, and 95% confidence intervals (CI) as in Ludbrook [18] in order to approach singular 95% CI. Otherwise, the unadjusted type-I-error-risk would be 0.143 (which is $1-0.95^3$) instead of 0.05.

The sample is based on the samples 2002–2018 of the German Socio-Economic-Panel (SOEP), which is a nationwide representative panel study for the German population. The migration-specific samples IAB-SOEP (German Institute for Employment research in German "Institute für Arbeitsmarkt- und Berufsforschung" - IAB) were additionally included [19,20]. After listwise deletion of participants with simultaneously missing data on BMI and MB, it consists of 64,089 respondents of whom 46.83% last participated in 2018. Apart from that, missing data ranged from 5.27% (BMI) to 18.94% (speaking skills). Hence, a multivariate imputation via chained equations (MICE) model was performed.

Five data sets were extracted based on 15 iterations max. For cardinal variables predictive mean matching was the imputation method, whereas multinomial logistic regression was used for categorical variables and logistic regression for binary variables [21,22]. The variables used for imputation match those of the following analysis. For an overview of the variables' possible levels, Table 1. As assessed by Kolmogorow-Smirnow-tests [22] there are no significant differences between the metric variables' distributions between the base and the five extracted data sets (as long version). For the descriptive and bivariate statistics, the five datasets were averaged after separated calculation. For the multivariate regression analyses, the calculation followed Rubin's rule [23].

While having at least one parent who is born outside Germany is the definition of a second-generation MB, a first-generation MB is defined as being born outside Germany yourself. A description of the final sample, separated into the three groups without MB, first-generation MB and second-generation MB, can be found in Table 2. Table 3 shows the top-10 countries of origin of the sample with its corresponding percentages. As opposed to the original SOEP data

Table 2
"In-detail description of the surveyed sub-samples"

Variable	No migration background (n = 45,390)	First-generation migration background (n = 14,229)	Second-generation migration background (n = 4470)
BMI (±SD)	25.183 ± 4.865	25.540 ± 4.863	24.311 ± 5.122
Obesity: yes (%)	16.138	17.900	13.311
Sex: female (%)	52.000	48.809	51.141
Education years (±SD)	12.215 ± 2.840	11.748 ± 2.881	12.202 ± 2.837
Employment: yes (%)	56.592	49.462	56.107
Marital status: married (%)	57.334	62.527	49.530
Children (±SD)	0.558 ± 0.954	1.154 ± 1.387	0.884 ± 1.158
Sporting activity: every week (%)	34.940	41.399	32.506
Income (±SD)	45,726.598		
± 53,979.710	43,090.237 ± 46,221.647	46,342.925 ± 45,793.721	
Age (±SD)	46.837 ± 18.827	40.934 ± 14.693	29.700 ± 12.411
Speaking skills: very good (%)	99.987	27.156	95.526
Religion: Islamic (%)	11.460	21.764	6.823

Table 3
BMI and obesity among migrants from ten most frequent countries of origin

Country of origin	Percentage	Presence of obesity (overall/women/men)	BMI (overall/women/men)
Syria	15.820%	19.325%/22.705%/17.439%	25.823/25.944/25.756
Poland	8.848%	17.474%/13.812%/22.430%	25.346/24.419/26.602
Turkey	8.658%	22.159%/26.387%/18.210%	26.614/26.647/26.584
Russia	8.258%	21.957%/22.866%/20.809%	25.930/25.614/26.329
Kazakhstan	6.782%	19.482%/20.381%/18.409%	26.025/26.329/26.025
Romania	4.463%	17.795%/13.941%/23.282%	25.606/24.853/26.679
Iraq	4.336%	16.370%/22.000%/12.534%	25.366/25.568/25.229
Afghanistan	3.718%	11.531% / 17.526% / 8.060%	24.584 / 25.531 / 24.036
Italy	3.387 %	20.124%/22.167%/18.638%	25.834/24.901/26.513
Greece	2.052%	21.575%/23.944%/19.333%	26.260/26.218/26.300

set and due to the minor prevalence of these categories, speaking German "poorly" (1.00%) and "not at all" (0.13%) were combined.

In order to examine the relationship between MB and BMI, pairwise t tests and two multiple OLS-regression models were calculated: a) no migration background versus first- and second-generation MB and b) first versus second-generation MB. The effect size is indicated using Cohen's D for t tests and β-coefficients as well as R^2 and adjusted R^2 for OLS-regression and the overall model [24]. Beforehand, the Levene-test of heteroscedasticity and a calculation of variance inflation factors (VIF) regarding the multiple regression had been done, where VIF of five and greater are considered critical [25,26].

The pairwise influence of MB on the risk of obesity was examined via Fisher's exact tests and two multiple logistic regression models: a) no migration background population versus first- and second-generation MB and b) first versus second-generation MB. The effect size is indicated using odds ratios (OR) and (un-)adjusted Mc Fadden's Pseudo-R^2 for logistic regression and the overall model [27]. Beforehand, a calculation of VIF regarding the multiple logistic regression had been done.

The interpretation of effect sizes is based on Ellis [28]. For the multiple OLS- and logistic regression, the following covariates are used: sex, education years, employment, marital status, count of children, sporting activity, gross annual income in €, age in years, speaking skills and religion. The reference categories for dummy variables are the ones mentioned first in Table 1.

Results

Description: BMI, obesity and migration background

In this epidemiologic sample, 22.20% (n = 14,229) have a first-generation and 6.98% a second-generation MB (n = 4470). MB is highly correlated with income (Cramer's V = 0.55) and speaking skills (Cramer's V = 0.57), however leading to no severe collinearity (s. VIF below).

Overall, the BMI is 25.20±4.90 on average *with a slightly higher BMI in first-generation migrants than in second-generation migrants and people without* MB. The median is 25.00, which indicates a slightly right-skewed distribution of the BMI with a minimum of 11.00 and a maximum of 84.00. A BMI equal to or above 30, which is defined as obesity, is present in 16.33% (n = 10,467).

Bivariate analysis: BMI x migration background

Between the three groups no, first- and second-generation MB, homoscedasticity is given or at least it cannot be ruled out (F = 0.635 (df = 2), P = .530). All three group-specific mean BMI-values differ significantly from each other (t = -7.634 (df: 59,617), t = 11.375 (df: 49,858), t = 14.543 (df: 18,697); P < .001 each). People with a first-generation MB show the highest BMI (25.54±4.86) followed by the German population without a MB with a BMI of 25.18±4.87 on average. With a BMI of 24.31±5.12, people with a second-generation MB have the lowest BMI in this epidemiologic sample. However, there is a negligible effect size between the groups first-generation versus no MB (d = 0.073, 95% CI: 0.055–0.092) and second-generation versus no MB (d = -0.178, 97.5% CI: -0.179 to -0.178) and a small effect size within the group of first versus second-generation MB (d = -0.249, 98.33% CI: -0.250 to -0.249). A graphic illustration of the relationship between BMI and MB is in the boxplots in Figure 1. The highest average BMI among first-generation migrants results from people from Turkey (26,614) and Greece (26,260). Among female respondents, Turkey (26,647) and Kazakhstan (26,329) show the highest values, while for male respondents it is Romania (26,679) and Turkey (26,584) (Table 3).

Multivariate analysis: BMI x migration background

Having a second-generation MB still correlates with a higher BMI in the multivariate model in relation to the non-migrants but loses its significance (ß = 0.170; 95% CI: -0.015 to 0.355). A second-generation MB is no longer associated with a lower BMI. On the

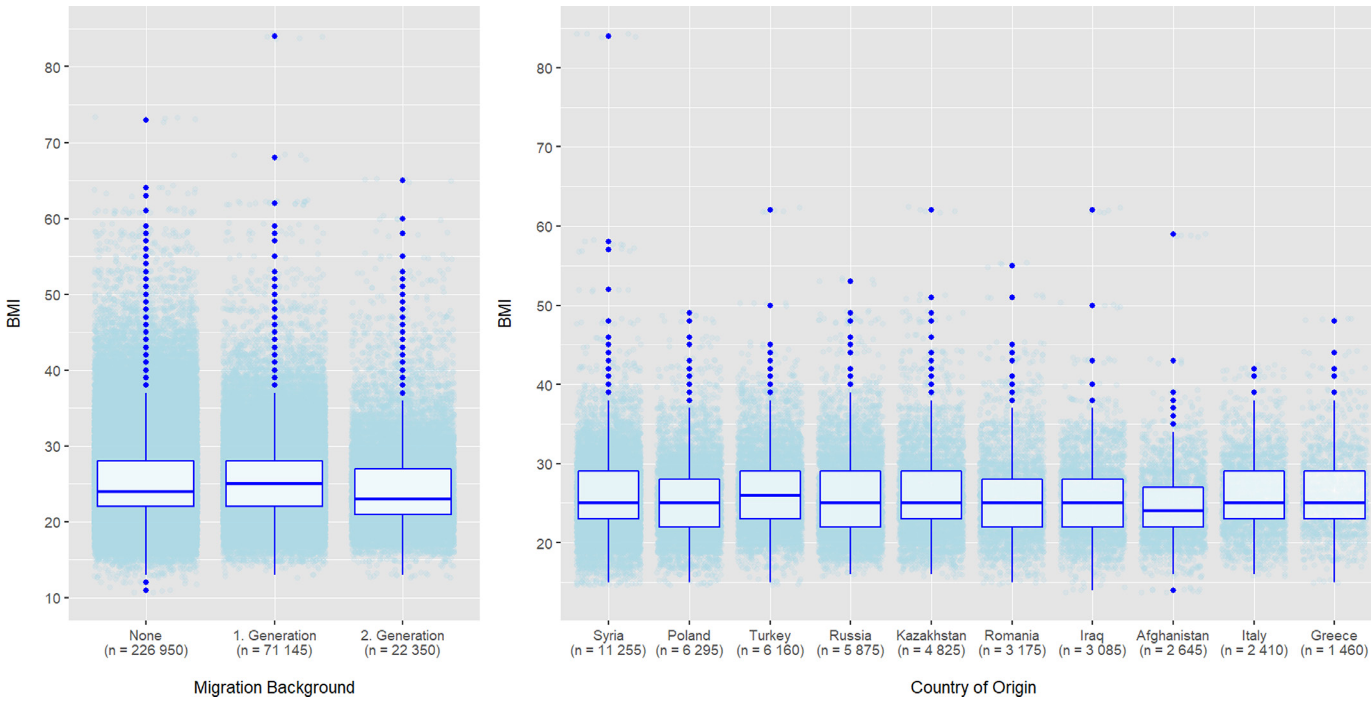

Fig. 1. Boxplots of BMI and migration background considering the ten most frequent countries of origin

Table 4
Coefficients of multivariate OLS-regression models analyzing the influence of migrant status on BMI

	β-Coefficients of OLS-regression of BMI (reference: no migration background)	β-Coefficients of OLS-regression of BMI (reference: first-generation migration background)
Intercept	23.363	22.268
Migration background: first-generation	0.170 (95% CI: -0.015–0.355)	-
Migration background: second-generation	0.297 (97.5% CI: 0.127–0.467)	0.366 (98.33% CI: 0.103–0.628)
Sex: female	-1.026	-0.750
Education years	-0.052	-0.050
Employment: yes	0.148	-0.031
Marital status: single	-0.196	-0.169
Marital status: widowed	-0.116	-0.348
Marital status: divorced	0.025	-0.279
Marital status: separated	-0.016	-0.151
Children	0.119	0.204
Sporting activity: every month	-0.331	-0.487
Sporting activity: less frequently	-0.350	-0.308
Sporting activity: never	-0.601	-0.502
Income	0.000	0.000
Age	0.071	0.103
Speaking skills: good	0.326	0.172
Speaking skills: fairly	0.648	0.377
Speaking skills: poorly/not at all	0.699	0.341
Religion: Islamic	0.337	0.473

contrary, in the multivariate analysis, there is a significant positive correlation between BMI and a second-generation migration status (ß = 0.297, 97.5% CI: 0.127–0.467). This is because in the multivariate model, among other influences, the lower age of respondents with (first- and second-generation) migration history compared to the respondents without MB is controlled for. Converted to Cohen's d result negligible effect sizes of 0.035 (without vs. first-generation MB, 95% CI: -0.003 to 0.073) and 0.061 (without vs. second-generation MB, 97.5% CI: 0.026–0.096). The R^2 is 0.091, the adjusted R^2 0.090, which indicates a clearly multifactorial genesis of obesity. All results of this first OLS-regression model can be found in Table 4. VIF range between 1.01 for sex and 3.25 for MB.

The second OLS regression model shows that a second-generation MB versus a first-generation MB significantly correlates with a higher BMI (ß = 0.366, 98.33% CI: 0.103–0.628), however this also translates to a negligible effect size (d = 0.075, 98.33% CI: 0.021–0.129). The variables used in this model explain 11.51% of the variance of the BMI, which indicates a medium goodness of fit. The adjusted R^2 is 0.11. All results of this second OLS-regression model are to be found in Table 5. VIF range between 1.01 for sex and 1.72 for speaking skills.

Bivariate analysis: Obesity x migration background

Obesity is persistent in 16.14% of the non-migrants versus 17.90% of the first-generation and 13.31% of the second-generation migrants. The highest percentage of obesity among first-generation migrants is found in Turkey (22.159%) and Russia (21.957%); among women, it is Turkey (26.387%) and Greece (23.944%); and among men, Romania (23.282%) and Poland (22.430%) (Table 3).

Table 5
"Coefficients of multivariate logistic regression models analyzing the influence of migrant status on obesity"

	OR-Coefficients of logistic regression of obesity (reference: no migration background)	OR-Coefficients of logistic regression of obesity (n = 18,699, reference: first-generation migration background)
Intercept	0.120	0.065
Migration background: first-generation	1.019 (95% CI: 0.922–1.127)	-
Migration background: second-generation	1.134 (97.5% CI: 1.018–1.262)	1.220 (98.33% CI: 1.045–1.423)
Sex: female	0.959	1.112
Education years	0.976	0.984
Employment: yes	1.029	0.952
Marital status: single	0.942	0.945
Marital status: widowed	0.969	0.915
Marital status: divorced	1.024	0.953
Marital status: separated	1.009	0.817
Children	1.044	1.085
Sporting activity: every month	0.865	0.818
Sporting activity: less frequently	0.826	0.879
Sporting activity: never	0.722	0.793
Income	1.000	1.000
Age	1.020	1.032
Speaking skills: good	1.158	1.099
Speaking skills: fairly	1.288	1.173
Speaking skills: poorly/not at all	1.308	1.160
Religion: Islamic	1.120	1.190

Table 6
Value-summary of effect sizes ($\alpha = 0.05$ Holm-corrected significant results in bold) in both bivariate and multivariate regression model for BMI (linear) and the presence of obesity (logistic)

BMI	Bivariate d (CI)	Multivariate d (CI)
First-generation versus no MB	**0.073 (0.055–0.092)**	**0.035 (-0.003 to 0.073)**
Second-generation versus no MB	**-0.178 (-0.179 to -0.178)**	**0.061 (0.026–0.096)**
Second-generation versus first-generation MB	**-0.249 (-0.250 to -0.249)**	**0.075 (0.021–0.129)**
Obesity	Bivariate OR (CI)	Multivariate OR (CI)
First-generation versus no MB	**1.133 (1.078–1.191)**	**1.019 (0.922–1.127)**
Second-generation versus no MB	**0.798 (0.719–0.884)**	**1.134 (1.018–1.262)**
Second-generation versus first-generation MB	**0.704 (0.625–0.792)**	**1.220 (1.045–1.423)**

The pairwise differences between non-migrants, first-generation and second-generation migrants regarding the obesity risk are significant ($P < .001$ each). Although this translates to a negligibly higher risk for first –generation versus no MB (OR = 1.133, 95% CI: 1.078–1.191), there is a decrease of the OR of second-generation versus no MB (OR = 0.798, 97.5% CI: 0.719–0.884) and second-generation versus first-generation MB (OR = 0.704, 98.33% CI: 0.625–0.792).

Multivariate analysis: Obesity x migration background

Compared to the respondents without MB and different from the bivariate analysis (but expected from the BMI analysis), there is no significant influence of a first-generation MB (OR = 1.019, 95% CI: 0.922–1.127) on the obesity risk. The effect of a second-generation MB however remains significant but changes its direction in the multivariate model (OR = 1.134, 97.5% CI: 1.018–1.262), which is also in line with the BMI analysis. Nonetheless, this translates to rather negligible effect sizes for both first- and second-generation MB (compared to autochthonous). The explanatory power of the total model is minor given McFadden-R^2 (0.028) and adjusted McFadden-R^2 (0.027). All OR-coefficients of this first logistic regression model are to be found in Table 5. VIF range between 1.01 for sex and 2.94 for MB.

The second logistic regression model indicates a directional change with lower odds in first versus second-generation migrants, which corresponds to a small effect size (OR = 1.220, 98.33% CI: 1.045–1.423). McFadden-R^2 (0.028) and adjusted McFadden-R^2 (0.027) are still on a minor level. All OR-coefficients of second first logistic regression model are to be found in Table 6. VIF range between 1.010 for sex and 1.616 for MB.

Table 6 summarizes the key values of the relationships between MB and BMI and obesity respectively (with significant test decisions in bold).

Discussion

There are significant effects of MBs on BMI and obesity (adjusted for multiple testing) which change their direction or at least significance level after controlling multiple demographic and socioeconomic covariates. Primarily, the respondents with a first- or second-generation MB are younger than the German respondents without MB. Thus, naively, there seems to be a significantly negative association between BMI and obesity as well as a first- or second-generation MB. After controlling, for example, age discrepancies, a second-generation MB is revealed as a risk factor while the effect of a first-generation MB loses its significance.

Following the coefficients and significance levels as well as the comparison between first- and second-generation MB, it can be stated that the negative effect of a second-generation MB is significantly more pronounced, resulting in the following order of adjusted mean BMI values and obesity risks: population without MB = first-generation migrants < second-generation migrants.

These findings of an undifferentiated MB as a risk factor of obesity and obesity are in line with the German Mikrozensus findings as well as with the report "Migration and Health" of the RKI [4,29]. They also extend to obese children and youth with MB in Germany as suggested by the RKI's KiGGS-study [5]. However, these results underline the importance of an adjusted analysis, which was not performed previously. Taking into account a number of relevant covariates, the described risk factor “migration background” is no longer persistent. Differentiating first and second-generation MB, research from 2008 on previous SOEP data did not observe a convergence effect but rather “a clear increase of the BMI with additional years in Germany”, which could be replicated here [6].

On the other hand, our results are in contradiction with previous surveys that describe young immigrants as being “healthier” and less often affected by obesity than German natives [30]. The observation of unexpectedly healthy migrants is also known under the term “healthy migrant effect” which is not only widespread but also very criticized [31,32].

However, the effect sizes are negligible (BMI) to small (obesity between MBs comparison) and the (pseudo) coefficients of determination indicate a clearly multifactorial genesis of a high BMI as well as the presence of obesity, which exceeds demographic and socio-economic factors.

In addition, it has to be considered that participants with a first-generation MB are overrepresented in the SOEP data, especially compared to those with a second-generation MB.

Since this is an observational study, causation cannot be established. As a desideratum for further research, it remains to discover why the effects occurs as they appear to be independent of common demographic and socio-economic risk factors. Because a randomization of MBs is not possible, diving deeper into epigenetic and lifestyle factors would be rational.

References

[1] Krueger DE, Moriyama IM. Mortality of the foreign born. Am J Public Health Nations Health 1967;57:496–503. doi:10.2105/AJPH.57.3.496.

[2] Constant A. The healthy immigrant paradox and health convergence. Munich; 2017.

[3] Grigg DBEG. Ravenstein and the “laws of migration. J Hist Geogr 1977;3:41–54. doi:10.1016/0305-7488(77)90143-8.

[4] Statistisches Bundesamt. Bevölkerung und Erwerbstätigkeit: Bevölkerung mit Migrationshintergrund – Ergebnisse des Mikrozensus 2017. Statistisches Bundesamt, Serie 1; 2.2; 2018; Article Nr. 5552010220187OO

[5] Koschollek C, Bartig S, Rommel A, Santos-Hövener C, Lampert T. Die Gesundheit von Kindern und Jugendlichen mit Migrationshintergrund in Deutschland – Querschnittergebnisse aus KiGGS Welle 2 2019. doi:10.25646/6070.

[6] Sander M. Changes in immigrants’ body mass index with their duration of residence in Germany 2008. https://www.diw.de/de/diw_01.c.452256.de/publikationen/soeppapers/2008_0122/changes_in_immigrants__body_mass_index_with_their_duration_of_residence_in_germany.html SOEP papers 122; JEL-Classification: C23;I12; accessed 21.01.2022.

[7] Van Hook J, Balistreri KS. Immigrant generation, socioeconomic status, and economic development of countries of origin: a longitudinal study of body mass index among children. Social science & medicine (1982) 2007;65:976–89. doi:10.1016/j.socscimed.2007.04.032.

[8] World Health Organization (WHO). Obesity. Obesity and overweight https://www.who.int/westernpacific/health-topics/obesity (accessed 21.01.22).

[9] World Health Organization (WHO). Body mass index - A healthy lifestyle - WHO recommendations https://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthy-lifestyle/body-mass-index-bmi (accessed 21.01.22).

[10] World Health Organization (WHO). Controlling the global obesity epidemic n.d. https://www.who.int/activities/controlling-the-global-obesity-epidemic (accessed 07.11.2022).

[11] Malik VS, Willett WC, Hu FB. Global obesity: trends, risk factors and policy implications. Nat Rev Endocrinol 2013;9:13–27. doi:10.1038/nrendo.2012.199.

[12] Ogden CL, Carroll MD, Fakhouri TH, Hales CM, Fryar CD, Li X, et al. Prevalence of Obesity among youths by household income and education level of head of household — United States 2011–2014. MMWR Morb Mortal Wkly Rep 2018;67:186–9. doi:10.15585/mmwr.mm6706a3.

[13] Hoebel J, Kuntz B, Kroll LE, Schienkiewitz A, Finger JD, Lange C, et al. Socioeconomic inequalities in the rise of adult obesity: a time-trend analysis of National Examination Data from Germany, 1990–2011. Obes Facts 2019;12:344–56. doi:10.1159/000499718.

[14] Robert-Koch-Institut (RKI). Übergewicht und Adipositas 2014. https://www.rki.de/DE/Content/Gesundheitsmonitoring/Themen/Uebergewicht_Adipositas/Uebergewicht_Adipositas_node.html. (accessed 07.11.2022)

[15] Henkel M. Familien mit Migrationshintergrund. 2., aktualis. und überarb. Aufl. Berlin: Bundesministerium für Familie, Senioren, Frauen und Jugend; 2014. urn:nbn:de:kobv:109-1-7840012.

[16] Bundesministerium für Familie, Senioren, Frauen und Jugend. Gelebte Vielfalt: Familien mit Migrationshintergrund in Deutschland. n.d. 09.12.2020, Bundesministerium für Familie, Senioren, Frauen und Jugend (BFSFJ).

[17] Haynes W. Holm’s Method. Encycl. Syst. Biol.. Dubitzky W, Wolkenhauer O, Cho K-H, Yokota H, editors editors. New York: Springer Reference; 2013.

[18] Ludbrook J. Multiple Inferences using confidence intervals: multiple inferences with confidence intervals. Clin Exp Pharmacol Physiol 2000;27:212–15. doi:10.1046/j.1440-1681.2000.03223.x.

[19] Liebig S, Schupp J, Brücker H, Kroh M, Goebel J, Bartels C, et al. IAB-SOEP migration sample 2018IAB-SOEP Migrationsstichprobe 2018 2020. doi:10.5684/SOEP.IAB-SOEP-MIG.2018. (data) and the publication 2020.

[20] Goebel J, Grabka MM, Liebig S, Kroh M, Richter D, Schröder C, et al. The German Socio-Economic Panel (SOEP). Jahrb Für Natl Stat 2019;239:345–60. doi:10.1515/jbnst-2018-0022.

[21] Little RJA. Missing-Data adjustments in large surveys. J Bus Econ Stat 1988;6:287–96. doi:10.1080/07350015.1988.10509663.

[22] Fahrmeir L, Kneib T, Lang S, Marx B. Regression: models, methods and applications. Berlin New York: Springer; 2013.

[23] Rubin DB. Multiple imputation for nonresponse in surveys. Hoboken, NJ: Wiley-Interscience; 2004.

[24] Cohen J. Statistical power analysis for the behavioral sciences, New York: Routledge; 2013. 0 ed.. doi:10.4324/9780203771587.

[25] Brown MB, Forsythe AB. Robust tests for the equality of variances. J Am Stat Assoc 1974;69:364–7. doi:10.1080/01621459.1974.10482955.

[26] Snee R. Who invented the variance inflation factor? 1981. doi:10.13140/RG.2.1.3274.8562.

[27] Zarembka P. Frontiers in econometrics. New York: Academic Press; 1974.

[28] Ellis PD. The essential guide to effect sizes: statistical power, meta-analysis, and the interpretation of research results. Cambridge: Cambridge University Press; 2010. doi:101017/CBO9780511761676.

[29] Robert-Koch-Institut (RKI) Migration und Gesundheit. Berlin; 2008.

[30] Wengler A. The health status of first- and second-generation Turkish immigrants in Germany. Int J Public Health 2011;56:493–501. doi:10.1007/s00038-011-0254-8.

[31] Razum O. Migrant Mortality, healthy migrant effect migrant mortality, healthy migrant effect. In: Kirch W, editor. Encycl. Public Health. Dordrecht: Springer Netherlands; 2008. p. 932–5. doi:10.1007/978-1-4020-5614-7_2188.

[32] Kohls M. Healthy-Migrant-Effect, Erfassungsfehler und andere Schwierigkeiten bei der Analyse der Mortalität von Migranten. 2008. Bundesamt für Migration und Flüchtlinge (BAMF) Forschungszentrum Migration, Integration und Asyl (FZ). https://nbn-resolving.org/urn:nbn:de:0168-ssoar-67829-7 (accessed 07.11.2022).