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# Associations between BMI and visual impairment of 33 407 preschool children in Germany: a pooled cross-sectional study

Weina Liu [1,2], Rainer Schwertz[3], Andreas Welker[3], Judith Welker[3], Simiao Chen[1,4], Peter Dambach [1], Michael Marx[1]

1 Heidelberg Institute of Global Health, University of Heidelberg, Heidelberg, Germany
2 Jiangsu Province Center for Disease Control and Prevention, Nanjing, China
3 Public Health Authority of Rhein-Neckar-Kreis, Heidelberg, Germany
4 Chinese Academy of Medical Sciences and Peking Union Medical College, Beijing, China

**Correspondence:** W. Liu, Heidelberg Institute of Global Health, University of Heidelberg, Heidelberg 69120, Germany, Tel: +49 17669391368, Fax: 06221-584617520, e-mail: weina.liu@uni-heidelberg.de

**Background:** Prevalence of overweight and obesity in Germany is increasing. High body weight can affect children's growth and development. This paper aimed to determine the association between body mass index (BMI) and visual impairment among preschool children and explore the potential role of obesity in predicting visual developmental disorder. **Methods:** Six consecutive years of data from the School Entry Examination were collected for all preschool children aged from 4 to 6 years residing in Rhine-Neckar County and the City of Heidelberg, Germany from 2013 to 2018. Univariate and multivariate regression were used to analyze the complete data, multiple imputation was used to deal with missing data. **Results:** Among the group with an immigrant background, children with obesity [OR = 1.20, 99% (1.02–1.42)] were more likely to have visual impairment compared to those with normal body weight ($P < 0.01$) after adjusting for survey year, age, and gender of children, education and occupation of parents, screen time-frequency, whether a television was in their bedroom, and quality of preschool outdoor environment. **Conclusion:** There were significant associations between obesity and visual impairment among German preschool children with immigrant backgrounds. Strategies to support vulnerable groups were needed across all regional schools.

## Introduction

Obesity has become a global public health concern among the general population in the 21st century. Globally, its prevalence among preschool children increased from 4.2% in 1990 to 6.7% in 2010.[1] According to recent estimates, 5.3% of European preschool children are obese.[2] Childhood obesity is linked to health problems beyond visual impairment including asthma, diabetes, non-alcoholic fatty liver disease, obstructive sleep apnoea, hypertension, dyslipidaemia.[3] Previous studies have shown that obesity is associated with

**Table 1** Definition and type of key variables

| Variables | Definition | Type |
|---|---|---|
| Visual impairment | Visual impairment according to scoring visual acuity measured with a refractometer in at least two out of three measurements 0.7. | Categorical |
| BMI category | Classification in normal weight, overweight, obesity and underweight by BMI-for-age z-scores of WHO child growth standards (For children age 5 years, Underweight <−2 SD, Overweight: >+2 SD, Obesity: > +3 SD; For children age > 5 years, Underweight <−2 SD, Overweight: >+1 SD, Obesity: > +2 SD) | Categorical |
| Age | Age at SEE, including children from 4 to 6 years | Categorical |
| Gender | Includes male and female children | Categorical |
| Survey circle | Every year of investigation from 2013 to 2018 coded as 'year-2013' | Continuous |
| Immigration background | Children with at least one of their parents being born abroad or the language spoken at home is not German or it is German together with another language | Categorical |
| Father's education | Education level as low (primary school), middle (high school) and high (college and above) | Categorical |
| Mother's education | Education level from low (primary school), middle (high school) and high (college and above) | Categorical |
| Father's occupation | Occupation type as full-time, part-time, unemployment | Categorical |
| Mother's occupation | Occupation type as full-time, part-time, unemployment | Categorical |
| TV in children's room | TV in children's room available, yes or no | Categorical |
| Screen time on weekends | The time of using electronic equipment such as smart phone, computer, tablet and TV on weekends (never, 30 min per day, 1–2 h per day, 3 h per day) | Categorical |
| Screen time on weekday | The time of using electronic equipment such as smart phone, computer, tablet and TV on weekends (never, 30 min per day, 1–2 h per day, 3 h per day) | Categorical |
| Quality of outdoor environment | Three dimensions measuring the environment of kindergartens are included in the survey: (i) open areas, (ii) green areas including number of trees, shrubberies and hilly terrains and (iii) the integration of open areas and green areas with a score ranging from 1 to 3. Here, we define quality of outdoor environment = 0 if total score 2 and quality of outdoor environment = 1 if total score > 2. | Categorical |

factors also correlated with visual impairment, including age, gender, parental education, television viewing,[4] access to a playground,[5] physical activity,[6] migrant background,[7] and socioeconomic status (SES).[8]

The multi-ethnic paediatric eye disease study (MEPEDS) defines visual impairment among children as the development of visual acuity due to an identifiable ocular cause.[9] Visual impairment may negatively affect school performance and overall health as well as quality of life post-childhood. Globally, 1.4 billion people were estimated to be affected with visual impairment in 2000.[10] The prevalence of myopia among school children was higher in Asia (60%) than in Europe (40%).[11] Visual impairment is known to be related to sex,[12] age, ethnicity, education,[13] socioeconomic status,[11,13] outdoor time, and availability of a television (TV) in children's bedrooms[14] among other factors. Available studies on the association of visual impairment and body mass index (BMI) are limited.[15,16] Several studies have examined and identified a positive relationship between obesity and visual impairment in school-aged children, but no prior studies have investigated the potential association in preschool children.[17,18] Questions therefore remain as to whether the association with school-aged children's BMI emerges from visual impairment among preschool children.

This study leveraged a large School Entry Examination (SEE) dataset that includes all pre-schoolers in the Rhine-Neckar County and the City of Heidelberg, Germany between 2013 and 2018. The aim was to explore the potential role of obesity in predicting visual impairment among preschool children in order to inform health policy decisions concerning interventions for obese children.

# Methods

## Study enrolment criteria

The School Entry Examination is a mandatory national screening of children's physical development in Germany. According to laws and regulations in Baden-Württemberg,[19–21] all preschool children are examined annually by the Public Health Service before entering school. Before the examination, parents receive a request for formal written consent from the public health office. The criteria and methodology used to identify developmental impairment during the examination follows the Work Guideline for School Entry Examination (WGSE) of the Ministry of Social Affairs and Integration, Baden-Württemberg.[22]

## Data description

From 2013 to 2018, 454 kindergartens in 54 district towns and municipalities in Rhine-Neckar County and the City of Heidelberg participated in the SEE. We obtained all children's data and used double-data entry to generate the dataset including 14 variables. Table 1 reports and defines the variables used in our analysis.

Anthropometric data include height and weight measurements, which were collected after children removed their shoes and while wearing light clothes. Body height was accurate to the nearest 1 cm, and body weight was accurate to the nearest 100 g. BMI was categorized as underweight, normal weight, overweight or obese according to BMI-for-age z-scores from the World Health Organization child growth standards.[23]

Information on the children's ages, immigration backgrounds, their parents' education levels and occupations, and usage of electronic equipment was obtained from the parents' questionnaire. Immigrant background was defined according to the standard described by Schenk et al.[24] The quality of outdoor environment[25–27] was proxied by the preschool's total outdoor areas and green areas. The location information of the preschool was extracted from Google Earth. QGIS (qgis.org, version 3.14 Pi) was used to calculate the quality of preschool outdoor environment. The survey year indicated the year of investigation. Other variables were defined according to the content of questionnaire.

## Statistical analysis

We described the baseline characteristics of preschool children by each BMI category in table 2. We also analyzed the relationship between each independent variable and visual impairment with univariate logistic regression analysis, while also testing for the interaction between BMI category and each independent variable in table 3. Finally, we performed multivariate logistic regression analyses to estimate the association between BMI category and visual impairment, with and without covariates and multiple imputation of missing data in table 4. Model I was adjusted by age, gender,

**Table 2** Baseline characteristics of preschool children by BMI categories

| | Normal | Overweight | Obesity | Underweight | *P* value[a] |
|---|---|---|---|---|---|
| | *n* = 26 977 | *n* = 4595 | *n* = 1478 | *n* = 357 | |
| Survey year | | | | | <0.001 |
| 2013 | 4671 (17.3%) | 689 (15.0%) | 218 (14.8%) | 87 (24.4%) | |
| 2014 | 4601 (17.1%) | 721 (15.7%) | 235 (15.9%) | 62 (17.4%) | |
| 2015 | 3664 (13.6%) | 629 (13.7%) | 220 (14.9%) | 44 (12.3%) | |
| 2016 | 4522 (16.8%) | 774 (16.8%) | 261 (17.7%) | 55 (15.4%) | |
| 2017 | 4756 (17.6%) | 902 (19.6%) | 245 (16.5%) | 53 (14.8%) | |
| 2018 | 4763 (17.6%) | 880 (19.2%) | 299 (20.2%) | 56 (15.7%) | |
| Gender | | | | | <0.001 |
| Boys | 13 701 (50.8%) | 2551 (55.5%) | 870 (58.9%) | 182 (51.0%) | |
| Girls | 13 276 (49.2%) | 2044 (44.5%) | 608 (41.1%) | 175 (49.0%) | |
| Age | | | | | <0.001 |
| 4 years | 3260 (12.1%) | 610 (13.3%) | 160 (10.8%) | 32 (9.0%) | |
| 5 years | 20 364 (75.5%) | 3384 (73.6%) | 1062 (71.9%) | 268 (75.1%) | |
| 6 years | 3353 (12.4%) | 601 (13.1%) | 256 (17.3%) | 57 (16.0%) | |
| Migration background | | | | | <0.001 |
| Non-migrant | 14 136 (52.4%) | 2101 (45.7%) | 537 (36.3%) | 197 (55.2%) | |
| Migrant | 12 841 (47.6%) | 2494 (54.3%) | 941 (63.7%) | 160 (44.8%) | |
| Vision impairment | | | | | <0.001 |
| No | 15 065 (55.8%) | 2391 (52.0%) | 699 (47.3%) | 187 (52.4% | |
| Yes | 11 912 (44.2%) | 2204 (48.0%) | 779 (52.7%) | 170 (47.6%) | |
| Father's education level | | | | | <0.001 |
| Low | 3866 (14.3%) | 905 (19.7%) | 409 (27.7%) | 61 (17.1%) | |
| Middle | 4722 (17.5%) | 903 (19.7%) | 301 (20.4%) | 69 (19.3%) | |
| High | 13 058 (48.4%) | 1822 (39.7%) | 385 (26.0%) | 152 (42.6%) | |
| Missing value | 5331 (19.8%) | 965 (21.0%) | 383 (25.9%) | 75 (21.0%) | |
| Mother's education level | | | | | <0.001 |
| Low | 3158 (11.7%) | 744 (16.2%) | 414 (28.0%) | 49 (13.7%) | |
| Middle | 6691 (24.8%) | 1207 (26.3%) | 419 (28.3%) | 92 (25.8%) | |
| High | 12 842 (47.6%) | 1892 (41.2%) | 369 (25.0%) | 157 (44.0%) | |
| Missing value | 4286 (15.9%) | 752 (16.4%) | 276 (18.7%) | 59 (16.5%) | |
| Father occupation type | | | | | <0.001 |
| Full-time | 9275 (34.4%) | 1407 (30.6%) | 417 (28.2%) | 138 (38.7%) | |
| Part-time | 430 (1.6%) | 75 (1.6%) | 29 (2.0%) | 7 (2.0%) | |
| Unemployment | 356 (1.3%) | 86 (1.9%) | 37 (2.5%) | 4 (1.1%) | |
| Missing value | 16 916 (62.7%) | 3027 (65.9%) | 995 (67.3%) | 208 (58.3%) | |
| Mother occupation type | | | | | <0.001 |
| Full-time | 1347 (5.0%) | 223 (4.9%) | 417 (28.2%) | 138 (38.7%) | |
| Part-time | 6082 (22.5%) | 919 (20.0%) | 29 (2.0%) | 7 (2.0%) | |
| Unemployment | 2914 (10.8%) | 480 (10.4%) | 37 (2.5%) | 4 (1.1%) | |
| Missing value | 16 634 (61.7%) | 3027 (65.9%) | 995 (67.3%) | 208 (58.3%) | |
| Screen time at weekend | | | | | <0.001 |
| Never | 866 (3.5%) | 126 (3.1%) | 28 (2.2%) | 13 (3.9%) | |
| 30 min/day | 5559 (22.6%) | 775 (18.8%) | 158 (12.1%) | 67 (20.3%) | |
| 1–2 h/day | 6586 (26.7%) | 1284 (31.2%) | 437 (33.6%) | 88 (26.7%) | |
| 3 h/day | 941 (3.8%) | 221 (5.3%) | 122 (9.4%) | 9 (2.7%) | |
| Missing value | 10 686 (43.4%) | 1707 (41.5%) | 556 (42.7%) | 153 (46.4%) | |
| Screen time at weekday | | | | | <0.001 |
| Never | 2570 (10.4%) | 328 (8.0%) | 54 (4.1%) | 28 (8.5%) | |
| 30 min/day | 7921 (32.1%) | 1286 (31.3%) | 338 (25.9%) | 96 (29.2%) | |
| 1–2 h/day | 3848 (15.6%) | 868 (21.1%) | 388 (29.8%) | 52 (15.8%) | |
| 3 h/day | 285 (1.2%) | 93 (2.2%) | 52 (3.9%) | 3 (0.9%) | |
| Missing value | 10 029 (40.7%) | 1540 (37.4%) | 471 (36.2%) | 150 (45.6%) | |
| TV in room | | | | | <0.001 |
| Yes | 612 (2.5%) | 158 (3.9%) | 81 (6.2%) | 7 (2.1%) | |
| No | 13 985 (56.8%) | 2401 (58.5%) | 710 (54.8%) | 169 (51.4%) | |
| Missing value | 10 022 (40.7%) | 1544 (37.6%) | 505 (38.9%) | 153 (40.5%) | |
| Quality of outdoor environment | | | | | |
| Good | 3197 (10.8%) | 238 (9.4%) | 79 (8.6%) | 45 (12.6%) | 0.017 |
| Bad | 26 408 (89.2%) | 2287 (90.6%) | 841 (91.4%) | 312 (87.4%) | |

a: *P* values for overall differences in prevalence by stratification.

immigrant background and survey year. Model II was adjusted by age, gender, immigrant background, survey year, parental education and occupation, whether there was a TV in the child's bedroom and screen time. Model III was adjusted by quality of preschool outdoor environment in addition to the variables in Model II. The heterogeneous effect of BMI category was analyzed for nationality. Data were processed by R 3.6.3 software to analyze the data. The generalized linear model function was used to run logistics regressions, and the *mice* package for multiple imputation in R software.

**Table 3** Univariate logistic regressions exploring the association between each variable and visual impairment

| | Visual impairment | |
|---|---|---|
| | OR (99% CI)[a] | Adjusted OR (99% CI)[b] |
| Survey year[c] | 0.92 (0.91, 0.94) | 0.59 (0.37, 0.93) |
| Gender | | |
| Boys | Ref | Ref |
| Girls | 1.06 (1.01, 1.12) | 1.15 (0.96, 1.39) |
| Age | | |
| 4 years | Ref | Ref |
| 5 years | 0.65 (0.60, 0.71) | 0.52 (0.35, 0.75) |
| 6 years | 0.44 (0.39, 0.50) | 0.30 (0.19, 0.48) |
| Immigrant background | | |
| Non-migrant | Ref | Ref |
| Migrant | 1.14 (1.08, 1.21) | 1.00 (0.81, 1.24) |
| BMI categories | | |
| Normal | Ref | Ref |
| Overweight | 1.16 (1.07, 1.26) | 0.57 (0.33, 1.06) |
| Obesity | 1.40 (1.22, 1.61) | 0.49 (0.20, 1.12) |
| Underweight | 1.14 (0.87, 1.51) | 1.07 (0.44, 2.62) |
| Father's education | | |
| Low | Ref | Ref |
| Middle | 0.77 (0.70, 0.85) | 1.00 (0.73, 1.34) |
| High | 0.60 (0.55, 0.65) | 0.79 (0.59, 1.05) |
| Missing value | | |
| Mother's education | | |
| Low | Ref | Ref |
| Middle | 0.86 (0.69, 1.09) | 0.57 (0.40, 0.79) |
| High | 1.18 (0.93, 1.50) | 0.53 (0.37, 0.76) |
| Missing value | | |
| Father occupation | | |
| Full-time | Ref | Ref |
| Part-time | 0.86 (0.69, 1.09) | 0.88 (0.57, 1.35) |
| Unemployment | 1.18 (0.93, 1.50) | 0.77 (0.47, 1.24) |
| Missing value | | |
| Mother occupation | | |
| Full-time | Ref | Ref |
| Part-time | 0.99 (0.86, 1.14) | 0.87 (0.65, 1.15) |
| Unemployment | 1.17 (1.00, 1.36) | 0.82 (0.59, 1.13) |
| Missing value | | |
| Screen time at weekend | | |
| Never | Ref | Ref |
| 30 min/day | 0.93 (0.78, 1.11) | 0.73 (0.49, 1.08) |
| 1–2 h/day | 1.13 (0.95, 1.34) | 0.79 (0.52, 1.20) |
| 3 h/day | 1.54 (1.24, 1.91) | 1.03 (0.55, 1.91) |
| Missing value | | |
| Screen time at weekday | | |
| Never | Ref | Ref |
| 30 min/day | 1.17 (1.05, 1.31) | 1.18 (0.90, 1.53) |
| 1–2 h/day | 1.48 (1.31, 1.67) | 1.07 (0.76, 1.52) |
| 3 h/day | 1.88 (1.44, 2.46) | 1.14 (0.49, 2.68) |
| Missing value | | |
| TV in children's room | | |
| Yes | Ref | Ref |
| No | 0.72 (0.60, 0.87) | 1.33 (0.86, 2.06) |
| Missing value | | |
| Quality of outdoor environment | | |
| Good | Ref | Ref |
| Bad | 1.02 (0.95, 1.10) | 1.17 (0.87, 1.56) |
| Immigrant background * BMI categories | | |
| Immigrant background * Normal weight | Ref | Ref |
| Immigrant background * Overweight | 1.24 (1.05, 1.47) | 2.53 (1.21, 5.35) |
| Immigrant background * Obesity | 1.18 (0.89, 1.56) | 2.43 (0.76, 8.05) |
| Immigrant background * Underweight | 0.88 (0.57, 1.34) | 0.82 (0.08, 8.41) |

a: 99% Confidence interval (CI) of odds ratio univariate logistic regression analysis.

b: 99% Confidence interval (CI) of odds ratio adjusted by survey year, age, gender, immigrant background, father education, mother education, father occupation, mother occupation, screen time at weekday and weekend, TV in children's room and quality of outdoor environment in the logistic regression model.

c: Survey year as discrete variable including year from 2013 to 2018.

**Table 4** The association between BMI category and visual impairment with estimates for the general population using multiple imputation

| | Unadjusted model[a] | Model I[b] | Model II[c] | Model III[d] |
|---|---|---|---|---|
| Multiple imputation | OR (99% CI) | OR (99% CI) | OR (99% CI) | OR (99% CI) |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.16 (1.07, 1.26) | 1.17 (1.07, 1.27) | 1.17 (1.07, 1.27) | 0.97 (0.89, 1.05) |
| Obesity | 1.40 (1.22, 1.61) | 1.44 (1.25, 1.65) | 1.44 (1.25, 1.65) | 1.11 (0.97, 1.27) |
| Underweight | 1.14 (0.87, 1.51) | 1.16 (0.88, 1.53) | 1.16 (0.88, 1.53) | 1.09 (0.88, 1.35) |
| German background | | | | |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.25 (0.93, 1.18) | 1.25 (0.94, 1.20) | 1.01 (0.89, 1.14) | 0.85 (0.75, 1.01) |
| Obesity | 1.39 (1.09, 1.72) | 1.39 (1.14, 1.80) | 1.18 (0.94, 1.50) | 0.96 (0.76, 1.21) |
| Underweight | 1.08 (0.83, 1.75) | 1.08 (0.81, 1.72) | 1.16 (0.79, 1.69) | 1.13 (0.85, 1.51) |
| Immigrant background | | | | |
| Normal | Ref | Ref | Ref | Ref |
| Overweight | 1.25 (1.12, 1.40) | 1.26 (1.13, 1.42) | 1.20 (1.07, 1.35) | 1.06 (0.95, 1.19) |
| Obesity | 1.39 (1.17, 1.66) | 1.45 (1.22, 1.73) | 1.25 (1.05, 1.50) | 1.20 (1.02, 1.42) |
| Underweight | 1.08 (0.71, 1.63) | 1.12 (0.74, 1.70) | 1.08 (0.71, 1.65) | 1.03 (0.75, 1.42) |

a: Unadjusted logistic regression results.
b: Adjusted for survey year, age, gender, immigrant background.
c: Adjusted for survey year, age, gender, immigrant background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend.
d: Adjusted for survey year, age, gender, immigrant background, father's education, mother's education, father's occupation, mother's occupation, TV in children's room, screen time at weekday, screen time at weekend and quality of outdoor environment.

## Results

### *Descriptive analysis*

A total of 33 407 children aged 4–6 years old were enrolled in the survey from 2013 to 2018, including 17 304 boys and 16 103 girls. Table 2 reports descriptive statistics of the demographic characteristics of participants. The prevalence of children with visual impairment was 44.2% among those with normal body weight, 48.0% among those who were overweight and 52.7% among those who were obese. The percentages of children falling into different categories of age, gender, survey year, immigrant background, social-economic status of parents, screen time and quality of preschool outdoor environment were significantly different across BMI groups.

### *Univariate regression results*

Table 3 reports the univariable results of the analysis. Except for parental occupation, mother's education and preschool quality of outdoor environment, all independent variables were significant in the univariate logistic regression model. Additionally, the interaction between BMI category and immigrant background was significant ($P = 0.02$) after adjusting for age, gender, survey year, parental education and occupation, weekday and weekend screen time, whether there was a TV in the child's bedroom and quality of preschool outdoor environment in the logistic regression model.

### *Multivariate regression results*

Table 4 summarizes the association between BMI category and visual impairment. In multiple imputation analysis, our results showed obesity was associated with visual impairment [OR = 1.20, 99% CI (1.02–1.42)] among children with an immigrant background in all models. After adding quality of outdoor environment in kindergarten as a variable in Model III, the association was still significant, although less strong than in Model II.

## Discussion

Our results indicate that among children with an immigrant background, those with obesity were significantly more likely to have a visual impairment.

In previous studies, associations between obesity and visual impairment have been observed among children and adolescents aged over 6 years.[17,18]. One possible explanation for this association is that both health problems already existed when these individuals were of preschool age. In our study, preschool children with obesity had a greater risk of visual impairment. Another explanation for this correlation from the biological perspective is that overweight and obese children may have low concentrations of serum retinol compared to those with normal body weight.[28]

For our analysis, we added quality of preschool outdoor environment as a covariate in multiple regression models. The results of Model III indicate that the quality of preschool outdoor environment is both correlated with obesity and visual impairment. It is possible that outdoor play time[29] and neighbourhood outdoor environment[30] may contribute to physical activity participation. Prior studies from South Korea,[31] Sweden,[29,32,33] the United States[34] and Spain[30] have shown that quality of school outdoor environment may explain part of the association between obesity and visual impairment but cannot do so fully.

Our study also found that obese children with a migrant background were more susceptible to visual impairment than migrant children with normal weight, which was consistent with previous research.[35] This result may be explained by differences in socioeconomic status, culture, family structure or parenting rearing pattern. Results from the German Socioeconomic Panel Study (SOEP) suggest that residential isolation of migrant groups exists in Germany and caused by differences in socioeconomic status in comparison with the general population. On average, migrant groups live in smaller homes with more family members and have less education than non-migrant groups.[36]

Research from Australia has shown that living in a supportive neighbourhood may promote children's physical activity [37] Supportive neighbourhood environments among migrant groups may positively affect physical activity, which could prevent obesity and associated visual impairment. Some research supports this view.[38,39] Low parental education may also increase children's likelihood of obesity,[8] which increases the risk of unhealthy life style such as low physical activity, and more time watching TV, and leads to visual impairment.

Our study had several strengths. First, this study leveraged a large sample that included all children who will enter primary school in Rhine-Neckar County and the City of Heidelberg. Second, this is

one of few population-based studies to explore the associations between weight status and development impairments among preschool children by using multiple logistics regression. Third, no selection bias occurred during the investigation procedure. Fourth, our study estimates the correlation between BMI category and visual impairment based on multiple regression models. Confounding and interaction factors were controlled for by the adjusted model and stratification. Missing values were predicted by multiple imputation. Overall, our research found that obesity was related to visual impairment in German preschool children and stressed the importance of obesity prevention and detection in early childhood.

This study also had some limitations. First, because we used multivariable regression and a pooled cross-sectional dataset, we cannot establish the causal effect of obesity on visual impairment. Second, although we took advantage of all the information in this dataset, confounders that could not be controlled for in multiple regression remain in the model. For example, because of protection of personal information, we were unable to obtain children's home addresses, so we could not measure the quality of neighbourhood outdoor environments. Biochemical examinations should be added to the SEE to generate more biological evidence for future research in this area. More specific information about children's families is also desirable.

## Conclusions

This study suggests that obesity is significantly associated with visual impairment in preschool children in Germany and that this association is stronger among children with immigrant backgrounds. We should therefore pay greater attention to children with immigrant backgrounds and provide additional support for immigrant health. Additional cohort studies are needed to determine the causal relationship between obesity and visual impairment in early childhood.

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## Ethical approval

The study was approved by the Ethics Committee of the Health Care Centre of Rhine-Neckar County in Heidelberg.

*Conflicts of interest*: We declare that we do not have any commercial or associative interest that represents a conflict of interest in connection with the work submitted.

## Key points

- Early childhood is a critical stage of life, marked by significant physical and neural development.
- Visual impairment is associated with obesity, which is prevalent among children with immigrant background.
- Quality of preschool outdoor environment is correlated with obesity and visual impairment.
- Prevention of obesity and support for children with immigrant backgrounds are needed to promote early childhood health.

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# Creating healthy and active life for the elderly in programmes conducted by rural and urban-rural communes in Poland

Anna Augustynowicz[1,2]*, Michał Waszkiewicz[1], Sławomir Szopa[1], Mariola Borowska [2], Aleksandra Czerw[2]

1 Department of Economics, Law and Management, Centre of Postgraduate Medical Education of Warsaw, Warsaw, Poland
2 Department of Health Economics and Medical Law, Medical University of Warsaw, Warsaw, Poland

**Correspondence:** Anna Augustynowicz, Department of Economics, Law and Management, Centre of Postgraduate Medical Education of Warsaw, ul. Kleczewska 61/63, Warsaw 01-826, Poland, Tel: + 48 (0) 22 56 01150, e-mail: aaugustynowicz@poczta.onet.pl

**Background:** In Poland, between 1989 and 2018 the number of the elderly increased by over 3.9 million. Demographic changes justify a senior policy focussed on the longest possible social, professional and family activity of the elderly. Directions of undertaken actions should include health policy programmes aimed at creating conditions healthy and active life of the elderly. The programmes should be particularly important in rural areas as the health of rural and urban residents differs. The study presents programmes for creating conditions for a healthy and active life of the elderly run by rural and urban-rural communes in 2012–17. **Methods:** The study was conducted on the basis of existing data analysis. Data from the summary information prepared by voivodes and provided to the Minister of Health about implemented health policy programmes were used. Data on programmes concerning a healthy and active life for the elderly conducted by rural and urban-rural communes between 2012 and 2017 were extracted from the aggregate information. **Results:** Between 2012 and 2017, 354 programmes were implemented, the most in 2016, and the least in 2015. There were 171 000 people participating in the programmes. The total cost was USD 2 491 664. **Conclusion:** It can be presumed that in 2016 communes implemented more diagnostic and therapeutic programmes than in 2017. A small number of programmes and a small involvement of financial resources in communes with the largest number of the elderly may indicate marginalization of the importance of an active and healthy life for the elderly.

## Introduction

In recent decades, aging of the society in Poland has been clear. Between 1989 and 2018, the number of elderly people increased by over 3.9 million. In these years, the share of people aged 60 or more in the general population increased by >10 percentage points, i.e. from 14.7% in 1989–24.8% in 2018.[1] The results of the Population forecast for 2014–2050 indicate that this trend will continue. At the end of the forecast horizon, the elderly population will increase to 13.7 million and will constitute over 40% of the total population of Poland.[2]