Regional and Social Disparities for Obesity among Austrian Adults: Representative Long-term Trends from 1973–2014


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ABSTRACT

Study aim To present regional long-term trends for the prevalence of obesity (BMI ≥ 30 kg/m²) among Austrian adults in Western, Central and Eastern Austria. Furthermore, the educational inequality regarding obesity was analysed in these regions in Austria for the investigation period.

Methods Self-reported data from six nationally representative, cross-sectional surveys (n = 194,030) conducted between 1973 and 2014 were analysed. Absolute changes (AC) and Etiologic fractions (EF) were calculated to measure trends. The extent of social inequality was presented by the relative index of inequality (RII) based on the educational level.

Results Since 1973, a clear east to west gradient for obesity among adults in Austria has been observed. In 2014, the age-standardized prevalence was highest among Eastern Austrian adults (women: 16.9%; men: 18.2%). A constant increase in obesity among men has been visible since 1983. Since 2007, the values for women have stabilized, while the prevalence of obesity among female Austrians in Western and Central Austria decreased. Considering the AC for the prevalence of obesity from 1983 on, the highest increase was found among women (+2.60%) and men (+1.56%) in Eastern Austria. The outcomes regarding social inequality are instable on a regional level, with the highest RII observed in 2014 for Central Austria.

Conclusion These study findings reveal significant regional differences in the prevalence of obesity in Austria and confirm the existence of an current east-west gradient in Austria for obesity. Considering the latest trends, especially men represent a risk group for obesity in the 3 regions.
Introduction

2016 estimates showed that about 13 % of the adult population globally suffered from obesity. Today, most people worldwide live in countries where obesity kills more people than malnutrition. Epidemiological surveys indicate that the prevalence of obesity has clearly risen in recent decades [1–11]. Since 1975, the prevalence has nearly tripled globally [1], and the prognosis shows a steady increase in the obesity epidemic [12], which causes very high health care budgets [13].

A wide range of determinants influence the development of obesity. The genetic, behavioral and socioeconomic origins of individuals are well-known examples [1, 2, 8, 14–16]. Studies have shown that environmental determinants, e.g., degrees of urbanization, street intersection, access to supermarkets and social cohesion also influence the development of obesity [17]. This means that the region where people live has an impact on the multi-dimensional nature of the development of obesity [14, 18]. Substantial regional differences in the prevalence of obesity have been reported [17–25]. Since 1980, the highest prevalence of obesity has been observed in Eastern Europe, while the increase in mean BMI was highest in Western Europe. Worldwide, subjects living in the USA have had the highest BMI [21].

Obesity is preventable [1] and, therefore, it is important to examine existing long-term trends to identify the factors associated with obesity that affect populations. Identification of these factors allows actors to plan preventive measures that target specific groups [2, 26]. In Austria, regional trends for obesity were observed in different subpopulations [27–31], as well as in the general adult population [32, 33]. Current national representative studies that address regional differences in the field of obesity are lacking. It is important to gather up-to-date information on geographic variations in obesity, however, because this information has important implications for public health planning [34]. This study was carried out to examine the most recent rates and trends for obesity among adults in different regions of Austria. Because several studies have reported observing an overall socioeconomic gradient in obesity in modern, industrialized societies [15, 23, 32], we also investigated whether inequalities in educational levels were associated with obesity in Austrian adults and their geographic region of residence.

Methods

Data source and sample

Data from 6 national, representative, cross-sectional health surveys with comparable methodology were analysed. The first four surveys were collected as part of the Austrian Microcensus conducted in 1973 (n = 90,308), 1983 (n = 63,083), 1991 (n = 56,002) and 1999 (n = 59,169). The last two health surveys, the AT-HIS (Austrian Health Interview Surveys), were conducted in 2007 (n = 15,474) and 2014 (n = 15,771) and replaced the former Microcensus surveys. Statistik Austria carried out the 6 health surveys. During each survey, a random sample was drawn from the Austrian population register. For representation, the sample was stratified according to the 32 administrative Austrian districts. Data were collected by a trained interviewer using interviewer questionnaires from persons aged 15 years and older who were living in private homes or long-term care facilities. During the first five surveys, data were obtained through standardised, face-to-face interviews. For the AT-HIS 2014, computer-assisted telephone interviews were conducted, combined with self-administered questionnaires for the participants. Verbal informed consent was obtained from all participants. We analysed the survey and questionnaire responses from people aged 20 years and older in order to specifically examine the adult population. In addition, and only entire age bands in five-year-intervals were available for the AT-HIS surveys. In total, we excluded 64,611 cases because study subjects were younger than 20 years old. After we had excluded cases that lacked body weight and/or body height data (n = 25,585), gender data (n = 4,124) and those with implausible BMI values (BMI ≤ 10, BMI ≥ 75; n = 11,457), the final number of study subjects was 194,030 individuals (53.5 % women). Overall, data from 64.7 % of the respondents were included in the analysis.

This study was approved by the Ethics Committee of the Medical University of Graz (EK-number: 30–077 ex 17/18).

Dependent and independent measure

To assess the body weight and body height, the subjects were asked "How much do you weigh without shoes and clothes?" and "How tall are you without shoes?" According to the WHO [1], obesity was defined as a BMI ≥ 30 kg/m². Due to significant differences between self-reported and measured BMI data in Austrian adults aged 45 years and older [35], correction factors were applied to subgroups (women: 45–59 years: +0.41 kg/m², ≥ 60 years: +1.09 kg/m²; men: 45–59 years: +0.50 kg/m², ≥ 60 years: +0.54 kg/m²). In former studies in which regional disparities in Austria were investigated, the country was divided into Western Austria, Central Austria and Eastern Austria. Therefore, we also chose this method of subdivision (▶ Fig. 1). Details about the 3 regions are described in a former article [32]. To measure social inequality, the variable ‘educational level’ was used. This was measured as the highest educational level reached, and results were then categorised as primary school or vo-
cational school (low level of education), secondary school with general qualification for university entrance (middle level of education) and university or college of higher education (high level of education). Educational status was not collected in 1973.

**Statistical analyses**

Selected and comparable variables of all surveys were entered into a common database using SPSS® Statistics 25.0. Merged data were weighted using age, sex and region-specific weights. Direct, age-based standardizations were calculated using the WHO European standard population. Binary logistic regression analyses were conducted with obesity as dependent variable and the survey period as the predictor, with the five-year-age-interval as the correction category. To represent trends for obesity prevalence, we calculated absolute changes, defined as $AC = PI - Pf$, and etiologic fractions, defined as $EF = (PI - Pf)/PI$, using the prevalence rates from the first (PF) and last (PI) years, estimated by using logistic regression models. The regression analyses were calculated for the period 1983 to 2014, since the prevalence of obesity increased only from the survey 1983 onwards. The following formulas were used:

$$AC = 1/(1 + \exp[-(B0 + B \times T)]) - 1/(1 + \exp[-B0])$$

$$EF = (RR - 1)/RR$$

$$RR = \text{Relative risk} = (1 + \exp[-(B0)])/(1 + \exp[-(B0 + B \times T)])$$

$$B = \text{Regression coefficient}; B0 = \text{Intercept}; T = \text{Time period in years}$$

The magnitude of inequality regarding obesity was measured by the relative index of inequality (RII). It describes the percentage of the predicted rate for the lowest level in the educational hierarchy related to the predicted rate for the highest level in the educational hierarchy. To obtain this the variable, ‘educational level’ was transformed into the variable ‘fractional rank’. A binary logistic regression with the dependent variable of obesity and the independent variable of fractional rank (correction variables: age in five-year intervals, sex) was carried out. The RII was calculated by the exponentiation of the regression coefficient from the logistic regression. Statistical tests were two-sided, and a $p < 0.05$ was considered statistically significant.

**Results**

In 2014, the prevalence for obesity was higher among men than women, with the highest rates among subjects living in Eastern Austria (women: 16.9%, men: 18.2%). The lowest age-standardized obesity rate was observed in 2014 in Western Austria (Table 1). Fig. 2 shows that from 1983 and on, the obesity prevalence was observed to increase constantly among men and in all regions. Both of the last surveys revealed a low increase in obesity prevalence among men living in Western Austria. From 2007 and on, the obesity rates decreased among women living in Central and Western Austria, while it stabilized for women living in Eastern Austria.

Because the prevalence of obesity increased from 1983 and on, the calculated trends are presented for the period 1983 to 2014. A significant increase in the prevalence of obesity was observed in every region for both sexes. The greatest AC was observed for women and men in Eastern Austria, and the lowest AC, in Western Austria. The greatest dynamics were observed for Austrians in the western part of the country (Table 2).

The associations between educational inequality and obesity were unstable during the investigation period. In 2014, the RII for obesity was highest in Central Austria (Table 3).

**Discussion**

Our study results confirm the existence of an East-West gradient for the prevalence of obesity in Austria, which was reported by other researchers [20, 27, 29, 31–33]. Population-based studies conducted in Germany also showed the highest rates of obesity in the eastern part of the country (except Berlin) [36]. We believe that these regional differences regarding obesity can be attributed to differences in lifestyle. Certain studies have cited evidence that environmental factors, such as lack of safety, poor housing conditions and socioeconomic deprivation, are associated with food consumption and the physical activity levels [24, 36, 37]. Other studies have also concluded that changes in physical activity and nutrition seem to be accountable for the strong, observed increase in obesity rates [37, 38]. The Austrian data showed that residents living in the western part of the country exercise more regularly than subjects living in the other regions of Austria. In Eastern Austria, the self-reported prevalence of physical activity was lowest. Moreover, it was observed that individuals living in Western Austria often had a healthier diet and ate less meat, followed by residents in Central and Eastern Austria [32, 33]. Overall, our findings indicate that it is important to create safe environments where physical activities can be performed, leading to positive consequences both in terms of body weight and the general health and well-being of individuals living in affected regions.

Many studies identified an overall socio-economic gradient in obesity in industrialized countries, showing that the rates for obesity increased with decreasing socio-economic status [23, 39]. The obesogenic environment was investigated in 5 countries as part of a European project. It was observed that residents from neighbourhoods of low socioeconomic status ate fewer fruit and vegetables, drank more sugary drinks and had consistently higher Body Mass In-

![Fig. 1 Map of Austria (dark red = Western Austria, red = Central Austria, light red = Eastern Austria).](image-url)
changes [22]. Regional disparities for Austria in the form of an east–west decline were also found regarding psychosocial discomfort and lack of social support. Psychosocial discomfort was strongly linked to obesity in Austria in a previous study [33]. In our study, associations between educational inequality and obesity were unstable during the investigation period for the defined regions. One possible reason for this is that the overall number of highly educated subjects was relatively low, especially among the women in the first surveys. In Germany, regional differences were also associated with socioeconomic differences. A regional socioeconomic deprivation index was developed to present associations between regional socioeconomic inequality and health and propose explanations for regional variations in health. The German Index of Socioeconomic Deprivation is used for health reporting, allowing new data sources to be analysed and associations between social inequality and health to be identified [40]. The development of such an index would also be helpful in Austria, enabling researchers to describe regional socioeconomic inequality more comprehensively.

Großschädl et al. [32] reported the greatest increase for the prevalence of obesity in Western and Central Austria. In Europe, a similar trend has been observed. The greatest increase took place in countries which had the lowest obesity prevalence in the past [21]. However, our most recent results showed that the prevalence of as well the increase in obesity was highest in Eastern Austria. The AC for obesity for women and men was higher or rather lower than the AC for the 3 regions in Austria stratified by sex (▶Table 2). This is probably related to the strong aggregation of data at the regional level. However, obesity is a serious problem in Eastern Austria.
Since 2007, the prevalence of obesity has visibly differed among the 3 defined regions, and our results provide evidence that regional differences in obesity prevalence will be relevant in Austria in the future. While the prevalence for obesity has decreased among women living in Western and Central Austria since 2007, the obesity prevalence has increased constantly among men, especially those living in the Eastern and Central Austria. It is interesting that, for the first time, the obesity prevalence is higher among men than women in Austria (16.8 vs. 14.6%). Previous studies showed that women have higher obesity rates than men [4–6, 10], and higher obesity rates were also observed for Austrian women in a former trend analysis [2]. But more recent studies and also the future prognosis show higher obesity prevalence among men than women in Europe [8, 15, 41]. The European male aging study concluded that weight and BMI are rising among men, especially in countries undergoing socioeconomic and political transitions [7]. It seems as though public health strategies applied the past most strongly influenced women living in Central and Western Austria. Another reason for these findings could be that women have paid more attention to maintaining a healthy diet and exercising regularly than men, because social norms have increased women’s awareness of their bodies [2]. We believe that this is especially true for women in Western and Central Austria; thus, they still showed lower obesity prevalence and increases than women in Eastern Austria. Due to the greater prevalence of obesity among men than women, new public health strategies should be developed, taking into account gender-based differences.

Limitations

We tried to compensate the self-report bias for the BMI by applying correction factors cited in a former Austrian validity study [35]. Calculating the RII was based on educational level. Other eligible variables, e.g. income, were not available for most surveys. Investigating income groups would have probably resulted in more stable values for RII. Another limitation was that differences in the data collection method existed. However, we found out that computer-assisted telephone interviews and face-to-face interviews have similar measurement properties [42]. The cross-sectional design of the 6 surveys restricted us to analyses of present causality.

Conclusions

This outcome highlights the existence of an East-West gradient for the prevalence of obesity among Austrian adults. The eastern and western regions of Austria differ most in their geographic appearances. While the Alps are located in the western part of the country, the Pannonian lowlands are located in Eastern Austria. These differences in landscape have had an impact on socio-cultural and socio-historic development [33]. The obesogenic environment of individuals seems to be an important factor in terms of obesity risk. Policies aimed at obesity reduction must address the region where subjects live more strongly in the future and not only the subjects themselves. Gaining a deeper understanding about the mechanisms of these environmental factors and obesity is necessary to find effective solutions, address specific issues and develop practical treatment strategies. More research is needed to study the causality of environmental aspects and obesity in order to justify potentially costly improvements to public spaces. Environmental characteristics (e.g. degree of urbanization, accessibility to supermarkets, or social cohesion) have received little attention to date in the research of obesity in Austria. The investigation of cultural and lifestyle factors is also recommended for different regions in Austria.

Table 2 Logistic regression of obesity prevalence change per period and absolute changes (AC) and etiologic fractions (EF) of obesity by sex and region. The analysis refers to the years 1983 to 2014 (n = 138,189).

<table>
<thead>
<tr>
<th>Predictor *</th>
<th>Exp(B) * *</th>
<th>Obesity (95% CI)</th>
<th>AC obesity in %</th>
<th>EF obesity in %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Austria</td>
<td>1.019 (1.016; 1.021)</td>
<td>1.21</td>
<td>42.22</td>
<td></td>
</tr>
<tr>
<td>Central Austria</td>
<td>1.022 (1.017; 1.028)</td>
<td>1.46</td>
<td>58.68</td>
<td></td>
</tr>
<tr>
<td>Eastern Austria</td>
<td>1.018 (1.014; 1.021)</td>
<td>1.77</td>
<td>54.54</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Western Austria</td>
<td>1.018 (1.015; 1.021)</td>
<td>2.60</td>
<td>54.13</td>
<td></td>
</tr>
<tr>
<td>Central Austria</td>
<td>1.028 (1.025; 1.030)</td>
<td>2.01</td>
<td>55.76</td>
<td></td>
</tr>
<tr>
<td>Eastern Austria</td>
<td>1.029 (1.023; 1.036)</td>
<td>0.86</td>
<td>48.98</td>
<td></td>
</tr>
</tbody>
</table>

* Correction variables: age in 5 years interval, sex

Table 3 Relative index of inequality for the prevalence of obesity between 1983 and 2007 per period, by region.

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>0.925 (0.967; 0.989)</td>
<td>0.937 (0.980; 1.007)</td>
<td>0.945 (0.992; 1.009)</td>
<td>0.947 (0.993; 1.009)</td>
<td>0.949 (1.000; 1.000)</td>
</tr>
<tr>
<td>West</td>
<td>0.912 (0.954; 0.971)</td>
<td>0.926 (0.976; 1.018)</td>
<td>0.934 (0.989; 1.023)</td>
<td>0.937 (1.000; 1.000)</td>
<td>0.940 (1.000; 1.000)</td>
</tr>
<tr>
<td>Central</td>
<td>0.900 (0.946; 0.954)</td>
<td>0.913 (0.969; 1.011)</td>
<td>0.921 (0.986; 1.036)</td>
<td>0.923 (1.000; 1.000)</td>
<td>0.926 (1.000; 1.000)</td>
</tr>
<tr>
<td>East</td>
<td>0.897 (0.944; 0.951)</td>
<td>0.910 (0.966; 1.016)</td>
<td>0.918 (0.985; 1.044)</td>
<td>0.921 (1.000; 1.000)</td>
<td>0.924 (1.000; 1.000)</td>
</tr>
</tbody>
</table>

* Correction variable for regions: five-years-interval of age (youngest age group = reference category). * * Exp(B) = ratio coefficient
Austria, because these seem to have an impact on the obesity prevalence among subgroups. Prevention and intervention programs should have an impact on spatial conditions, especially in deprived areas. Counteracting social inequality on a spatial level and preventing the clustering of problems in certain areas is a challenge for members of the scientific, political and social communities.

Conflict of Interest

The authors declare that there is no conflict of interest.

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