

ORIGINAL ARTICLE

Secular trends in overweight and obesity among Icelandic adolescents: Do parental education levels and family structure play a part?

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Abstract

Aims: To investigate whether the secular trend in the increasing prevalence of overweight and obesity among 16- to 20-year-old adolescents in Iceland varied by levels of parental education and family structure. **Methods:** Odds ratios were calculated from repeated population-based, cross-sectional surveys comprising cohorts of 16- to 20-year-old Icelandic adolescents attending junior colleges in 1992 ($n=4,922$), 2004 ($n=11,031$), 2007 ($n=11,229$), and 2010 ($n=11,388$). Body mass index (BMI) was calculated from self-reported weight and height and categorised as normal weight or overweight and obese, and examined in relation to parental education level and family structure. **Results:** The odds of being overweight increased by 2.62 and 1.71 for boys and girls respectively over each of the survey time points. The prevalence of overweight and obesity increased across all three subgroups (low, medium, and high) of parental education level. The probability of overweight across all years were consistently the highest for youths with parents in the low-education category followed by middle-educated and high-educated parental background ($p<0.05$). The gap in overweight and obesity trends between respondents' parental education backgrounds increased over time and was generally explained more by the fathers' education than by the mothers' education ($p<0.05$). Family structure was not associated with the prevalence of overweight and obesity in our data. **Conclusions:** Differences in parental levels of education are associated with accelerating trends in prevalence of overweight and obesity among 16- to 20-year-old adolescents in Iceland.

Key Words: Adolescents, children, family structure, obesity, overweight, socioeconomic factors

Introduction

The prevalence of overweight and obesity among adolescents has increased rapidly in many European countries [1]. Among 14- to 20-year-old Icelandic adolescents, the prevalence increased from 14.7% to 26.3% among boys and 11.5% to 17.8% among girls from 1992 to 2007 [2]. The highest increase was in the oldest age group, those 20 years of age. Moreover, the degree of obesity also grew more severe among 15- and 17-year-old boys and 20-year-old girls.

The adverse health effects of obesity [3] make this increase a serious threat to public health and highlight

the need for effective interventions. The causes for the increased prevalence, however, are not entirely understood and current evidence for successful public health interventions is incomplete [4]. Moreover, the relationship of different socioeconomic circumstances to overweight and obesity in adolescents and young adults has not been fully examined. Generally, studies of socioeconomic status (SES) and adolescent weight find higher prevalence obesity among minority youth from low-SES backgrounds [5–8] or in adolescents from single-parent families [9].

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The population of Iceland has been considered comparatively homogenous in terms of socioeconomic class [10] but to this date no published studies have focused on socioeconomic disparities and adolescent overweight and obesity. Thus, this study sought to investigate the trends in overweight and obesity over time and determine whether the prevalence of overweight and obesity among 16- to 20-year-old adolescents in Iceland varied by SES indicators such as parental levels of education and family structure.

Methods

Population and data sources

Data for this study came from 38,570 participants in four separate Youth in Iceland surveys that were conducted in junior colleges in 1992 ($n=4,922$), 2004 ($n=11,031$), 2007 ($n=11,229$), and 2010 ($n=11,388$). These are cross-sectional surveys conducted to gain understanding of risk and protective factors in the health and development of youth. The findings are used to enhance public knowledge of adolescent lifestyles and to inform public policies and programs that can promote the health and wellbeing of Icelandic youth. Participation in these surveys ranges from 71% (2007 and 2010) to 81% (2004); there is no estimate for the 1992 survey, which was based on a random probability sample. Males comprise 48–49% of the respondents [11].

Procedures

Data collection was guided by a strict methodological protocol [12] and conducted by the Icelandic Centre for Social Research and Analysis (ICSRA) at Reykjavik University in cooperation with the Icelandic Ministry of Education, Science, and Culture, the municipalities, and all junior colleges in the country. All aspects of data collection were performed in accordance with guidelines issued by the Icelandic authority that governs the use of human subjects.

With the exception of the 1992 survey data (collected by the Institute for Educational Research), the ICSRA distributed anonymous questionnaires to all junior colleges in Iceland following written notification to parents for passive consent. All students who were present in school on the survey day in October completed the questionnaire inside. Teachers at individual school sites assisted the students with their participation in the study and specific contact agents supervised the distribution of surveys within each classroom as well as the return of the questionnaires.

Questionnaires that contained insufficient responses about gender, age, height, weight, or other survey questions of interest were excluded from the analysis. In addition, respondents who reported being either younger or older than 16–20 years, heavier than 170 kg, or shorter than 130 cm or taller than 220 cm were excluded from the analysis. The total number of participants included in the analyses was 30,832, 79.9% of whom provided data for any of the surveys across the four study years.

Measures

Body mass index. Self-reported height and weight was used to calculate the body mass index (BMI; kg/m^2). For 18-year-olds and older, BMI was categorised according to the World Health Organization classification [13] as follows: overweight, 25–29.9 kg/m^2 ; obese $\geq 30 \text{ kg}/\text{m}^2$. For adolescents under 18 years of age, the International Obesity Task Force (IOTF) age- and gender-specific cut-off points for overweight and obesity (based on centile curves defined to pass through the BMI of 18.5, 25, and 30 kg/m^2 at age 18) were used [14, 15]. Because most of the respondents already had experienced birthdays for that year, whole-year cut-off values for BMI were used. The BMI categories for all participants were then dichotomised into 0 (under/normal weight) and 1 (overweight/obese).

Parental level of education. This was obtained by asking respondents separate questions about their father's and mother's educational attainment. The response option varied slightly from year to year and was collapsed and recoded into the following categories: "finished elementary school or less" (low level), "started or finished school on the secondary level" (medium level), and "began university or finished a university degree" (high level).

Family structure. Respondents were asked to indicate who lives at home with them. The checklist option varied slightly from year to year and was combined into the following four categories: "living with both parents", "living with a parent and a step-parent", "living with a single parent", and "living on their own".

Statistical analysis

Descriptive statistics were used to describe the sample and subgroups over the four study time points. Prevalence of overweight by survey year and gender, and by parental level of education subgroup and family structure, was calculated. Odds ratios were

Table I. Mothers' and fathers' education level and family structure (living alone, with a single parent, with a step-parent, or with both parents) by survey year cohorts for Icelandic adolescents.

Year	Mothers' level of education			Total	Fathers' level of education			Total	Family structure				Total
	Low	Middle	High		Low	Middle	High		Alone	Single	Step	Both	
1992	47.5	32.0	20.5	100	20.0	54.8	25.1	100	6.1	12.9	9.1	71.8	100
2004	21.0	45.6	33.4	100	13.8	52.9	33.3	100	5.7	13.4	10.6	70.4	100
2007	15.5	43.3	41.1	100	12.1	48.6	39.3	100	4.7	12.8	9.6	72.9	100
2010	13.2	41.2	45.6	100	12.1	47.7	40.2	100	5.4	14.1	10.5	70.0	100

Values are %.

derived from logistic regression, which was used to analyse linear and curvilinear trends in BMI and parental level of education by year of study and gender. Trends were statistically significant at an *a priori* alpha level of $p < 0.05$.

Results

Parental education and family structure

Table I shows parental education levels and the reported family structure of survey respondents for each of the study years. While the middle-education subgroup remained fairly stable across the survey years, there was a sharp increase in mothers with high education and decrease in mothers with low education. Although not as pronounced, a similar trend was observed for fathers' education subgroups.

Prevalence of overweight and obesity by parental education level

Overall, the prevalence of overweight and obese boys increased from 15.3% to 28.2% and from 12.2% to 20.9% among girls over the survey years. Figure 1 shows the trends in the prevalence of overweight and obesity in boys and girls by education levels of mothers and fathers. In each survey year, the prevalence of overweight and obesity increased in all three subgroups. The prevalence of overweight and obesity was statistically significantly different across mothers' education subgroups as determined by one-way ANOVA ($F(2,28.065)=21.095$, $p < 0.001$). A post-hoc test revealed that the prevalence of obesity was statistically significantly lower for the higher educated group compared to the low- ($p < 0.001$) and middle- ($p < 0.001$) education subgroups. The difference between the low- and medium-education subgroups was not statistically significant ($p = 0.668$). Similarly, for fathers' education, there was statistically significant difference across groups as determined by one-way ANOVA ($F(2,27.909)=75.109$, $p < 0.001$). A post-hoc test revealed that the prevalence of obesity

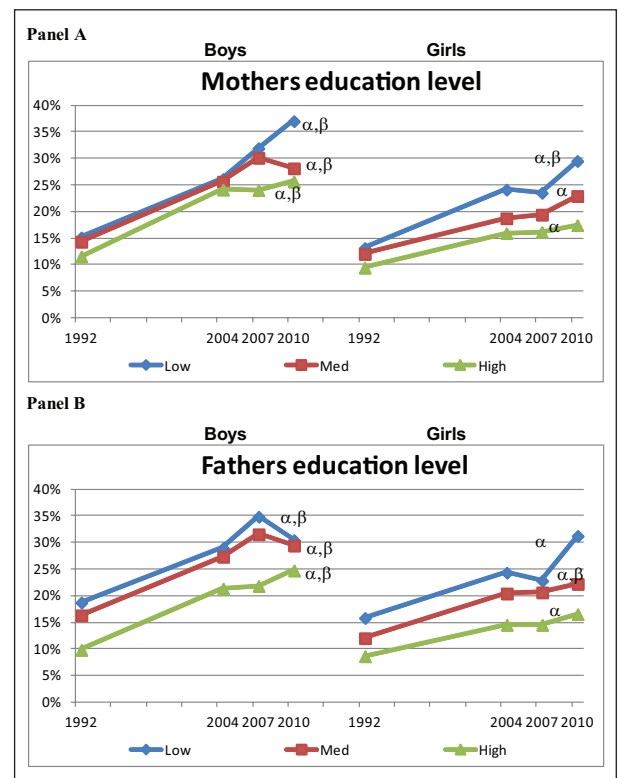


Figure 1. Trends in prevalence of overweight and obesity for 16- to 20-year-old Icelandic adolescents by gender and parental level of education in 1992, 2004, 2007, and 2010.

α = significant linear trend; β = significant curvilinear trend.

was statistically significantly across all the three subgroups ($p(\text{low,med})=0.001$; $p(\text{med,high}) < 0.001$; $p(\text{high,low}) < 0.001$). In addition, the magnitude of the differences between the education subgroups increased over time.

Mothers' education. The prevalence of overweight and obesity was lower in those of both genders who had mothers with higher education across all time points (Figure 1). Among boys, the percentage of overweight and obesity increased from 15.1% to 37% for those with low-educated mothers, 14.3% to 28.1% for those with middle-educated mothers, and

11.5% to 25.6% for those with high-educated mothers, from 1992 to 2010. A similar trend of increase in percentage of overweight and obesity was observed for girls: overweight and obesity went up from 13.1% to 29.5% for those with low-educated mothers, 12% to 22.9% for those with middle-educated mothers, and 9.4% to 17.4% for those with high-educated mothers, from 1992 to 2010. In addition, the gap in overweight and obese percentage between high-educated and low-educated subgroups increased from 3.6% in 1992 to 11.4% in 2010 among boys and from 3.7% in 1992 to 12.1% in 2010 among girls.

Fathers' education. Similarly, the prevalence of overweight and obesity was significantly lower across all years for both boys ($p < 0.001$) and girls ($p < 0.001$) with fathers of higher-educated subgroups. Among boys in the low-educated subgroup, the percentage of overweight and obesity increased from 18.7% to 30.4%, from 16.3% to 29.4% for boys in the middle-educated subgroup, and from 9.8% to 24.7% for the boys in the high-educated subgroup during 1992 to 2010. A similar trend was observed for girls, in whom the overweight and obesity ratio went from 15.8% to 31.2% for girls in the low-educated subgroup, from 12% to 22.2% for girls in the middle-educated subgroup, and from 8.6% to 16.5% for the girls in the high-educated subgroup during 1992 to 2010. The differences in overweight and obesity percentage between the low-educated and high-educated subgroups increased with time. For boys, the gap expanded from 8.9% in 1992 to 13% in 2007 but closed to 5.7% in 2010; for girls, the gap went from 7.2% in 1992 to 14.7% in 2010.

Parental education level and the odds of being overweight and obese

Overall, the odds of being overweight and obese increased by 2.62 among boys and by 1.71 among girls across each time period in the data (between 1992 and 2004, 2004 and 2007, 2007 and 2010). There was also a curvilinear relationship for both genders over time.

Table II shows the odds ratios for prevalence of overweight and obesity for boys and girls by parental education level. The odds of being overweight and obese among boys with low-educated mothers increased by 2.63, for boys with middle-educated mothers by 3.50, and with high-educated mothers by 2.47, between each time point. There was a significant linear and curvilinear trend in overweight and obesity rates across all subgroups for boys by mothers' education (Figure 1). Among boys with middle-educated mothers, overweight and obesity rates

declined by 2% between 2007 and 2010, and among boys from high-educated mothers the rate of increase plateaued between 2004 and 2007, followed by a further increase between 2007 and 2010. Among girls, the odds of being overweight and obese increased for each survey year by 2.37 for those with low-educated mothers, by 1.60 for the girls with mothers in the middle-educated subgroup, and by 1.85 among the girls with mothers in the high-educated subgroup. There was also a significant curvilinear relationship over time among girls with low-educated mothers, as the prevalence rate of overweight and obesity increased from 1992 to 2004, then it decreased between 2004 and 2007, before increasing again in 2010.

Between each time point, the odds of being overweight and obese among boys with low-educated fathers increased by 3.32, for those with middle-educated fathers by 3.23, and among those with high-educated fathers by 2.54 (Table II). We also observed a curvilinear relationship between the change in overweight and obesity ratios over time among all the three subgroups of fathers' education. As seen in Figure 1, for boys with low- and middle-educated fathers, the prevalence of overweight and obesity decreased in 2007 and 2010 by 4.4%, and 2.1%, respectively. For boys with high-educated fathers, the prevalence levelled off between 2004 and 2007, followed with an increase between 2007 and 2010. The odds of being overweight and obese among girls with low-educated fathers increased by 1.41, for girls with middle-educated fathers by 2.19, and with high-educated fathers by 1.75 for each time point. Additionally, there was also a curvilinear relationship over time among girls with middle-educated fathers, as the prevalence of overweight and obesity increased from 1992 to 2004, but levelled off between 2004 and 2007, before increasing again in 2010.

Family structure and the odds of being overweight

Figure 2 shows the trend in prevalence of overweight and obesity by gender and family structure subgroups. The prevalence of overweight and obesity across family structure subgroups varied across time and gender, although boys and girls living on their own had most frequently the highest prevalence of overweight and obesity among all the subgroups, it was not statistically significant. There was also no significant linear or curvilinear relationship across family structure over time among boys. Among girls, a linear relationship across family structure over time was observed for those living with a single parent and for those living with both parents, as seen in Table III.

Table II. Odds ratios for overweight and obesity for boys and girls by parental level of education.

Education level	Boys						Girls					
	B	SE	Wald	df	p-value	OR	B	SE	Wald	df	p-value	OR
(A) Mothers												
Low												
Year	0.965	0.250	14.860	1	0.000	2.626	0.863	0.234	13.608	1	0.000	2.370
Year ²	-0.116	0.049	5.617	1	0.018	0.890	-0.113	0.460	5.984	1	0.014	0.893
Middle												
Year	1.254	0.203	38.284	1	0.000	3.505	0.469	0.209	5.055	1	0.025	1.599
Year ²	-0.197	0.036	29.428	1	0.000	0.821	-0.052	0.037	1.910	1	0.167	0.950
High												
Year	0.904	0.230	15.394	1	0.000	2.470	0.602	0.255	5.561	1	0.018	1.825
Year ²	-0.135	0.040	11.249	1	0.001	0.847	-0.085	0.045	3.619	1	0.057	0.919
(B) Fathers												
Low												
Year	1.201	0.308	15.171	1	0.000	3.324	0.341	0.286	1.418	1	0.234	1.406
Year ²	-0.196	0.058	11.292	1	0.001	0.822	-0.018	0.054	0.114	1	0.736	0.982
Middle												
Year	1.172	0.166	49.962	1	0.000	3.229	0.784	0.176	19.940	1	0.000	2.190
Year ²	-0.186	0.031	36.765	1	0.000	0.831	-0.116	0.032	12.963	1	0.000	0.890
High												
Year	0.932	0.228	16.704	1	0.000	2.538	0.558	0.257	4.698	1	0.030	1.747
Year ²	-0.130	0.040	10.333	1	0.001	0.878	-0.073	0.046	2.582	1	0.108	0.929

B, coefficient of regression; SE, standard error; Wald, the index of regression effect; df, degrees of freedom; OR, odds ratio.

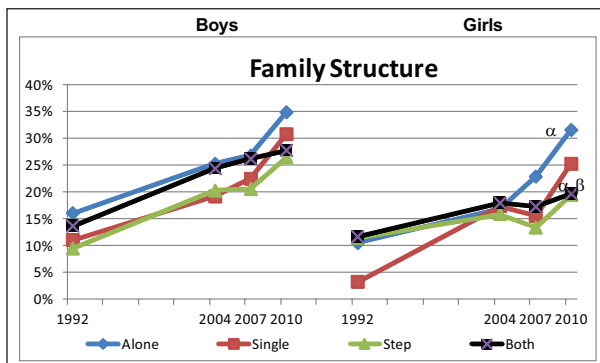


Figure 2. Trends in prevalence of overweight and obesity for 16- to 20-year-old Icelandic adolescents by gender and family structure in 1992, 2004, 2007, and 2010.

α = significant linear trend; β = significant curvilinear trend.

The odds of being overweight and obese increased by 3.26, and 1.63, respectively, for these two categories across each survey year. In addition, there was a curvilinear relationship across family structure over time among girls living with both parents, where the prevalence declined by 1% from 2004 to 2007 and increased again by 3% between 2007 and 2010.

Discussion

Our data show that Icelandic adolescents and young adults from all three subgroups of parental education level experienced an overall increase in overweight and obesity over the study period, with the exception

of two minor declines and a plateau between few study points. Further, the prevalence of overweight and obesity was consistently highest among youth in the low-educated parent subgroup, followed by middle-educated parents, and lowest among youth with high-educated parents. The net increase in overweight and obesity over the survey years was also highest among youth who had low-educated parents, followed by middle-educated and lowest in those who had high-educated parents. The exception occurred in boys when looking at the associations by fathers' education, where the net increase was nearly similar in all education subgroups. The highest proportional increase in overweight and obesity percentages occurred among youth with low-educated parents between 2007 and 2010, which could be a result of more severe impact of the recent financial crisis on families of low education. Moreover, the gaps between education subgroups increased over time and were larger when examined by the fathers' education than by mothers' education. The associations between family structure and prevalence of overweight and obesity among different subgroups were not significant throughout the study period, suggesting that education levels are more important correlates of overweight and obesity in adolescents, as markers for socio-economic disparities.

We observed an increase in the prevalence of overweight and obesity in all mothers' and fathers' education subgroups, which suggests that some common factors in addition to education levels are behind

Table III. Odds ratios for overweight and obesity for Icelandic boys and girls by family structure.

Family structure	Boys						Girls					
	B	SE	Wald	df	p-value	OR	B	SE	Wald	df	p-value	OR
Alone												
Year	0.525	0.551	0.909	1	0.340	1.691	0.549	0.583	0.885	1	0.347	1.731
Year ²	-0.046	0.109	0.174	1	0.677	0.955	-0.021	0.109	0.037	1	0.847	0.979
Single parent												
Year	0.537	0.367	2.139	1	0.144	1.710	1.183	0.424	7.798	1	0.005	3.264
Year ²	-0.030	0.066	0.213	1	0.645	0.970	-0.133	0.074	3.218	1	0.073	0.875
Parent and step-parent												
Year	0.784	0.448	3.058	1	0.080	2.190	-0.088	0.426	0.043	1	0.836	0.916
Year ²	-0.091	0.080	1.287	1	0.257	0.913	0.046	0.077	0.361	1	0.548	1.048
Both parents												
Year	0.549	0.583	0.885	1	0.347	1.731	0.491	0.151	10.588	1	0.001	1.634
Year ²	-0.021	0.109	0.037	1	0.847	0.979	-0.065	0.028	5.523	1	0.019	0.937

B, coefficient of regression; SE, standard error; Wald, the index of regression effect; df, degrees of freedom; OR, odds ratio.

these trends in weight gain in Iceland, affecting the entire adolescent population. Studies examining socioeconomic disparities in the time trends of adolescents' overweight and obesity in other populations have found increase in the prevalence of overweight and obesity across all SES subgroups studied, with generally no differences in the rate of increase in overweight and obesity between SES groups [16–18], while other studies, in line with our results, have reported some variation between them according to age, sex, race/ethnicity, or different time periods [19–21]. The increasing differentiation in weight gain between subgroups depending on parental education level in Iceland suggests an overall increase in class difference such as access and availability of nutritious food.

Iceland is comparatively homogenous in terms of social class, thus the results of this study are somewhat surprising. Our results demonstrate that adolescents who have low-educated parents were consistently overrepresented among the numbers of overweight and obese across all four survey years, and the magnitude of the disparities between the high- and low-educated subgroups increased over time. Moreover, the prevalence rate of overweight and obesity has begun to plateau in recent years among adolescents with high-educated parents; while in contrast, the prevalence has continued to rise among youth with low-educated parents. However, it should be kept in mind that interpreting secular changes in SES or education level over time is complex, because the structure of social groups in Iceland has changed over this same time period. The number of low-educated residents, as defined by education, has decreased in relative terms during the past two decades, while the proportion of high-educated people has been growing. This suggests that the society

as a whole is becoming more affluent, but that there may be increasing polarity between the highest and lowest income groups, as is occurring in many other countries [22]. Also, with the ongoing financial crisis in Iceland that experienced a collapse of its banking system in October 2008, we speculate that, as the population of adolescents with low-educated parental backgrounds has decreased, the low-educated group has become a more disadvantaged group than it was two decades ago. Correspondingly, the proportion of adolescents with high-educated parental backgrounds has grown, and while they are generally assumed to have a healthier lifestyle than low-educated or low SES youth [23], increasing numbers of adolescents from more privileged backgrounds are also gaining weight.

This study has several strengths. First, we analysed high-quality data that were obtained from a large, representative population data with a high response rate. Second, the survey methods were nearly identical throughout all survey years. Third, the data encompass 70–80% of the total population in this age group, representing the majority of adolescents in the Icelandic population.

The study also has notable limitations. First, although BMI is generally accepted as a valid indicator of body composition for purposes of population-level assessment [24], using BMI as an index of adiposity poses some challenges [25]. Second, the use of self-reported height and weight data can be problematic because some adolescents may overreport their height and underreport their weight [26]. Third, this study used parental education as a proximal measure for SES, although it has been shown to be a good indicator of SES [21].

In order to better understand trends in overweight and obesity we need to consider population-wide

societal changes, including changes in economic, social, and cultural circumstances that shape individual behaviour across socio-demographic groups. For example, Iceland experienced a financial collapse in 2008, which may be reflected in the highest proportional increase in BMI experienced by youths from low SES backgrounds from 2007 to 2010. The few existing studies in Iceland suggest that intake of fat decreased between 1990 and 2002 [27], whereas there was a 6% increase in the rate of vigorous physical activity, from 1992 to 2006 among 14- to 15-year-olds, with a 15% increase in active sports club participation [28]. Despite these levels of reported activity, over half of adolescents in Iceland did not achieve recommended levels of participation in physical activities. Furthermore, there was an overall increase in the proportion of inactive adolescents over time, with girls consistently reporting higher levels of physical inactivity than boys, even though the net increase in physical inactivity was higher for boys over this time period.

In conclusion, while Icelandic adolescents from all three subgroups of parental education level experienced increase in BMI, the prevalence was consistently highest among youth with low-educated parents, followed by middle-educated parents, and lowest among youth with high-educated parents. In addition, the net increase in BMI over time was also highest among youth with low-educated parents, followed by middle-educated parents, and lowest in youth with high- parents, with the highest proportional increase among youth with low-educated parents between 2007 and 2010. The gaps between education subgroups also increased over time and were larger when examined by the fathers' education level than by mothers' education level. Family structure was not related to prevalence of overweight and obesity among different subgroups, indicating that parental education levels are more important correlates of BMI in adolescents than family structure.

Conflicts of interest

The authors declare no conflicts of interest.

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