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## Trends of overweight and obesity, physical activity and sedentary behaviour in Czech schoolchildren: HBSC study

Dagmar Sigmundová, Erik Sigmund, Zdenek Hamrik, Michal Kalman

Institute of Active Lifestyle, Faculty of Physical Culture, Palacky University, Olomouc, Czech Republic

**Correspondence:** Dagmar Sigmundová, Faculty of Physical Culture, Palacky University, Tr. Miru 115, 77111 Olomouc, Czech Republic, Tel: +420 585 636 119, Fax: +420 585 636 104, e-mail: [dagmar.sigmundova@upol.cz](mailto:dagmar.sigmundova@upol.cz)

**Background:** The decline of physical activity (PA) and the increased prevalence of overweight and obese children have been discussed worldwide. This study assessed the trends in the prevalence of overweight and obesity, PA and sedentary behaviour in Czech school-aged children. **Methods:** A cross-sectional questionnaire from the Czech Republic was administered in cycles in 2002, 2006 and 2010 under the Health Behaviour in School-Aged Children (HBSC) study. In the study, 14 219 children aged 11–15 years participated. **Results:** In comparison with 2002, there is a significant increase ( $P < 0.01$ ) of obese and overweight boys in 2010. The same trend has been recorded in girls, except those in the 13-year-old group. There has been a significant decline ( $P < 0.05$ ) in meeting PA recommendations in 11-year-old girls and boys and in 13-year-old girls when comparing the 2006 and 2002 data. In 2010, we found a non-significant increase or stagnation of the share of children meeting the PA recommendation compared with 2006. We found an increasing length of sedentary time for children. There were significant associations between  $>2$  h being spent sitting by a TV or PC and consuming fruit and vegetables (negative associations) or sweets and sweetened lemonades (positive associations). **Conclusions:** An increasing percentage of obese or overweight children, increased sedentary time and a decline or stagnation of the proportion of children meeting recommendations for PA were found among Czech schoolchildren. Future research should evaluate PA recommendations with respect to gender, age and effective intervention approach to reduce the obesity incidence in childhood.  
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### Introduction

Increased weight and obesity are important determinants influencing children's health.<sup>1</sup> Overweight and obese youth have an increased risk of becoming overweight or obese in adulthood.<sup>2</sup> A timely analysis of the state and trends can foster interventions, especially school interventions,<sup>3</sup> which can affect the future by reducing the number of overweight and obese adults. Understanding the changes in obesity prevalence requires additional studies.<sup>4</sup>

The increase in child obesity has been reported by the WHO, which argued that the proportion of overweight and obese children in the European countries is still increasing.<sup>1</sup> There is great variability among European countries.<sup>5</sup> For example, a study of seven European countries (Belgium, Greece, Hungary, Netherlands, Norway, Slovenia and Spain) showed that in 2010, 26% of boys and 22% of girls were overweight, and obesity was found in 5% of boys and 4% of girls. Greece, Hungary, Slovenia and Spain had a higher percentage of obesity than in Belgium, Netherlands and Norway.<sup>6</sup>

In the Czech Republic, a study of trends in adolescents aged 14–18 showed that at present, every 10th adolescent was either overweight or obese, which was roughly twice the rate in adolescents 10 years ago.<sup>7</sup> A current US study has shown that in boys, there has been a significant increase in the prevalence of obesity during the past 10 years; in general the authors summarize that the rapid increase in obesity prevalence observed in the 1980s and 1990s has not continued into the present decade.<sup>4</sup>

Insufficient levels of physical activity (PA) and constant decreases of PA with age, as well as the increased number of overweight and obese children, have highlighted the importance of constant

monitoring of changes in BMI and monitoring PA levels and its effects in childhood. A significant decrease in PA occurs mainly during adolescence in combination with a simultaneous increase in sedentary behaviour, most likely owing to the excessive use of computers.<sup>8–10</sup> Sedentary behaviours, such as TV watching, may be more important predictors of overweight or obese children than the PA behaviour.<sup>11,12</sup> Present studies show that correlates of time spent watching television and leisure computer use are different, and it is necessary to understand these differences to create more effective interventions.<sup>12,13</sup>

It is necessary to monitor and understand trends and changes in the occurrence of overweight and obese body habitus.<sup>4,14</sup> We cannot neglect the economic impact of inactivity and obesity<sup>15,16</sup> or the differences in the political-economic development in post-communist states, such as the Czech Republic, as opposed to economically well-developed Western countries. Post-communist countries (including the Czech Republic) have the tendency to repeat the PA patterns and behaviour that had been previously witnessed in Western countries in terms of the tendency to replicate the 'negative' development of decreased PA and increased overweight and obesity observed in economically developed countries.<sup>1,16</sup>

Monitoring of changes in the prevalence of overweight and obese body habitus, the trends and related behaviour in Czech children could provide critical information for future programmes aimed at healthy behaviour in children in the Czech Republic and further afield in other Central and Eastern Europe nations.

This study assessed the trends in the prevalence of overweight and obese body habitus, PA and sedentary behaviour of school-aged children in the Czech Republic.

Specific aims are as follows:

- (i) For each cohort, describe the proportion of children by their BMI categories (based on self-reported height and weight and international cut-off points);
- (ii) To describe eating behaviour and sedentary behaviour (TV watching and computer use) for each cohort, gender and age; and
- (iii) To examine the influence of sedentary behaviour, PA and eating habits on the prevalence overweight and obesity by gender.

## Methods

This research is a part of the international study Health Behaviour in School-Aged Children (HBSC). HBSC is a collaborative cross-national research study, monitoring various health and lifestyle determinants in school-aged children. School-based anonymous surveys were conducted in the academic years ending in 2002, 2006 and 2010 according to a common research protocol.<sup>17</sup> A national representative sample of children aged 11, 13 and 15 years was selected in these years. The completion of the HBSC questionnaire by children was voluntary. The final data inspection was performed by the International Databank, University of Bergen, Norway, in compliance with the international HBSC standards. Students' response rates were >70% in all years. The data from 2002 included 5012 children (35%); in 2006 (34%) the analysis included 4782 children, and in 2010, 4425 children were eligible for the analysis. A brief historical overview of the methodological development of the HBSC survey is described in the study by Roberts *et al.*<sup>18</sup>

### Items

To analyse the trends and associations, the questions in the HBSC questionnaire included performance of a PA for at least an hour a day in past seven days (one question; children were asked to report the number of days over the past week during which they were physically active for a total of at least 60 min per day, the question was preceded by explanatory text that defined moderate to vigorous PA as any activity that increases their heart rate and makes them get out breath for some time<sup>19</sup>); time spent sitting and watching television, PC—playing games and searching the internet, chatting (two questions in 2002 and three questions in 2006 and 2010 because the question regarding the time spent by the PC was divided into playing games, play station, searching the internet, chatting and homework); eating behaviour (consuming fruit, vegetables, sweets, sweet drinks, breakfast and working days); present weight and height and gender and age (age categories 11, 13 and 15 years). Overweight and obese body habitus was assessed using the BMI, age and sex according to the WHO growth reference for school-aged children, where overweight and obese body habitus

represent the 85–97 and 97 percentiles, respectively, of age-differentiated BMI.<sup>20,21</sup>

### Statistical analysis

The data analyses were conducted with IBM SPSS v. 19. Descriptive analyses were used to characterize the national sample. We evaluated trends in reports of the prevalence of overweight and obese body habitus, and meeting the recommendations for PA using a logistic regression (method Enter) analyses that modelled achievement to be overweight or obese body habitus. The achievement of the recommendation for PA (yes or no) was the dependent variable with year of survey cycle (2002; 2006; 2010) as the independent categorical variables. The association between the sedentary behaviour and eating behaviour was evaluated using a Spearman correlation coefficient. The influence of sedentary behaviour, PA eating habits on overweight and obesity was evaluated using a logistic regression analysis for boys and for girls.

## Results

The analysis included data from 14 219 children, of which 49% were boys and 51% were girls. The participants' ages ranged from 11 to 15 years (33% were 11, 33% were 13 and 34% were 15).

### Secular trends in overweight and obesity

The logistic regression of the occurrence of overweight and obese body habitus (table 1) showed different trends in boys and girls. There is a gradual increase in overweight and obese boys when comparing years 2002, 2006 and 2010. The highest increase of incidence of overweight and obese body habitus between 2002 and 2010 was found in 13-year-old boys, and the lowest rate was in 15-year-old boys.

In girls, we recorded an increased incidence of overweight and obese body habitus from 2002 to 2010. Unlike in boys and in comparison with 2002, in 2006, there was an increase and later a slight decrease or stagnation in the number of overweight and obese girls. In total, in 2010, there were significantly more overweight and obese girls in comparison with 2002, except in the age category of 13-year-olds (table 1).

### Trends in the achievement of the PA recommendations (at least 1 h per day moderate to vigorous intensity PA)

In 11-year-old boys, there was a decline in the proportion of individuals who met the recommendations for PA, especially in 2006. In 2010, 11-year-old boys were less likely to meet the recommendations for PA than in 2002 (table 2). In the age category of 13- and

**Table 1** Trends in prevalence of overweight and obesity HBSC study, 2002–10

Variable	2002 % <sup>a</sup>	2006 % <sup>a</sup>	2010 % <sup>a</sup>	2006 vs. 2002 OR (95% CI)	2010 vs. 2002 OR (95% CI)
<b>Boys</b>					
11 years	21.4	30.1	30.7	1.580 (1.259–1.984)***	1.625 (1.289–2.050)***
13 years	17.1	21.2	27.3	1.300 (1.009–2.343)*	1.817 (1.409–2.343)***
15 years	16.6	16.8	22.3	1.010 (0.779–1.311)	1.434 (1.112–1.851)**
<b>Girls</b>					
11 years	10.7	23.1	15.7	2.541 (1.929–3.347)***	1.558 (1.155–2.102)**
13 years	8.7	16.4	11.0	2.061 (1.524–2.786)***	1.295 (0.934–1.795)
15 years	6.6	11.6	11.4	1.868 (1.322–2.640)***	1.830 (1.285–2.607)**

Results from logistic regression.

a: Percentage of participants who are overweight or obese.

OR = odds ratio (cohorts from year 2002 are reference groups), CI = 95% confidence interval.

\* $P \leq 0.05$ ; \*\* $P \leq 0.01$ ; \*\*\* $P \leq 0.001$ .

**Table 2** Achievement of at least 1 h per day of moderate to vigorous intensity PA; HBSC study 2002–10

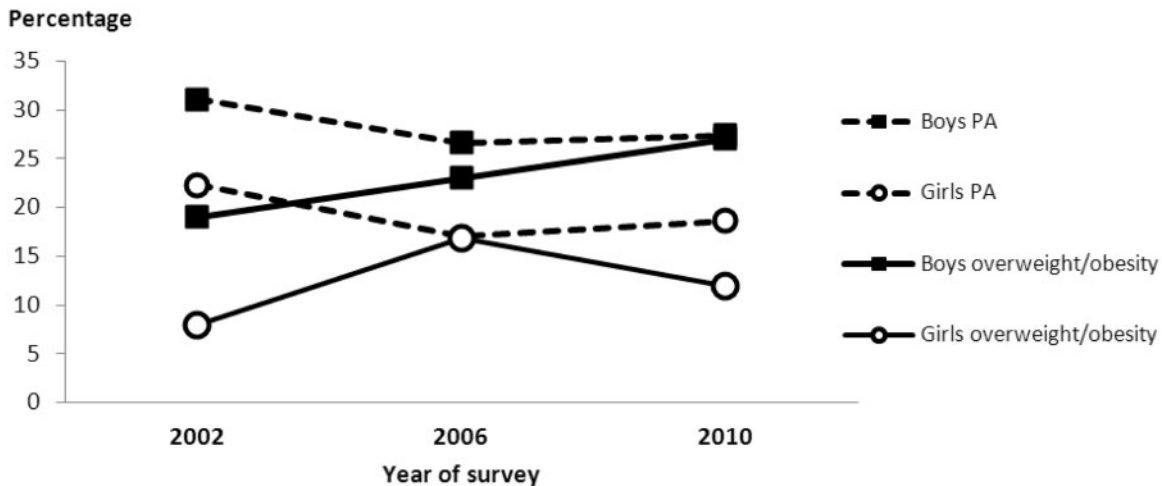
Variable	2002 % <sup>a</sup>	2006 % <sup>a</sup>	2010 % <sup>a</sup>	2006 vs. 2002 OR (95% CI)	2010 vs. 2002 OR (95% CI)
<b>Boys</b>					
11 years	34.3	24.6	28.0	0.625 (0.502–0.778)***	0.745 (0.599–0.926)**
13 years	32.1	27.9	29.5	0.822 (0.663–1.020)	0.888 (0.709–1.111)
15 years	27.0	27.2	24.8	1.005 (0.809–1.250)	0.888 (0.707–1.115)
<b>Girls</b>					
11 years	27.3	18.7	23.3	0.614 (0.484–0.779)***	0.811 (0.644–1.021)
13 years	21.8	16.9	19.0	0.729 (0.570–0.932)*	0.841 (0.662–1.068)
15 years	17.8	15.6	14.3	0.857 (0.662–1.108)	0.769 (0.588–1.004)

Results from logistic regression.

a: Percentage of participants who met recommendation for PA (at least 1 h per day moderate to vigorous intensity PA).

OR=odds ratio (cohort from year 2002 is reference group), CI=95% confidence interval.

\* $P \leq 0.05$ ; \*\* $P \leq 0.01$ , \*\*\* $P \leq 0.001$ .



**Figure 1** Prevalence of overweight or obesity (using the WHO cut-off point of BMI) and performance of at least 1 h per day of moderate- to vigorous-intensity PA

15-year-old boys, significant changes were not observed in meeting PA goals between 2002 and 2010.

The logistic regression showed that (table 2) 11- and 13-year-old girls in 2006 were less likely to meet recommendations for PA in comparison with 2002. Regardless of the age (11, 13 and 15 years), there were no significant changes in the proportion of girls meeting the health recommendations for PA. The results show that in comparison with 2002, we have recorded negative trends or stagnation in the proportion of children meeting the health recommendations for PA (table 2).

Figure 1 shows the trends of a slight decline or stagnation of boys and girls who report at least 1 h per day of moderate to vigorous intensity PA. On the other hand, the proportion of overweight/obese children increased from 2002 to 2010.

The analysis of the average number of days on which students carry out at least an hour of PA a day shows that in 2002 boys carried out PA an hour a day on average on 4.66 days and girls on 4.16 days. In 2010, boys reported an hour of PA a day on average on 4.52 days and girls on 4.05 days.

### Sedentary and eating behaviour

Figure 2 shows a slight increase of sedentary behaviour from 2002 and 2010 in both boys and girls. The increase in sedentary time is observed on weekdays and weekends. There is an apparent increase of the time spent on the computer; in girls, this time increased from 0.7 h per weekday in 2002 to 3 h per weekday in 2010, and in boys, it increased from 1.6 h per weekday in 2002 to 4 h per weekday in 2010. The time spent watching television and videos remained stable

at an average of 2.3 and 3.3 h a day during the monitored years. In 2010, boys are, on average, able to spend >7 h a day on the computer or watching TV on the weekends, and girls spend on the average slightly more than 6 h a day on the weekends engaging in these activities.

When analysing children's responses concerning the daily consumption of selected foods, we found that the daily consumption of fruit, vegetables, sweets and sweet drinks has not changed considerably for boys or girls. Girls consume fruit and vegetables slightly more frequently than boys. Boys consume more soft drinks. The proportion of children who have breakfast daily on weekdays is similar in the monitored years and ranges from 52–59% in boys and 45–50% in girls.

Regardless of age, sex and the year of monitoring, there were small, but significant, associations found in the entire sample of participants between >2 h of sedentary television watching and consuming fruit ( $r = -0.053$ ), vegetables ( $r = -0.058$ ), sweets ( $r = 0.119$ ) and sweetened lemonades ( $r = 0.134$ ). Similar significant associations were found between spending >2 h using a PC and the consumption of fruit ( $r = -0.066$ ), vegetables ( $r = -0.058$ ), sweets ( $r = 0.92$ ) and sweetened lemonades ( $r = 0.107$ ).

### Influence of sedentary behaviour, PA and eating habits on overweight and obesity

Girls who participated in the surveys in 2006 (OR=2.28;  $P < 0.001$ ; 95% CI 1.77–2.94) and 2010 (OR=1.49;  $P = 0.002$ ; 95% CI 1.15–1.92) were significantly more likely to be overweight or obese than girls who participated in the survey in

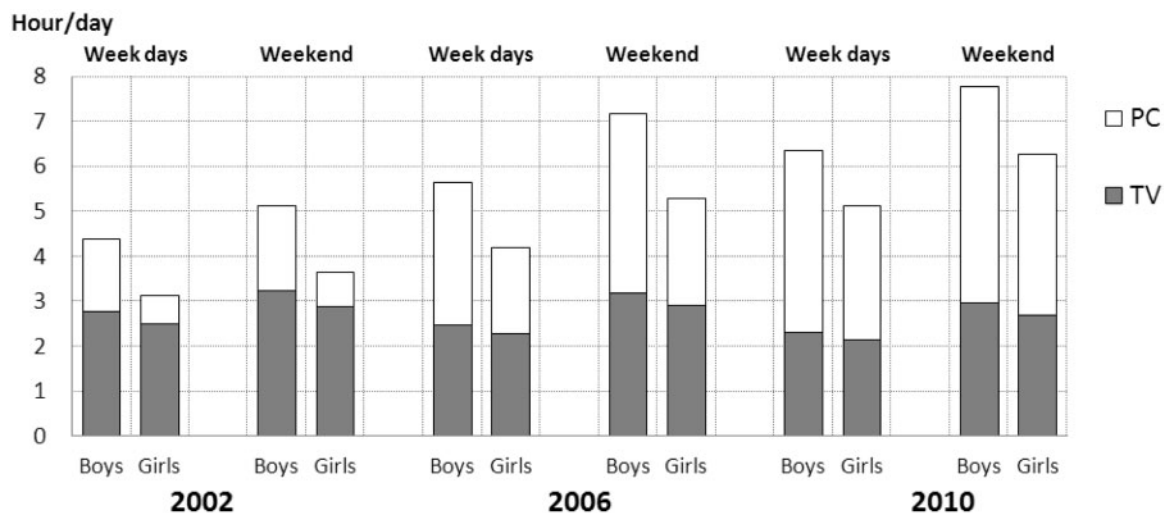


Figure 2 Sedentary behaviour—watching television (TV) and computer use (PC) in h per day

2002. As far as eating habits are concerned, girls who reported daily consumption of fruits (OR=0.82;  $P=0.03$ ; 95% CI 0.68–0.98) were significantly less likely to be overweight or obese. On the contrary, girls who reported daily consumption of sweets (OR=1.75;  $P<0.001$ ; 95% CI 1.47–2.08) or sweetened lemonades (OR=1.46;  $P=0.001$ ; 95% CI 1.17–1.83) were more likely to be overweight or obese.

A significant interaction (by year of study) in logistic regression was detected in girls only in case of daily sweets consumption, where significant changes from 2002 to 2006 (OR=1.71;  $P=0.009$ ; 95% CI 1.15–2.56) and from 2002 to 2010 (OR=1.73;  $P=0.02$ ; 95% CI 1.12–2.69) were observed for daily consumption compared with less than daily consumption of sweets. Computer use, meeting PA recommendations, television watching and daily vegetable consumption were not significant regression analysis factors in girls.

Boys who participated in the surveys in 2010 (OR=1.34;  $P=0.006$ ; 95% CI 1.09–1.65) were significantly more likely to be overweight or obese than girls who participated in the survey in 2002. Boys who spent >4h watching television a day were roughly 1.5 times more likely to be overweight or obese (OR=1.45;  $P<0.001$ ; 95% CI 1.20–1.76). As for eating habits, boys who reported daily consumption of sweets (OR=1.54;  $P<0.001$ ; 95% CI 1.34–1.77) or sweetened lemonades (OR=1.35;  $P<0.001$ ; 95% CI 1.14–1.60) were more likely to be overweight or obese than boys with less than daily consumption of sweets and sweetened lemonades.

A significant interaction (by year of study) in logistic regression was detected in boys only in case of daily sweets consumption, where significant changes from 2002 to 2006 were observed for daily consumption compared with less than daily consumption of sweets (OR=1.44;  $P=0.03$ ; 95% CI 1.03–2.03).

Computer use, meeting PA recommendations and daily vegetable and fruit consumption were not significant regression analysis factors in boys.

## Discussion

This study assessed the trends in PA and in the prevalence of overweight and obese school-aged children in the Czech Republic. The prevalence of overweight and obesity in most countries of Europe show rising trends.<sup>16</sup> The economic cost of obesity and inactivity is as high as 6% of the total health care cost in some countries.<sup>15,16</sup> Economic and political development is another factor influencing trends in overweight and obese body habitus and PA. In Russia, obesity increased by 38% during the transition from a planned to a market economy.<sup>22</sup> Knowledge concerning

trends in weight gain is important in understanding the new broad-based changes in technology.<sup>14</sup>

Our study shows an increase in the prevalence of overweight and obese body habitus in both boys and girls, except in 13-year-old girls. After 2006, there was a slight decrease in the prevalence of overweight and obese adolescents. In Danish boys, there was an increase of obesity in 1997–98, which was not present in the girls studied.<sup>23</sup> A study of the trends in overweight and obese Australian children between 1985 and 2008 showed a plateau or slight increase in the percentage of boys and girls classified as overweight or obese.<sup>24</sup> With respect to the socio-economic transition in Europe, there has been a marked increase in the prevalence of obesity among Eastern Europeans since the region began its transformation to democracy in 1989.<sup>25</sup> The economic transformations that have taken place in the Czech Republic since 1989 have led to many positive as well as negative changes in dietary behaviour, PA and lifestyle.<sup>26</sup> Although the current study shows that the generation of children monitored in 2010 are more likely to be overweight or obese than the generation in year 2002, we can see a certain plateau, which is consistent with weight stabilization observed over the recent years.<sup>27</sup> National Anthropological Surveys of children and adolescent in the Czech republic from 1951, 1981, 1991 and 2001 showed an increase in obesity rates among children in recent years after a period of relatively low prevalence.<sup>26</sup>

There are various criteria for evaluating PA. The recommended level of PA for children and youths (aged 5–17) is  $\geq 60$  min of moderate to vigorous intensity PA daily.<sup>28,29</sup> A more detailed recommendation mentions the realization of 45 min a day of moderate PA, and 15 min of vigorous PA is recommended for the prevention and treatment of obesity.<sup>30</sup> Earlier studies recommended five or more sessions of moderate to vigorous PA per week.<sup>31,32</sup> This study has shown the stagnation and decline in the proportion of children who meet the health recommendations daily for at least 1 h per day moderate to vigorous intensity PA. The proportion of Czech schoolchildren who achieved 1 h per day of moderate to vigorous intensity PA ranges from 14 to 35%. A slightly worse result is observed in German children, where 13.1% of girls and 17.4% of boys meet the daily PA guidelines.<sup>33</sup> In a study of Czech children aged 14–18 that assessed the number of steps taken within a period of time, about half to three quarters of the adolescents met the health-related criterion for the achieved number of steps, with a decrease in PA amongst adolescents.<sup>7</sup> There was an increase of leisure time activity identified between 1985 and 2004 in Australian boys but not in girls.<sup>34</sup>

This study has several limitations. The observed data were self-reported, and children's responses about their weight, height or



health-related behaviour are not objective. Nevertheless, there was a high association,  $r=0.70$ , between self-reported height and weight and the measured height and weight.<sup>35</sup> The results for sedentary behaviour could be influenced by changes in the questionnaire's formatting. In 2002, the questionnaire included one question about time spent sitting at the PC, which included playing games, mailing, chatting and searching the internet. Since 2006, time spent by PC was addressed using two questions, one including games or videogame consoles, the other regarding PC use for chatting, searching, mailing or homework. This difference in approach could exaggerate the differences between the time spent sitting by the computer between the 2002 and 2006 questionnaires.

In summary, this study shows an increase in the prevalence of overweight and obese school-aged children along with stagnation or decline in the proportion of children meeting the recommendations for PA from 2010 to 2002. As opposed to 2002, 2010 showed an increased amount of screen time, especially in computer use. Significant associations were found in Czech children between >2 h being spent on the computer or watching television and daily consumption of fruit, vegetables, sweets and sweet drinks. Significant changes in sweets consumption contribute to the prevalence of overweight and obesity. Future research should evaluate the recommendations for PA with respect to gender and age. The support of PA and the reduction of obesity could be carried out as school interventions by including more physical education lessons in school programmes. More comprehensive studies should be performed to investigate these trends and should address the prevalence of overweight and obese body habitus, sedentary behaviour and PA.

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## Key points

- The process of modernization and technological changes contribute to the increasing numbers of overweight and obese individuals.
- In children, the sedentary time increases, and the level of physical activity decreases.
- Few studies have focused on secular trends in overweight, obesity, physical activity and sedentary behaviour in Eastern or Central Europe.
- This study shows an increase in the prevalence of overweight and obese school-aged children between 2002 and 2010 along with stagnation or a negative trend in the proportion of children meeting recommendations for physical activity and an increase in sedentary time on school days and weekend days.

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## Anthropometric measures in relation to risk of heart failure hospitalization: a Swedish population-based cohort study

Yan Borné<sup>1</sup>, Bo Hedblad<sup>1</sup>, Birgitta Essén<sup>2</sup>, Gunnar Engström<sup>1</sup>

1 Department of Clinical Sciences in Malmö, Cardiovascular Epidemiology, Skåne University Hospital, Lund University, Malmö, Sweden

2 Department of Women's and Children's Health, International Maternal and Child Health (IMCH), Uppsala University, Uppsala, Sweden

**Correspondence:** Yan Borné, Department of Clinical Sciences in Malmö, Cardiovascular Epidemiology, Skåne University Hospital, Lund University, CRC, House 60, Level 13, 20502 Malmö, Sweden, Tel: +46 40391327, Fax: +46 40391322, e-mail: Yan.Borne@med.lu.se

**Background:** It is unclear which anthropometric measure is most useful for assessment of the cardiovascular risk. We investigated the association between different anthropometric measures and risk of heart failure (HF) hospitalization. **Methods:** BMI, waist–hip ratio (WHR), waist circumference (WC), body fat percentage (BF%), weight and height were measured among 26 653 subjects (aged 45–73 years) without history of myocardial infarction (MI), stroke or HF from the Malmö Diet and Cancer cohort at baseline in 1991–96. Incidence of HF hospitalizations was monitored during a mean follow-up of 15 years. **Results:** Seven hundred and twenty-seven subjects were hospitalized with HF as primary diagnosis, of whom 157 had an MI before or concurrent with the HF. After adjustment for potential confounding factors, the hazard ratios of HF hospitalization (fourth vs. first sex-specific quartile) were 1.80 (95% CI: 1.45–2.24) for BMI, 1.87 (1.50–2.34) for WC, 1.77 (1.43–2.19) for WHR, 1.35 (1.09–1.68) for BF%, 1.93 (1.57–2.39) for weight and 1.18 (0.96–1.44) for height. Significant interactions between BMI and WC and WHR, respectively, were observed, and the joint exposure of high BMI and high WC or high WHR further increased the risk. The results were similar in secondary analyses, i.e. excluding incident HF with previous MI during the follow-up. **Conclusion:** Our results support the view that raised BMI, WC, WHR or BF% increases the risk of HF hospitalization. The joint exposure of high BMI and high WHR or high WC further increased the risk in an additive way.

## Introduction

Obesity is a major risk factor for several cardiovascular diseases (CVD),<sup>1–5</sup> including an increased risk of heart failure (HF).<sup>6–8</sup> The underlying causal links between obesity and cardiac dysfunction are complex. Obesity is associated with a higher risk of hypertension,<sup>9</sup> insulin resistance and diabetes mellitus,<sup>4</sup> inflammation,<sup>10–12</sup> socio-economic status and lifestyle,<sup>13–15</sup> all of which could increase the cardiovascular risk.

It is still controversial which anthropometric measure is most useful for assessment of the cardiovascular risk. BMI, being the marker for general fat, is the most practical and commonly used. However, the INTERHEART study, a multi-national case–control study of myocardial infarction (MI), reported substantially stronger

relationships for the waist–hip ratio (WHR) than for BMI.<sup>3</sup> Because visceral fat is more metabolically active than other fat tissues, it has been proposed that WHR or waist circumference (WC) is preferable.<sup>2,16</sup> However, few have studied the relationships with incidence of HF, and the results are not consistent. Some studies have shown that BMI, WC and WHR had similar prediction for incident HF.<sup>17</sup> Others found that abdominal body fat distribution may be a stronger risk factor for HF than overall obesity.<sup>18,19</sup>

The aim of the study was to explore the relationship between risk of HF hospitalization and different anthropometric measures, i.e. BMI, WC, WHR, body fat percentage (BF%), weight and height, in a population-based cohort study. We also explored whether there is any combined effect of the different anthropometric measures on the risk of HF.