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Differences in prevalence of overweight and stunting in 11-year olds across Europe: The Pro Children Study

Agneta Yngve[1], Ilse De Bourdeaudhuij[2], Alexandra Wolf[3], Andrej Grjibovski[1,4], Johannes Brug[5], Pernille Due[6], Bettina Ehrenblad[1], Ibrahim Elmadfa[7], Bela Franchini[8], Knut-Inge Klepp[9], Eric Poortvliet[1], Mette Rasmussen[6], Inga Thorsdottir[10], Carmen Perez Rodrigo[11]

Objectives: To assess country differences in prevalence of overweight, obesity, underweight and stunting in the Pro Children Survey. **Methods:** A cross-sectional study conducted in a random sample of schools in nine European countries in 2003. The subjects were 8317 11-year-old children from Austria, Belgium, Denmark, Iceland, The Netherlands, Norway, Portugal, Spain and Sweden. Parents reported height and weight of the children, and BMI values were analysed using the US Centers of Disease Control and Prevention and the International Obesity Task Force reference populations. Continuous variables were compared with one-way analysis of variance (ANOVA) with Games-Howell post hoc tests. Categorical variables were analysed using chi-square tests. **Results:** The prevalence of overweight + obesity varied between the countries from 8.6% to 30.6% and 5.9% to 26.5%, respectively, depending on the reference population, with the lowest prevalence in Dutch girls, the highest in Portuguese boys. Obesity prevalence varied from 1.1% (Dutch and Danish girls) to 10.7% (Portuguese boys) and from 0.3% (Dutch girls) to 6.2% (Portuguese boys), respectively. Portugal and Spain had the highest prevalence of overweight and obesity for both genders. The ranking of the countries according to overweight and obesity prevalence was roughly the same, independent of reference population. The prevalence of underweight varied from 2.3% (Swedish boys) to 12.3% (Belgian boys), using the American reference population. The proportion of stunted children was highest in Portugal, Spain and Belgium. **Conclusions:** The highest levels of overweight, obesity and stunting in the pro children material are found in Portugal and Spain.

Keywords: childhood, Europe, growth, short stature

Introduction

Childhood overweight has been described as a crisis in public health of epidemic proportions.[1,2] Childhood overweight has both short-term and long-term adverse psychosocial and physical health consequences.[3–6] Childhood obesity is an important predictor of adult obesity and metabolic and cardiovascular risk profiles tend to track from childhood into adult life resulting in elevated risk of ill health and premature mortality.[1–8] Moreover, adults who were obese adolescents are more likely to have lower income and experience higher degree of social exclusion.[9–11]

Thus, the potential public health and economic impact of childhood obesity is expected to be enormous warranting accurate estimates of its prevalence and close monitoring of the existing trends in order to plan appropriate preventive strategies. Considerable variations in the prevalence of obesity both between and within European countries have been observed. However, not many of the existing surveys[12,13] are large and/or use random sampling frames[14] or consistent cut-off levels. More and more studies use definitions of overweight and obesity proposed by the International Obesity Task Force (IOTF)[15] or the US Centers for Disease Control (CDC)[16] to ensure comparability of their findings. While the IOTF cut-offs are more internationally based and are more frequently used in European settings, there is no IOTF cut-off for underweight and no corresponding *Z*-scores are available precluding analyses of continuous data.

Few studies were conducted simultaneously in several countries using the same data collection protocols and international cut-offs for overweight and obesity in childhood.[17]

The Pro Children Cross-Sectional Survey is the first large international study designed to estimate the fruit and vegetable consumption in European school children and their parents as well as its socioeconomic, cultural and cognitive determinants and parental reports of height and weight. The aim of this article is to describe anthropometric characteristics

1 Unit for Preventive Nutrition, Department of Biosciences at Novum, Karolinska Institutet, Stockholm, Sweden
2 Department of Movement and Sport Sciences, Ghent University, Ghent, Belgium
3 Austrian Agency for Health and Food Safety, Vienna, Austria
4 Division of Epidemiology, Norwegian Institute of Public Health, Oslo, Norway
5 VU University Medical Center, Amsterdam, The Netherlands
6 Department of Social Medicine, University of Copenhagen, Denmark
7 Institute for Nutritional Sciences, University of Vienna, Austria
8 Faculty of Nutrition and Food Sciences, University of Porto, Portugal
9 Department of Nutrition, Faculty of Medicine, University of Oslo, Norway
10 Unit for Nutrition Research, Landspitali University Hospital, Reykjavik, Iceland
11 Community Nutrition Unit, Bilbao, Spain
Correspondence: Agneta Yngve, Unit for Preventive Nutrition, Department of Biosciences at Novum, SE 141 57 Huddinge, Sweden, tel: +46 8 608 9209, fax: +46 8 608 3350, e-mail: agneta.yngve@prevnut.ki.se

and estimate the prevalence of underweight, overweight and obesity in 11-year-old children from nine European countries using the database of the Pro Children Study.

Methods

Data collection

The Pro Children Cross-Sectional Survey was conducted in Austria, Belgium, Denmark, Iceland, The Netherlands, Norway, Portugal, Spain and Sweden. The sample population consisted of all children born in these countries in 1992. Schools were the sampling units and from each participating country, samples with at least 20 schools with a minimum of 1300 eligible children (born in 1992) were selected randomly from a list of schools. If a school refused to participate for some reason, the next school on the list was asked to take part. All classes in the eligible age group at each school were asked to participate. If some children in the class were born in 1991 or 1993, they were kept in the sample. Nationally representative samples of schools were drawn from each country with the exception of Austria and Belgium, where the samples were drawn from regions of Eastern Austria and Flanders, respectively, using the same procedure as in other countries. Data collection was performed during October–December 2003. The study was approved by the research ethics committees within participating countries where this is requested. Parental written consent was obtained.

The class teachers from the sampled schools were asked to collect the data according to standardized instructions.[18,19] The children were asked to bring a questionnaire home to be completed by one of their parents/guardian and then to bring it back to the teacher. The parent questionnaire included questions about fruit and vegetable intake of the parent as well as availability of fruit and vegetables at home. The questionnaires also included questions regarding educational level of the parents and occupation. Data on height and weight of the participating children were also included in the questionnaire to be completed by the parents. Data on sexual maturation was not collected. The data were entered at the national centres, according to a standardized protocol, prior to submission to the joint Pro Children Data Management Centre at University of Vienna, where data processing including calculation of body mass index (BMI) and quality control took place. Further details on the sampling, data collection and validity of the fruit and vegetable intake part of the questionnaires is described elsewhere and the pro children questionnaires and protocols can be accessed at www.prochildren.org

Data presentation

Continuous data on age- and gender-specific characteristics of attained growth are presented as *Z*-scores. Mean *Z*-scores were used for all analyses. Using mean *Z*-scores is advantageous in comparing nutritional status on a population level compared to using subsets of individuals below set cut-offs due to higher statistical power for a given sample. *Z*-scores are normally distributed and allow the use of parametric statistics.

Children were classified as underweight if their BMI-for-age was below the 5th percentile of the CDC-2000 reference population. Overweight was defined as 85th to <95th percentile and ≥95th percentile was used as a cut-off for obesity. Stunting was defined as height-for-age below the 5th percentile of the reference population. In addition, the IOTF cut-off values for overweight and obesity were applied as described by Cole *et al.*[15]

Table 1 Valid parental responses for BMI of child, by country and total response

		Cases		
		Valid		Total
Gender	**Country**	***N***	**%**	***N***
Girls	Austria	634	84.3	752
	Belgium	469	83.3	563
	Denmark	528	76.1	694
	Iceland	373	78.4	476
	The Netherlands	365	76.8	475
	Norway	340	71.0	479
	Portugal	631	75.8	833
	Spain	366	75.5	485
	Sweden	471	81.8	576
	Total	4177	78.3	5333
Boys	Austria	547	87.5	625
	Belgium	496	78.1	635
	Denmark	538	79.2	679
	Iceland	341	72.2	472
	The Netherlands	319	77.8	410
	Norway	330	66.8	494
	Portugal	545	76.8	710
	Spain	379	72.9	520
	Sweden	417	80.0	521
	Total	3912	77.2	5066

Data analysis

Differences in mean values of the studied characteristics were tested using one-way analysis of variance (ANOVA) with Games-Howell post hoc tests assuming non-equal variances between the groups. Welch tests for ANOVA were used since we assumed non-equal variances. Chi-squared tests of homogeneity were used to compare the proportions of stunted, underweight, overweight and obese children between the countries. Height-for-age, weight-for-age and BMI-for-age *Z*-scores were calculated in the NutStat module of the Epi-Enfo software using the CDC-2000 reference population.[16] The significance level was set to <0.05 and the confidence interval at 95%.

Results

Altogether, the questionnaires from both children and their parents were received from 10 519 subjects. Of these, parents of 8089 (77.8%) children provided information on their child's height and weight with considerable variations between countries ($\chi^2(8) = 93.7$, $P < 0.001$). Table 1 provides gender-separated information regarding response rates of height and weight data from the parental questionnaires. The highest proportions of missing height and weight data were observed in Norway (31.2%), Spain (25.9%) and Iceland (24.7%) and the lowest in Austria (14.2%). No gender difference between children with available and missing data on height and weight was found.

Table 2 presents age, height, weight and BMI of the study participants by gender and country. Mean values for age and all anthropometric characteristics significantly differed between the countries ($P < 0.001$ for all global tests). Austrian and Dutch children were younger and older, respectively, than the rest of the sample in both genders. Both boys and girls from the Netherlands were significantly taller than their counterparts from other countries. Belgian boys were lighter than boys in all other participating countries. Portuguese and Spanish children had considerably higher BMI compared with children from other countries in both genders.

Table 2 General characteristics of the sample by country. Age, height, weight and BMI are presented as means (M) and standard deviations (SD)

Gender	Country	*N*	Age		Height (cm)		Weight (kg)		BMI (kg/m^{-2})	
			M	SD	M	SD	M	SD	M	SD
Girls	Austria	656	10.9	0.6	147.5	8.0	39.2	9.0	17.9	3.0
	Belgium	479	11.5	0.5	149.6	8.2	39.6	8.9	17.6	3.2
	Denmark	548	11.3	0.4	150.2	7.3	39.6	8.0	17.4	2.6
	Iceland	377	11.3	0.3	148.5	7.4	39.8	8.1	18.0	2.7
	The Netherlands	372	11.7	0.4	153.5	7.5	41.7	7.8	17.6	2.6
	Norway	353	11.3	0.3	149.1	7.7	39.7	8.0	17.7	2.6
	Portugal	645	11.5	0.4	148.1	8.1	42.1	8.7	19.1	3.2
	Spain	372	11.4	0.4	148.8	7.9	42.3	8.1	19.1	3.1
	Sweden	484	11.4	0.5	150.2	8.0	40.4	8.5	17.7	2.7
	Total girls	4286	11.3	0.6	149.3	8.0	40.4	8.5	18.0	3.0
Boys	Austria	566	11.0	0.6	147.4	8.1	40.0	9.2	18.3	3.0
	Belgium	508	11.5	0.4	148.1	7.5	38.4	7.8	17.4	2.7
	Denmark	561	11.4	0.4	150.4	7.5	40.5	8.0	17.8	2.6
	Iceland	352	11.3	0.3	149.7	7.1	41.4	8.1	18.4	2.8
	The Netherlands	322	11.8	0.5	154.1	7.5	42.7	8.2	17.9	2.7
	Norway	340	11.3	0.3	148.9	7.3	40.9	8.2	18.4	2.8
	Portugal	552	11.5	0.4	147.5	8.7	42.4	9.8	19.4	3.8
	Spain	389	11.4	0.4	148.2	8.2	41.8	8.8	18.9	3.0
	Sweden	441	11.4	0.5	149.8	7.3	41.1	7.7	18.3	2.8
	Total boys	4031	11.3	0.6	149.1	8.0	40.9	8.6	18.3	3.0

Height-for-age

As expressed by height-for-age *Z*-scores, Portuguese children were significantly shorter (all at $P < 0.01$) than children in other countries except Spain ($P = 0.319$ for girls and $P = 0.558$ for boys) and Belgium ($P = 0.073$ for girls and $P = 0.755$ for boys). In spite of the fact that they were the shortest in the study sample, they were taller than the CDC-2000 reference population ($P < 0.001$ in boys; $P = 0.004$ in girls). Dutch boys were significantly taller than all other boys in the sample ($P < 0.001$) except boys from Iceland. The prevalence of stunting (<5th percentile of the CDC 2000 reference population) was the highest in Portugal in both genders followed by Spain and Belgium.

Weight-for-age

Spanish girls had the highest and significantly different weight-for-age *Z*-scores compared to all other countries (P for all comparisons <0.05) except Portugal ($P = 0.932$) and Austria ($P = 0.242$). In boys, weight-for-age *Z*-scores were significantly lower in Belgium than in all other countries (P for all comparisons <0.001) where they were relatively similar. Compared to the reference population, weight-for-age *Z*-scores were higher in Spanish ($P < 0.001$), Portuguese ($P < 0.001$) and Austrian ($P = 0.006$) girls and lower in Belgian girls ($P = 0.002$). In boys, weight-for-age *Z*-scores were significantly higher in all countries except Belgium, where they were lower compared to the reference population ($P = 0.007$). The prevalence of underweight (< 5th percentile of the CDC 2000 population) was the highest in Belgium in both genders, in girls lowest in Spain and Portugal and in boys lowest in Sweden.

BMI-for-age

Mean BMI-for-age *Z*-scores in girls were significantly above the reference population in Spain ($P < 0.001$) and Portugal ($P < 0.001$) and lower in all other countries except Austria ($P = 0.086$) and Iceland ($P = 0.127$). Portuguese and Spanish girls had similar BMI-for-age *Z*-scores, which were significantly higher compared to the rest of the sample. Portuguese and Spanish boys also had higher BMI-for-age *Z*-scores than boys in other countries except Iceland. Compared to the reference population, BMI-for-age *Z*-scores in boys were lower in Belgium ($P < 0.001$), Denmark ($P = 0.031$) and the Netherlands ($P = 0.026$) and higher in all other countries.

Table 3 Mean *Z*-scores with standard deviations for height, weight and BMI by gender and country

Gender	Country	Height-for-age *Z*-score		Weight-for-age *Z*-score		BMI-for-age *Z*-score	
		M	SD	M	SD	M	SD
Girls	Austria	0.53	0.99	0.11	1.01	−0.07	1.09
	Belgium	0.32	1.14	−0.15	1.07	−0.35	1.17
	Denmark	0.53	1.00	−0.05	0.96	−0.30	1.02
	Iceland	0.37	1.01	0.03	0.93	−0.08	0.96
	The Netherlands	0.63	1.01	0.04	0.84	−0.30	1.00
	Norway	0.40	1.01	−0.02	0.93	−0.17	0.95
	Portugal	0.12	1.09	0.18	0.94	0.26	0.95
	Spain	0.29	1.07	0.26	0.88	0.26	0.93
	Sweden	0.46	1.05	0.00	0.98	−0.20	1.00
	Total girls	0.40	1.05	0.05	0.96	−0.09	1.04
Boys	Austria	0.52	1.05	0.32	0.95	0.15	1.13
	Belgium	0.28	1.02	−0.11	0.94	−0.31	1.14
	Denmark	0.60	1.04	0.17	0.89	−0.10	1.02
	Iceland	0.63	0.97	0.37	0.86	0.17	1.02
	The Netherlands	0.87	1.00	0.27	0.85	−0.12	1.00
	Norway	0.50	1.02	0.28	0.91	0.14	1.01
	Portugal	0.18	1.19	0.33	1.02	0.39	1.14
	Spain	0.33	1.15	0.33	0.95	0.33	0.98
	Sweden	0.58	0.96	0.31	0.83	0.11	0.96
	Total boys	0.48	1.07	0.24	0.93	0.09	1.08

In the total sample, both mean height-for-age and weight-for-age *Z*-scores were significantly above zero in both genders (both at $P \leq 0.001$). However, the mean BMI-for-age *Z*-score was significantly below zero in girls ($P < 0.001$), but above zero in boys ($P < 0.001$).

Mean values for height-for-age, weight-for-age and BMI-for-age *Z*-scores are summarized in table 3.

Prevalence of overweight + obesity

The prevalence of overweight + obesity (table 4) varied between the countries by both CDC-2000 and IOTF criteria in both genders ($P < 0.001$ for all tests). Similar results were obtained for the differences in obesity ($P < 0.001$ for all comparisons).

Table 4 Prevalence of stunting, underweight, overweight and obese children by CDC-2000 and IOTF criteria with 95% confidence intervals (CI)

Gender	Country	Stunting (CDC)		Underweight (CDC)		Overweight + obese (CDC)		Obese (CDC)		Overweight + obese (IOTF)		Obese (IOTF)	
		%	CI	%	CI	%	CI	%	CI	%	CI	%	CI
Girls	Austria	1.5	0.7–2.8	8.2	6.2–10.6	15.1	12.4–18.1	4.0	2.6–5.8	13.7	11.2–16.6	2.4	1.4–3.9
	Belgium	3.3	1.9–5.4	12.3	9.5–15.6	11.3	8.6–14.5	3.1	1.8–5.1	8.4	6.0–11.2	2.1	1.0–3.8
	Denmark	1.3	0.5–2.6	8.2	7.5–12.7	9.9	7.5–12.7	1.1	0.4–2.4	7.3	5.3–9.8	0.4	0.04–1.3
	Iceland	2.7	1.3–4.8	5.3	3.3–8.1	13.8	10.5–17.7	2.4	1.1–4.5	10.8	7.9–14.5	1.3	0.4–3.1
	The Netherlands	1.1	0.3–2.7	10.8	7.8–14.4	8.6	6.0–11.9	1.1	0.3–2.7	5.9	3.7–8.8	0.3	0.01–1.5
	Norway	2.3	1.0–4.4	6.1	3.7–9.0	11.8	8.5–15.4	1.4	0.5–3.3	11.3	8.0–14.8	0.9	0.2–2.5
	Portugal	5.6	3.9–7.6	3.6	2.3–5.3	21.6	18.4–24.9	5.3	3.7–7.3	17.7	14.8–20.8	2.2	1.2–3.6
	Spain	5.1	3.1–7.8	3.0	1.5–5.2	19.7	15.7–24.0	4.9	2.9–7.5	15.6	12.1–19.7	1.3	0.4–3.1
	Sweden	2.1	1.0–3.8	7.6	5.4–10.4	11.4	8.7–14.5	1.7	0.7–3.3	8.5	6.2–11.3	0.6	0.1–1.8
	Total girls	2.8	2.3–3.3	7.2	6.5–8.1	14.0	13.0–15.1	2.9	2.4–3.5	11.3	10.4–12.3	1.4	1.1–1.8
Boys	Austria	1.9	1.0–3.5	4.6	3.0–6.7	23.5	20.1–27.2	6.4	4.5–8.7	16.9	14.0–20.3	2.1	1.1–3.7
	Belgium	3.5	2.1–5.5	11.0	8.4–14.1	11.0	8.4–14.1	2.2	1.1–3.8	9.5	7.1–12.3	0.6	0.1–1.7
	Denmark	1.8	0.9–3.3	6.6	4.7–9.0	13.7	11.0–16.9	3.0	1.8–4.8	12.7	10.0–15.7	1.6	0.7–3.0
	Iceland	1.1	0.2–2.5	4.8	2.8–7.6	23.3	19.0–28.1	5.4	3.3–8.3	17.9	14.0–22.3	1.7	0.6–3.7
	The Netherlands	0.9	0.2–2.7	6.2	3.8–9.4	13.7	10.1–17.9	3.4	1.7–6.0	10.8	7.7–14.8	1.2	0.3–3.2
	Norway	1.9	0.7–3.8	4.7	2.5–7.2	18.1	13.2–21.5	6.2	3.6–8.9	14.7	10.3–18.0	1.6	0.5–3.4
	Portugal	6.2	4.3–8.5	4.0	2.5–6.0	30.6	26.8–34.7	10.7	8.2–13.6	26.5	22.8–30.3	6.2	4.3–8.5
	Spain	3.4	1.8–5.7	3.9	2.2–6.3	25.5	21.2–30.1	7.7	5.3–10.8	20.4	16.4–24.7	3.4	1.8–5.7
	Sweden	1.1	0.4–2.6	2.3	1.1–4.1	18.4	14.9–22.3	4.8	3.0–7.1	15.7	12.4–19.4	2.5	1.3–4.4
	Total boys	1.4	1.1–1.8	5.4	4.7–6.2	19.9	18.6–21.1	5.6	4.9–6.3	16.2	15.1–17.4	2.4	2.0–2.9

The prevalence of overweight + obesity and obesity estimated by CDC-2000 criteria showed consistently higher proportions of overweight and obese children in all countries (table 4). By CDC-2000 criteria, the prevalence of overweight + obesity varied from 11.0% (Belgium) to 30.6% (Portugal) in boys and from 8.6% (The Netherlands) to 21.6% (Portugal) in girls. While the IOTF cut-offs for overweight showed similar between-country patterns, the countries could be ranked differently by the prevalence of obesity by these criteria though the confidence intervals were wide and overlapped.

Discussion

The anthropometric characteristics of 11-year-old children across the European countries related to the CDC 2000 reference population vary greatly, with the highest values for overweight and obesity in Portugal and Spain.

The classification of overweight in our study according to the international cut-offs suggested by Cole *et al*. also showed large international variation. Results were consistent to some extent (ranked the countries similarly) with findings from the Health Behaviour in School-Aged Children (HBSC) study 2001–02,[13] even though the pro children means were slightly higher.

Two previous overviews have been published regarding the prevalence of overweight and obesity in Europe, using the above mentioned cut-off levels.[15] Lobstein and Frelut[12] published data from different surveys, collected through the IOTF and with large differences in age of the participants and method of collection. They only included studies with anthropometric measures of height and weight. Janssen *et al*. presented data from the HBSC study from 34 countries, collected as self-reported data in the school year 2001–02. The collection took place using the HBSC classroom questionnaire, which is collected in 11-, 13- and 15-year-old children and provides mean prevalence values of overweight and obesity for all age groups.

It is important to highlight the differences in height-for-age that were detected in this study. The Dutch children were consistently and significantly taller than children from all other countries in both genders. Girls from Portugal and Austria were significantly shorter than girls from Denmark, Sweden and the Netherlands. Boys from Portugal and Austria were significantly shorter than boys from Denmark, Sweden, Iceland and the Netherlands.

The parental reporting of height and weight within the Pro Children Study, gives the same ranking of countries according to overweight prevalence as the HBSC Study, where self-reporting is used in 11-year olds. Self-report by children, completed at home, using a methodology very close to the Pro Children Survey, has been validated in a Norwegian study.[20] In that study, the correspondence is quite good between reported and measured height and weight in children of comparable age with our study, with BMI Pearson correlation coefficients of 0.93 and 0.92 in girls and boys, respectively. However, in a recent study[21] from the Netherlands, quite large differences in overweight and obesity prevalence were found between 12-and 13-year-old children's self-report and measured BMIs, showing a Pearson correlation coefficient of 0.75. The Dutch study showed larger discrepancies in overweight adolescents, indicating underreporting of weight as large as 11.4 kg. It is important to note that we were using parental reports of height and weight rather than children's self-report as in the Dutch study.[23]

The high rates in some countries (29.0% and 33.2% in Norwegian girls and boys, 27.8% of Icelandic boys and 27.1% of Spanish boys) of missing height and weight data do justify caution when interpreting the data—when comparing prevalence of overweight across countries, since parents of overweight children may be more prone to non-response.

Due to the cross-sectional design of the survey, we had no information on the history of weight development in those children who were identified here as overweight/obese. We had no data on fat mass, only BMI, which may lead to some misclassification in relation to overweight as cardiovascular risk factor.

Our data from the Pro Children Cross-Sectional Survey has been collected using a standardized questionnaire in all nine countries, which resulted in a large sample size. The current study has the main advantage of having been collected during a relatively short time span, during 3 months in the autumn of 2003. Our data on overweight and obesity rates do fill a void in an area where not much information is gathered, and can therefore be considered as important from a policy point of view. The results provide information on overweight

prevalence as such and show the importance of inclusion of height data in interpretation of country differences. Prospective studies are needed for future research regarding overweight development.

Conclusions

The pro children data on BMI show a high prevalence of overweight as well as stunting in Portugal and Spain. The different cut-offs according to IOTF and CDC provided did not lead to significantly different levels of overweight and obesity.

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Conflicts of interest: None declared.

Key points

- This article adds to the current knowledge base regarding overweight and obesity prevalence in European 11-year olds.
- The results build on nationally representative samples in 7 of the 9 countries, in the other two countries on regionally representative samples.
- This article provides information also regarding underweight and stunting in the nine European countries.
- Two different cut-offs are used for overweight and obesity (CDC and IOTF).

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