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Prevalence and trends of thinness, overweight and obesity among children and adolescents aged 3–18 years across Europe: a protocol for a systematic review and meta-analysis

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ABSTRACT

Introduction Increasing prevalence of both thinness and excess weight during childhood and adolescence is a significant public health issue because of short-term health consequences and long-term tracking of weight status. Monitoring weight status in Europe may serve to identify countries and regions where rates of these disorders are either slowing down or increasing to evaluate recent policies aimed at appropriate body weight, and to direct future interventions. This study protocol provides a standardised and transparent methodology to improve estimating trends of thinness, overweight and obesity in children aged 3–18 years and adolescents across the European region between 2000 and 2017.

Methods and analysis This protocol is guided by the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) and the Cochrane Collaboration Handbook. To identify relevant studies, a search will be conducted in MEDLINE, EMBASE, Cochrane Library, CINAHL and Web of Science databases. From the selected studies, relevant references will be screened as supplemental sources. Finally, open search in websites from health institutions will be conducted to identify weight status data not published in scientific journals. Cross-sectional, follow-up studies and panel surveys reporting weight status (objectively measured height and weight) according to the International Obesity Task Force criteria, and written in English or Spanish will be included. Subgroup analyses will be carried out by gender, age, study year and country or European region.

Discussion This study will provide a comprehensive description of weight status of children and adolescents across Europe from 2000 to 2017. The results will be disseminated in a peer-reviewed journal. This study will use data exclusively from published research or institutional literature, so institutional ethical approval is not required.

PROSPERO registration number CRD42017056917.

Strengths and limitations of this study

► This systematic review protocol presents a comprehensive and standardised methodology to identify relevant studies and retrieve information for monitoring trends in thinness, overweight and obesity among children and adolescents across European countries.

► Study selection, data extraction and risk of bias assessment will be carried out independently by two researchers.

► The exclusive use of the International Obesity Task Force criteria will limit comparability with studies using criteria such as those from the Centers for Disease Control or WHO.

► Differences in sample characteristics, geographical location and quality of the included data may increase heterogeneity between studies, which might reduce the quality of evidence on time trends in weight status.

INTRODUCTION

Over the past two decades, the steady increase in overweight and obesity among children and adolescents has become a major public health problem, which has now reached epidemic dimensions in most low/middle-income countries.[1–3] According to estimates from the WHO Childhood Obesity Surveillance Initiative (COSI), around 33% European children aged 6 to 9 years were overweight or obese in 2010.[4] This is a significant increase compared with 2008, when estimates were 25%.[5] Paradoxically, while some projections anticipated that prevalence rates would continue to increase significantly,[6] previous reviews have shown a plateau, or even a decrease, in prevalence rates of overweight and obesity among children and adolescents in some countries.[7 8] Notwithstanding, excess weight in early life will be a persistent worldwide public health problem due to its elevated frequency, and its

association with physical and mental health disorders in childhood[9 10] and adult life.[11–13]

There is also evidence of a growing prevalence of underweight in school-age children in some wealthy countries.[14–16] Although overweight and thinness in childhood frequently coexist within a single family, the former has been investigated deeply, while the latter has received less attention. This coexistence of weight status disorders, sometimes referred as 'dual burden households', occurs in all countries and is of great relevance because population strategies mainly focus on reducing obesity and may have a negative impact on children with normal or below normal weight.[17 18]

Several analyses of excess weight trends among European children and adolescents over the last few decades have rendered somewhat discrepant results.[1 19] Also, some studies are relatively outdated,[20] were based on self-reported weight and height data,[20–22] and included only a few European countries[19] or may have limited uncertain population representativeness.[23] Thus, monitoring both underweight and excess weight trends across European countries using data objectively measured and obtained with comparable methods should be considered a public health priority.

The COSI project[4 5] is a valuable effort to obtain population-based data on the prevalence of overweight and obesity among children aged 6 to 9 years from 12 European countries using harmonised surveillance methods. However, we are not aware of any previous study that has summarised the prevalence and trends of both thinness and overweight/obesity in children and adolescents in a wide range of ages from most European countries. Therefore, this novel methodological study protocol was aimed at presenting a clear, standardised and transparent procedure to systematically review, assess and summarise the existing objectively measured information on the latest estimates of European children and adolescent's weight status categories prevalence and trends from 2000 to 2017.

OBJECTIVES

The purpose of this study protocol is to report a standardised and transparent methodology for conducting a systematic review and meta-analysis aimed to (1) assess the prevalence and trends of thinness, overweight and obesity among children aged 3–18 years and adolescents across Europe from 2000 to 2017; and (2) determine if the prevalence and trends of anthropometrics vary according to gender, age, study year and country or European region.

METHODS AND ANALYSIS

This systematic review and meta-analyses protocol is based on the Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P)[24] and the Cochrane Collaboration Handbook.[25] The protocol

for this review was registered and published on the Prospero database (Registration number: CRD42017056917).

Inclusion/exclusion criteria for study selection

Studies providing prevalence estimates of thinness (equivalent to BMI<18.5 kg/m^2 at 18 years, including thinness grades 1, 2 and 3); overweight (BMI≥25 kg/m^2) and obesity (BMI≥30 kg/m^2) that meet all of the following criteria will be included: (1) cross-sectional or follow-up studies and panel surveys in which weight and height were objectively measured by trained personnel; (2) studies reporting population-based weight status prevalence estimates according to body mass index (BMI) cut-offs proposed by the International Obesity Task Force criteria (IOTF)[26–28]; (3) studies including population in the age range of 3–18 years; and (4) studies written in English or Spanish.

Studies will be excluded from the analyses when they (1) provide self-reported data only; (2) include a sample size less than 100; (3) do not report the sampling method or the sample composition; (4) the target population was a specific population subgroup, such as aboriginal groups, immigrants or those with a narrow socioeconomic status; (5) are not population-based (eg, athletes or children with specific weight-related morbidities); (6) the prevalence of overweight and obesity is not reported separately; and (7) do not use IOTF criteria to determine weight status categories.

Search strategy

The literature search will be conducted in MEDLINE (via PubMed), EMBASE, Cochrane Library, CINAHL and Web of Science databases from their inception. Study records will be managed using the Mendeley reference manager.

The search terms will include the following terms combined using Boolean operators: (1) population (children, childhood, schooler, schoolchildren, preadolescent, adolescent, school aged, school-aged); (2) outcome (thinness, underweight, obesity, overweight, body composition, body constitution, weight status, anthropometry, (3) study design (prevalence, trend, epidemiology, observational, cross-sectional, longitudinal); and (4) location (Russia, Germany, Turkey, France, UK, Italy, Spain, Ukraine, Poland, Romania, Kazakhstan, Netherlands, Belgium, Greece, Czech Republic, Portugal, Sweden, Hungary, Azerbaijan, Belarus, Austria, Switzerland, Bulgaria, Serbia, Denmark, Finland, Slovakia, Norway, Ireland, Croatia, Bosnia and Herzegovina, Georgia, Moldova, Armenia, Lithuania, Albania, Macedonia, Slovenia, Latvia, Kosovo, Estonia, Cyprus, Montenegro, Luxembourg, Transnistria, Malta, Iceland, Andorra, Liechtenstein, Monaco, San Marino, Vatican city, Europe) (table 1).

Previous reviews and meta-analyses will be scanned for additional references. Also, relevant references included in the selected studies will be screened as supplemental sources. Finally, an open search in national and international institutional public health and health ministry

Table 1 Search strategy for Medline

	Search terms
1. Population	(Children OR Childhood OR Schooler OR Preadolescent OR Adolescent OR 'School aged' OR 'School-aged')
2. Outcome	(Thinness OR Underweight OR Obesity OR Overweight OR 'Body composition' OR 'Body constitution' OR 'Weight status' OR anthropometr*)
3. Study design	(Prevalence OR Trend OR Epidemiolog*)
4. Types of studies	(Observant* OR 'cross-sectional' OR longitudinal NOT (survey* OR review))
5. Location	(Russia OR Germany OR Turkey OR France OR 'United Kingdom' OR Italy OR Spain OR Ukraine OR Poland OR Romania OR Kazakhstan OR Netherlands OR Belgium OR Greece OR Czech Republic OR Portugal OR Sweden OR Hungary OR Azerbaijan OR Belarus OR Austria OR Switzerland OR Bulgaria OR Serbia OR Denmark OR Finland OR Slovakia OR Norway OR Ireland OR Croatia OR Bosnia and Herzegovina OR Georgia OR Moldova OR Armenia OR Lithuania OR Albania OR Macedonia OR Slovenia OR Latvia OR Kosovo OR Estonia OR Cyprus OR Montenegro OR Luxembourg OR Transnistria OR Malta OR Iceland OR Andorra OR Liechtenstein OR Monaco OR 'San Marino' OR 'Vatican city' OR Europe* [title])
	1 and 2 and 3 and 4 and 5

Truncation symbol: *=all possible word endings included.
Limits, publication languages: English.

websites will be conducted to identify weight status estimates not reported in scientific journals.

Selection of studies and data extraction

To identify eligible studies for this systematic review, two reviewers will independently screen titles and abstracts. After excluding those clearly not meeting the selection criteria, the full text of the identified studies will be retrieved and examined. Finally, two reviewers will check the included and excluded studies, and verify the reasons why they were included or excluded. Disagreements will be resolved by consensus; when disagreements persist after discussion, a third reviewer will be consulted. The process of identifying, screening and including or excluding studies will be shown using the PRISMA[24] flow chart (figure 1).

Two authors will extract data on first author's name, publication year, study design, period of study, country,
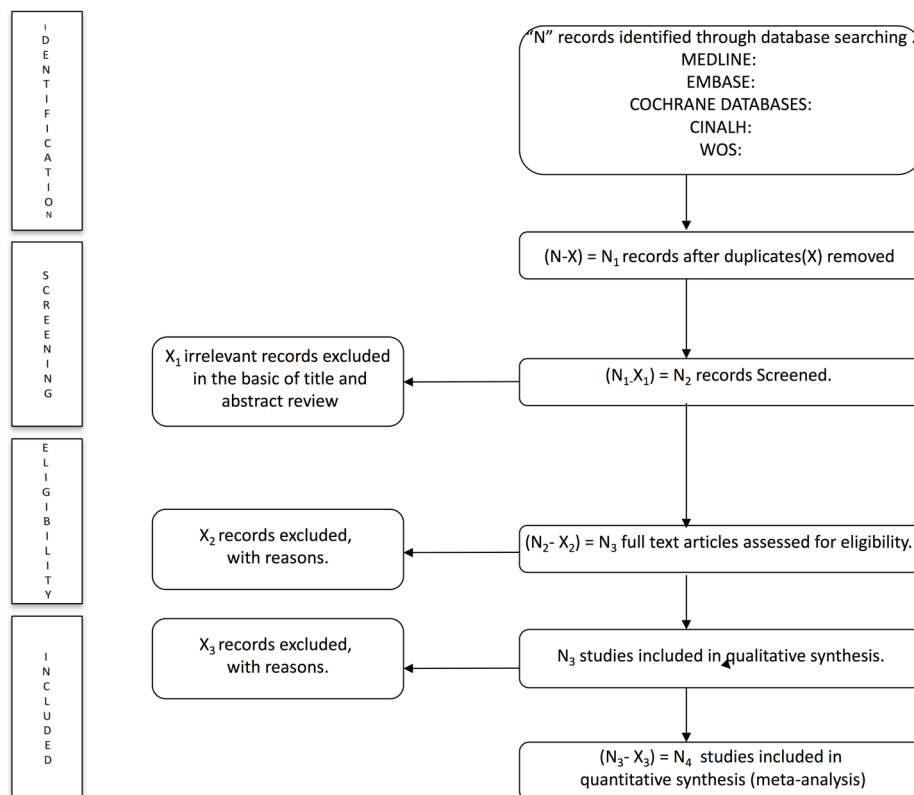
Figure 1 PRISMA (referred Reporting Items for Systematic Review and Meta-Analysis) flow diagram of identification, screening, eligibility and inclusion studies.

characteristics of the study population (sample size, age of participants, sex) and prevalence of thinness, overweight and obesity.[26–28] Then, based on the information provided in each paper, the total prevalence for each weight status category will be extracted for the following strata: country or region, age range (3–6, 7–13 and 14–18 years), sex and age–sex combined. Finally, trends in three different time periods (2000–2006, 2007–2010 and 2011–2017) for each weight category will be assessed.

Any disagreement in data extraction will be resolved by discussion to reach a consensus. When necessary, authors of potentially eligible studies will be contacted to obtain any missing information.

Assessment of risk of bias

Two reviewers will independently assess risk of bias of each study using the Joanna Briggs Institute tool.[29] This tool includes 10 criteria that can be assessed as 'yes' (=1), 'no' (=0), 'not applicable' (=NA) or 'unclear' (=?) (online supplementary appendix 1). Thus, the score for each study can range from 0 to 10. Depending on the number of criteria that each study meets, it can be considered as low risk of bias (7–10), moderate risk of bias (4–6) or high risk of bias (1–3). The Effective Public Health Practice Project[30] Quality Assessment Tool for Quantitative Studies (online supplementary appendix 2) will be used to assess the quality of longitudinal studies. Studies will be evaluated in seven domains: selection bias, study design, confounders, blinding, data collection method, and withdrawals and drop-outs. Each quality domain could score as strong, moderate or weak, and quality of studies could be classified as strong (with no weak domains), moderate (with one weak domain) and weak (with two or more weak domains). A third reviewer will independently evaluate both assessments and conflicts will be resolved by consensus.

Statistical analysis

Researchers will summarise the main characteristics of selected studies, including the study's general profile, methods, characteristics of study participants and outcomes in table 2. After data have been extracted, they will determine whether a meta-analysis is possible. At least two observations addressing the same specific outcome will be required to conduct pooled analyses. Data from cross-sectional and longitudinal studies will

be used to determine the pooled means of prevalence. For longitudinal studies, data from the beginning and the end of the study will be used as prevalence information sources, without considering reported changes in prevalence. When studies presented estimates of morbid obesity (equivalent to BMI≥35 kg/m^2 at 18 years), they will be included in the obesity category, in order to estimate an unique valour for obesity (defined as equivalent BMI≥30 kg/m^2 at 18 years). Finally, when more than one population provides data on the same sample, the one reporting the most detailed results and/or the largest sample size will be retained in data synthesis.

Whenever possible, a meta-analysis will be conducted using STATA V.14 software to combine the pooled mean differences with 95% CIs. The Mantel-Haenszel fixed-effect method[31] will be used if there is no evidence of heterogeneity; otherwise, the DerSimonian and Laird random-effects method[32] will be used.

Heterogeneity among studies will be assessed using the I^2 statistic, whose values will be classified as follows: no relevant heterogeneity (0%–40%), moderate heterogeneity (30%–60%), substantial heterogeneity (50%–90%)%) and considerable heterogeneity (75%–100%)%).[25] If there is substantial heterogeneity among studies and a meta-analysis is not possible, a descriptive analysis will be conducted. Finally, publication bias will be evaluated graphically using a funnel plot, as well as with the method proposed by Sterne *et al*.[33]

Subgroup analysis and meta-regression

Subgroup and meta-regression analyses will be carried out on the main factors which may cause heterogeneity, such as gender, age (3–6, 7–13 and 14–18 years), country, region (Northern, Central and Southern Europe) and study outcomes (thinness, overweight and obesity)[26–28] Moreover, to assess prevalence trends, all subgroup analyses will be stratified by three time periods (2000–2006, 2007–2010 and 2011–2017). Additionally, study design, different IOTF criteria,[26–28] pubertal status based on Tanner score and risk of bias scores[25] will be considered for additional subgroup analyses.

Sensitivity analysis

Sensitivity analyses will be conducted excluding studies from the analysis one by one.

Table 2 Characteristics of studies included in the systematic review and/or meta-analysis

Reference	Period of study	Country	European region	Study design	Age distribution	Sample size	Underweight (%)	Overweight (%)	Obesity (%)
				Population characteristics			**Outcome**		
Fist author's name and year of publication	Period of data collection	Country	European region	Design of the study	Age range of participants (years)	Number of participants by sex	Prevalence of underweight according to IOTF criteria by sex	Prevalence of overweight according to IOTF criteria by sex	Prevalence of obesity according to IOTF criteria by sex

IOTF, International Obesity Task Force.

DISCUSSION

Measuring the prevalence of childhood and adolescence thinness, overweight and obesity, and monitoring changes over time is important from a population health surveillance perspective, and can be used to assist when developing interventions for prevention and control of the obesity epidemic and the increasing prevalence of thinness. However, few studies have reported changes in rates of weight status categories in European countries using a standardised methodology. Therefore, this systematic review and meta-analysis protocol aims to provide a precise, transparent and generalisable methodology for estimating the prevalence and overtime trends of thinness, overweight and obesity for three age groups (3–6, 7–13 and 14–18 years) across the European region during 2000–2017.

Many health interview surveys include questions on self-reported data to monitor weight trends overtime.[33 34] However, self-reported data could be limited by certain biases. For example, parental report of weight and height could result in height underreporting, which results in biased (higher) BMI estimates.[35] Thus, only objectively measured data will be used for this systematic review in order to avoid this source of bias.

Furthermore, sources of heterogeneity, such as different geographical locations, study design and sample characteristics (size, age ranges and gender distribution), will be considered in this review. To evaluate whether these variables could affect heterogeneity, random-effects meta-regression will be used.[34]

Children's obesity and parental socioeconomic status have been consistently worldwide related[36]; thus, abrupt socioeconomic changes such as the financial crisis of 2007 presumably influence negatively on the health and welfare of European families, particularly in some southern European countries such as Greece, Spain or Portugal, in which the effect of this crisis have been more serious. In those countries, it has been estimated that between 2005 and 2010, the proportion of children at risk of poverty increased from 20.6% to 23.7%, and the proportion of them living in unemployed families from 3.7% to 11.2%.[35] For this reason, we decided to separately analyse these three slightly unbalanced time periods: 2000–2006 (a wealthy period), 2007–2010 (the peak of the financial crisis) and 2011–2017 (the aftermath of the crisis)

IOTF criteria[26–28] will be used because their cut-offs for children and adolescents are representative of the whole world's population, and will allow for better intercountry comparability during the period 2000–2017 than other international criteria, such as those from the Centers for Disease Control (CDC)[37] or WHO.[38] Furthermore, considering that two versions of these IOTF criteria[26–28] have been published during this period (although with minimal differences in their cut-offs), we will perform subgroup analysis in order to discriminate the potential effect of these differences on prevalence determinations. However, using only IOTF criteria[26–28] limits comparability with other relevant studies across the world, mainly from the USA, where CDC criteria are common and prevent us from collect data prior to 2000. However, as the main objective of this systematic review and meta-analysis is to assess weight status trends, this will not substantially influence on the trend estimations.

Additional potential limitations of this research are publication bias, information bias, poor statistical analyses, and inadequate reporting of methods and findings of the primary studies. It is important to take into account that these sources of bias will be greater in some regions and countries (eg, high-income countries vs low-income countries). However, it is important to summarise the information available from these reports and publications.

In summary, due to lack of complete and unbiased information about prevalence and trends of thinness, overweight and obesity in European children and adolescents, it seems a priority to conduct a systematic review including children and adolescents over the last two decades in order to provide high-quality evidence regarding this important public health problem. Furthermore, given that the European children and adolescents share multiple geographical and socioeconomical circumstances that make them an epidemiological entity, it seems thoughtful to monitor the weight status trends focusing in this region of the world. Also, it is important to show a new model for presenting studies addressing prevalence and trends of cardiovascular risk factors that could be useful as guidelines for future research of these types of issues. Finally, this study will provide updated and valuable information for policymakers and healthcare providers at national and continental levels in order to monitor the effectiveness of ongoing preventive policies in European children and adolescents.

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