Socioeconomic, demographic, environmental and behavioral factors associated with overweight in adolescents: a systematic literature review.

Fatores socioeconômicos, demográficos, ambientais e comportamentais associados ao excesso de peso em adolescentes: uma revisão sistemática da literatura.

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Resumo

Objetivo: Identificar fatores socioeconômicos, ambientais e comportamentais associados ao excesso de peso (EP) em adolescentes por meio de uma revisão sistemática da literatura. **Métodos:** Foram consultadas seis bases de dados (*Lilacs*, *Adolec*, *SciELO*, *Medline* via *Pubmed*, *ISI Web of Knowlwdge* e *Cochrane Library*) entre os dias 03 e 13 de janeiro de 2008. Os descritores e respectivos termos MeSH utilizados foram: "sobrepeso", "obesidade", "adolescência", "adolescentes", "fatores de risco", "fatores associados". Foram avaliados artigos em inglês, espanhol e português publicados entre 1997 e 2007 e incluídos estudos observacionais que estudaram adolescentes com idades entre 10 e 19 anos, cujo desfecho era o EP diagnosticado por critérios internacionalmente utilizados. Foram excluídos estudos com base em amostras de conveniência ou que não investigavam fatores sociais, ambientais e psico-comportamentais entre as variáveis independentes. **Resultados:** Da leitura dos títulos e resumos e da aplicação inicial dos critérios de elegibilidade resultaram 202 artigos. A revisão das publicações completas permitiu a inclusão e análise de 56 artigos. Observou-se que o nível socioeconômico associou-se inversamente com o EP em países desenvolvidos e de forma direta em países em desenvolvimento. Dieta para emagrecer, número de horas alocadas em TV/vídeo por dia, mãe e/ou pais obesos e ocorrência de EP na infância associaram-se diretamente com o EP. Foram identificados como fatores protetores o hábito de consumir desjejum e a prática de atividade física. **Conclusão:** Variáveis socioeconômicas, comportamentais, familiares e do início da vida associaram-se com EP e estas devem ser consideradas nas intervenções dirigidas para este agravo entre adolescentes.

Palavras-chave: sobrepeso, obesidade, fatores de risco, adolescente.

Abstract

Objective: To identify socioeconomic, environmental and behavioral factors associated with overweight (OW) in adolescents through a systematic literature review. **Methods:** Six databases were consulted (*Lilacs*, *Adolec*, *SciELO*, *Medline* via *Pubmed*, *ISI Web of Knowlwdge* and *Cochrane Library*) between January 3 and 13, 2008. The following key-words and respective MeSH terms were used: "overweight", "obesity", "adolescence", "adolescents", "risk factors", "associated factors". Articles in English, Spanish and Portuguese published between 1997 and 2007 were evaluated, and only observational studies with adolescents aged from 10 to 19 years, diagnosed with OW using international criteria were included. Studies based on convenience samples or that did not investigate social, environmental and psycho-behavioral factors as independent variables were excluded. **Results:** 202 articles were selected by reading the titles and abstracts and applying initial eligibility criterion. The review of complete publications allowed including and analyzing 56 articles. Socioeconomic level was found to be inversely associated with OW in developed countries and directly associated in developing countries. The habit of going on weight loss diets, the number of hours per day watching TV/video, having an obese mother and/or father and the occurrence of OW in childhood were directly associated with OW. The habit of having breakfast and physical activity were observed to be protective factors. **Conclusion:** Socioeconomic, behavioral, family, and childhood variables were associated with OW and should be considered in interventions directed toward the problem among adolescents.

Key Words: Overweight. Obesity. Risk factors. Adolescent.

INTRODUCTION

Overweight (including obesity) has become increasingly more important in the global epidemiological scenario, not only as a function of its growing prevalence, but mainly because it is associated with a series of deleterious effects on health. Data published by the World Health Organization – WHO in 2004 suggests that the prevalence of overweight and obesity has been growing at an alarming pace, both in developed and developing countries. In most European countries, the prevalence of excess weight (overweight and obesity together) in adults ranges between 50 and 75%. In the United States, obesity affects about 20% of men and 25% of women[1]. In Africa and Latin America, with the fast urbanization and growth of the socioeconomic level in some countries, obesity has been growing and surpassing the prevalence of underweight, as is the case of Cape Town, in South Africa, and of Brazil. In these countries, 44 and 13.1% of women and 10 and 8.9% of men, respectively, are obese[1,2].

Another striking feature of the epidemic growth of overweight is the increase of this disorder in increasingly younger ages. In 2004, 10% of children and adolescents in the world were already estimated to be overweight and, among them, one fourth to be obese[3]. A study performed by Wang *et al.*[4] in countries in different stages of social and economic development revealed a significant increase in the prevalence of overweight children and adolescents in past decades. Major increments of magnitude have been observed, especially among adolescents: 62% in the United States (from 16.8 to 27.3% in the US) and 240% in Brazil (from 3.7 to 12.6%).

Longitudinal studies have identified obesity in childhood and adolescence, particularly during the second decade of life, as an important predictor of obesity in adult life, especially for extremely obese children with obese parents[5-8]. The literature has documented some consequences of obesity, such as substantial risk for hypertension, type II

diabetes mellitus, respiratory and muscular-skeletal complications, in addition to major psychosocial repercussions [9-12].

The changes in diet and exercise patterns that occurred in several societies, have contributed to an increased overweight population[13]. It should be pointed out, however, that the determinants of overweight comprise a complex set of biological, behavioral and environmental inter-related factors that mutually augment each other. For children and adolescents, conditions and situations present in the school, family and neighborhood environment are examples of these factors. Characteristics present during pregnancy and in the beginning of life, such as mother's nutritional status previous to pregnancy, smoking during pregnancy and nutritional status in childhood also stand out[14-19].

In face of the complexity of the process that determines the condition, a set of interventions aimed at preventing obesity during childhood and adolescence has been proposed. Interventions involve actions oriented toward habits, family and individual choices and collective measures, such as for example, regulation of food commercial practices and publicity, and reorganization of the urban space. Nonetheless, in order to formulate actions, it is necessary to acknowledge the network of determinants and to identify the set of factors that can respond to interventions targeted at overweight in adolescents[20-22].

In past years, some systematic revisions on the efficacy or effectiveness of interventions oriented toward prevention or treatment of overweight and obesity in childhood have been published, although specific studies on adolescents were not found[23-28]. So far, systematic revisions on risk factors for overweight in this specific group of the population have not been found either. Thus, the objective of the present study was to identify the socioeconomic, environmental and behavioral factors associated with overweight (OW) in adolescents by means of a systematic literature review.

METHODS

Databases and search strategies

The following databases were consulted: *Lilacs*, *Adolec*, *SciELO*, *Medline* via *Pubmed*, *ISI Web of Knowlwdge* and *Cochrane Library* between January 03 and 13, 2008. The keywords and respective MeSH terms used for the search were: "overweight", "obesity", "adolescence", "adolescents", "risk factors", "associated factors", in the *title/abstract words* field of the reference bases. In the *Medline* database, six search equations were built to which the term "*Major*" was added to the side of each keyword alternately: "Overweight"[Majr] OR "Obesity"[Majr] AND "Adolescent"[Mesh] OR "risk factor"[Mesh]; Overweight"[Mesh] OR "Obesity"[Mesh] AND "Adolescent"[Majr] OR "risk factor"[Mesh]; Overweight"[Mesh] OR "Obesity"[Mesh] AND "Adolescent"[Mesh] OR "risk factor"[Majr]; Overweight"[Majr] OR "Obesity"[Majr] AND "Adolescent"[Majr] OR "risk factor"[Mesh]; Overweight"[Majr] OR "Obesity"[Majr] AND "Adolescent"[Mesh] OR "risk factor"[Majr]; Overweight"[Majr] OR "Obesity"[Majr] AND "Adolescent"[Majr] OR "risk factor"[Majr]. This strategy enabled the utilization of equations with different levels of specificity, which expanded the range for selecting the studies to be examined. The period of publication ranged between 1997 and 2007 and articles published in English, Spanish and Portuguese were selected. Such period was defined because, in mid 1995, the WHO recommended using the Body Mass Index (BMI, weight (kg)/height^2 (m)) associated with skin fold measurements as a new diagnostic criteria for overweight and obesity among adolescents of the population, since then an international recommendation for defining overweight and obesity for this age group[29].

Selection criteria

Complete articles that met the following criteria were included in the present revision: population in the 10 to 19 year-old age

group; observational (cross-sectional, cohort or case-control) study design; subjects selected with a probabilistic sample in cross sectional studies or an article with a sample design used in the remaining study designs; having as the main or secondary objective the identification of factors (environmental, social, demographic or psycho-behavioral) associated with overweight or obesity, analyzed as a categorical variable.

It is worth explaining that there is no consensus in the literature as to the anthropometric diagnosis of overweight and/or obesity in adolescents. For the present study, only articles that used at least one of the following criteria were included:

i) *World Health Organization*[29]: BMI by sex and age above percentile 85 of the American population (data of the *National Health and Nutrition Examination Survey*, 1971/05), associated or not with skin fold values above percentile 90 of the same reference population;

ii) Cole *et al.*[30]: BMI by sex and age above the values that correspond to 25.0 and 30.0kg/m^2 at 18 years of age, which is the equivalent to the cut-off points that define overweight and obesity in adults. Values were obtained in a database built with six population studies: Great Britain, Brazil, The Netherlands, Hong Kong, Singapore, and the United States. This is the criterion recommended by the *International Obesity Task Force – IOTF*;

iii) *Centers for Disease Control and Prevention*[31]: BMI by age and sex above percentile 85 or 95 of the American population (data from the *National Health and Nutrition Examination Survey* collected between 1963 and 1994);

iv) *World Health Organization*[32]: BMI by sex and age above 1 or 2 standard deviations (SD), using the American standard as reference (data of the *National Health and Nutrition Examination Survey* of 1977 supplemented with those of the growth standard of children less than 5 years old).

We excluded studies whose population assessed included pregnant or puerperal women, adolescents or individuals with any disease, and those published as editorials, comments, letters, validation, and intervention studies.

Data extraction

Studies were selected and information extracted by two independent revisers, with the help of a standardized tool. Information on the country where the study was conducted, characteristics of individuals studied (age, sex, ethnicity), sample size, study design, independent variables measured, parameters used to define overweight, statistical analysis technique used, and results obtained were collected. Independent variables were grouped into demographic, socioeconomic, dietetic, exercise, other behaviors, psychological, previous, family, and environmental. Whenever available, the results of the adjusted models were chosen for the present study. In the absence of this information, results from the univariate analysis were collected.

After data extraction, the STROBE (*Strengthening the reporting of observational studies in epidemiology*)[33] report was used as a guideline to assess availability of information and the methodological procedures adopted in selected articles. This report aims to help building observational study publications and has a checklist of items that should be observed by authors and that varies from the wording of the title to the mention of funding sources of the study. Each one of the items considered in the articles selected received points (integral (1,0), partial (0,5) or non existing (0)) according to the availability of information and/or adoption of the procedure studied in that specific item. Afterwards, points were summed and the percentage of points over the total items applicable was calculated.

The aim of the present study was to identify factors associated with OW among adolescents without the intention of quantifying the magnitudes of existing associations or producing a summary measure, and

for this reason, a meta-analytical synthesis was not performed in the present systematic revision.

As the information analyzed was obtained from studies already performed, the present study was not submitted to the Human Research Ethics Committee.

RESULTS

Initially, 942 studies were identified. Of these, 741were excluded after reading titles and abstracts (when available), mainly when they identified overweight as an exposure variable or because they were merely descriptive studies (376 articles) or, still, when they were intervention, revision or tool validation studies, notes or opinions of researchers (261 publications). As a result, 202 articles were left. When abstracts were not available in the databases consulted, a complete manuscript was sought and a first reading performed. In this second stage, after reading complete articles, 59 articles were selected. Afterwards, 3 studies were excluded: 2 because they did not inform the age group of participants and 1 because it did not present the reference population used for diagnosing overweight, even after two attempts to contact the authors. Therefore, 56 articles remained, selected by consensus for analysis. Figure 1 presents the study selection process flow.

General characteristics of studies

Studies analyzed were conducted between 1971 and 2005, with a higher number of studies done after the 1990's. Most studies (n=37) were conducted in developed countries, mainly in the United States (n=20). Among developing countries, Brazil had an expressive representation among the studies selected (n=14). Results analyzed in this article came mostly from cross-sectional studies (n=38), whose main data sources were surveys with representativeness of population segments, 10 of which with national representativeness. This characteristic is partly reflected in the wide range observed in the number of participants: from 281,630 adolescents assessed in the "Avena Study"[34] to the 173 adolescents examined in a case-control study conducted in Brazil[35]. Only 5 studies assessed adolescents between 10 and 19 years of age. The age group studied most frequently was that between 12 and 19 years.

Table 1 presents in detail the variables and indicators analyzed, criteria for defining overweight and/or obesity, statistical techniques used, main results, STROBE scores, and the limitations of the 56 studies assessed.

The group of independent variables studied most frequently were socioeconomic variables, followed by dietary ones, then exercising, and other behaviors related to lifestyle followed by demographics. Most studies used calibrated weight and height data (n=40) and adjusted regression models in statistical analysis (n=46). None of the studies assessed adopted the WHO's recommended (2007) diagnostic criteria for overweight.

The percentage of points obtained by studies according to the STROBE report guide ranged between 38.7 and 84.4% with a mean of 64.5%. Small differences were observed when comparing characteristics of designs and methods of the publications that presented the highest point percentage (above 75%) with those that obtained the lowest results (below 25%). In the group of studies with highest points, the cohort design was observed to be more frequent in comparison to the lowest point group. Socioeconomic variables were assessed more frequently in the group of studies with lowest points.

Most studies found a statistically significant association between factors studied and OW, and only in three studies [36-38] no association was found. Fourteen studies that assessed obesity as outcome, presented, in general, results similar to those observed for OW.

Socioeconomic, demographic and environmental variables and EP

Of all studies, 45 studied socioeco-

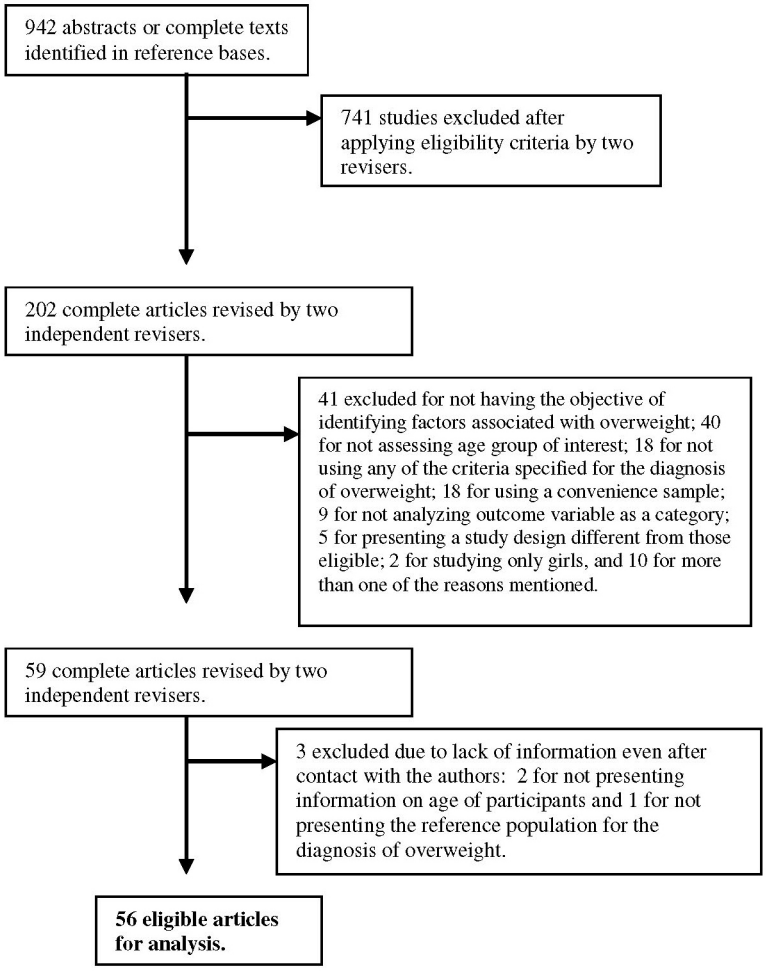

Figura 1. Fluxo de seleção dos estudos incluídos na análise.
Figure 1. *Flow chart of the selection of the studies included in the analysis.*

nomic variables: 28, demographic and 9, environmental. In general, the direction of the association between socioeconomic level (assessed by individual and/or clustered variables, ex: family income, parents' schooling, type of health insurance, type of school (public or private) etc.) and OW was distinct between developed and developing countries. An inverse association between socioeconomic level and OW was observed in developed countries[34,39-51], while a direct relation was observed in developing countries. The fact that these results were also found in studies with a higher point percentage according to the STROBE report checklist[44,48,51] should also be pointed out. Environmental variables that characterize geographical areas as sites of higher or lower development (living in cities with 10,000 or more inhabitants; living in urban areas and mean income of neighborhood) were also inversely associated with OW in developed countries. In three studies, two of them conducted in Brazil[52,53] and one in China[54], a direct association between living in an urban area and OW was observed.

This pattern of association was similar when analyses were stratified by sex. However, in two studies carried out in developed countries whose specific objective was to identify the association between socioeconomic level and OW, no statistically significant association was observed among girls [34,48].

Tabela 1. Variáveis independentes, aspectos relacionados à variable dependente, procedimentos de análises estatísticas, results, pontuação segundo relatório STROBE e limitações metodológicas dos articles analisados.

Table 1. Independent variables, aspects related to the dependent variable, statistical analysis procedures, results, score according to the STROBE report and methodological limitations of the analyzed articles.

Article	Independent Variables and Indicators analyzed	Information on weight and height (Aferida or Referred) / Criterion for defining OW*/ reference population	Statistical analysis technique	Main results (PA= Positive Association; IA= Inverse Association)	Variables / Indicatores utilized in the adjustment of the final model	Points assessment of STROBE report (%)	Methodological limitations listed by authors
Wang & Zhang (2006)[82]	De*=age, ethnicity; So*= parents' schooling, family income, occupational status and family income and value of poverty line ratio.	Assessed / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model	IA with OW among boys: socioeconomic level in all periods. IA with OW among girls: socioeconomic level between 1988 and 1994.	-	53.2	-
Miech *et al*. (2006)[39]	So=family income; Di*=proportion of calories consumed from soft drinks, having breakfast; At*=practicing moderate or intense PE**.	Assessed /BMI over percentile 95 / CDC (2000).	Univariate analysis	IA with OW: socioeconomic level (association shown for 15-17 year old adolescents; Black adolescents of any age).	-	72.6	Only income used to assess NSE; cross-sectional data, impossibility to guarantee exposure previous to outcome
Kvaavik et al. (2005) [81]	So= parents' schooling; At= frequency of leisure PE; Co=smoking; Fa=mother smoking and during pregnancy; parents' EN[5]; Pr=duration of breastfeeding	Assessed /BMI over corresponding 25.0 and 30.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model	IA with OW: duration of breastfeeding.	Sex; schooling and parents' EN; mother smoking and mother smoking during pregnancy.	80.0	Parents' weight and height information; referred not specified exclusive maternal breastfeeding and indirect assessment of smoking during pregnancy.
Salsberry & Reagan (2007)[17]	De= ethnicity, mother's civil status throughout life and at time of study; So= mother's schooling, per capita income throughout life and at time of study; Pr*= duration of mother breastfeeding; Fa*= smoking during pregnancy and mother's EN.	Assessed and Referred / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model with variance estimated by the Huber/White Sandwich method (presence of siblings in sample)	PA with OW: smoking during pregnancy; overweight mother during pregnancy; mother was never married, current overweight mother; black ethnicity. IA with OW: duration of breastfeeding (only among adolescents of obese mothers).	Sex; Age; Age of mother; method of assessing weight and height measures.	80.0	Occurrence of differential losses (underestimation of estimates); distinct methods for obtaining weight and height of adolescents.
Mamun *et al*. (2006)[18]	De=mother's age; So=mother's schooling, annual family income, mother's civil status; Di=, frequency of food consumptim; At= period of PE weekly; Co*=time watching TV; Fa= smoking during pregnancy; Pr= duration of breastfeeding.	Assessed / BMI over corresponding 25.0 and 30.0 at 18 years for age and sex / Cole (2000).	Multinomial Regression Model	PA with OW: mother smoking during pregnancy.	Age; sex; frequency of consumption of fast food greenery, soft drinks, red meat; # of hours of TV and PE/day.	73.4	Differential loss; possibility of measurement bias for mother smoking, adolescents' PE and food consumption variables.

Mamun *et al.* (2005)[40]	De=ethnicity, mother's parity; So=family income, mother's schooling at birth; Di=frequency of fast food, soft drinks and red meat consumption; At= PE time weekly; Co=hours of TV daily; Fa=opinion and attitude of mothers on meals with family and Pr=EN at 5 years.	Assessed / BMI over corresponding 25.0 to 18 years for age and sex / Cole (2000).	Multivariate logistic regression model.	PA with OW: presence of overweight at 5 years; consumption of soft drinks 3 days or more/week; watching TV 3 hours or more a day; acknowledgement by mother of importance of avoiding consumption of "fattening" food for children. IA with OW: family income, practicing sports more than 4 days a week.	Sex; ethnicity; schooling and mother's parity; frequency of dinner with family; frequency of consumption of fast food; mother's opinion on habit of having meals with family.	71.0	Possibility of differential losses
Moreno *et al.* (2001)[41]	De=size of population of municipality; Am*=type of school (public or private).	Assessed / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model (with stepwise strategy for inclusion of variables)	IA with OW: studying in private school, living in a city of 10,000 inhabitants or more.	Sex; year study performed; term of interaction between both variables.	56.7	-
Wang *et al.* (2007)[42]	De= family composition, # of siblings; Di=consumption of breakfast; At=frequency of PE; Fa= parents' EN	Assessed / BMI over corresponding 25.0 and 30.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model.	IA with OW among boys: Living in families with 3 or more children; having older siblings and sisters. PA with OW among girls: Living in families with one child.	Age; parents' BMI; consumption of breakfast; frequency of PE.	65.5	Half siblings were not considered, only siblings of same father and mother.
Neutzling *et al.* (2000)[52]	So=location of household (urban/rural), adjustment age/grade of adolescent; per capita income	Assessed / BMI over percentile 85 / NHANES (1974/5)	Multivariate logistic regression model.	PA with OW among boys: Household income; adjustment of age/grade; living in urban area. PA with OW among girls: household income; living in urban area.	Age, parents' schooling, region and locationof home.	64.5	-
O'Malley *et al.* (2007)[43]	De=ethnicity; So=parents' schooling; Am= characteristics of school: kind of school (public, private-catholic, non catholic private), average schooling of parents, region of school, population density of region of school and % of black and Hispanic individuals at school.	Referred / BMI over percentile 85 / CDC (2000)	Multilevel multivariate logistic regression model.	PA with OW: % of black and Hispanic individuals at school; IA with OW: schooling of parents.	Type and size of school; population density of region of school; region of country; most prevalent ethnicity.	59.7	Possibility of measurement bias in key parents' BMI and schoolingvariables (self-referred)
Delva *et al.* (2007)[68]	De=ethnicity; So=mother working and parents' schooling; Di=frequency of consumption of selected foods and breakfast; At=frequency of vigorous exercise; Co=hours of TV/ day; hours of sleep/day; Fa= # of hours/week of presence of at least one adult at home.	Referred / BMI over percentile 85 / CDC (2000)	Multivariate logistic regression model, considering the effect of sample design.	IA with OW among boys: economic level and frequency of vigorous exercise. PA with OW among girls: hours of TV/day. IA with OW among girls: economic level and frequency of vigorous exercise.	Population density; region of country; grade; year study was performed.	61.3	Unavailability of data of family caloric ingestion and routines of PE; referred information of weight and height, with possible underestimating of outcome estimates.

Goodman *et al*. (2002)[44]	De=ethnicity, family composition; So=family income and parents' schooling; At=frequency of PE; Co= smoking; Psi*=depression, self-esteem, delinquent behavior; Fa=parents' EN	Referred / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model.	PA with OW: # of obese parents. IA with OW: parents' schooling.	Age; ethnicity; presence of depression; # of obese parents; presence of father and mother in household; schooling of parents.	75.0	Possibility of measurement bias in psychological assessment scales.
Gordon-Larsen *et al*. (2002)[67]	So=family income, parents' schooling; At=frequency, duration and intensity of PE, changes in PE after one year; Co= smoking, TV, video and computer time/ week	Assessed / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model.	PA with OW among boys: watching TV/vídeo 35h or more a week. IA with OW among boys: frequency of moderate and intense PE /week; change from moderate to intense PE. PA with OW among girls: watching TV/ vídeo 35h or more a week; change of PE from intense and moderate to light. IA with OW among girls: frequency of moderate and intense PE /week.	Age; family income; schooling of parents; location of residence; smoking; presence of father and mother in household.	57.6	-
Haas *et al*. (2003)[45]	De=ethnicity, family composition; So=receiving government benefit, family income, parents' schooling,type of health insurance	Referred / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model.	PA with SP: no health insurance or public health insurance. IA with SP: family income.	Age; sex; ethnicity; country of birth; parents' schooling; family income; # of parents in household; region of the country; having health insurance.	51.6	Other variables determinants of OW were not measured; utilization of referred weight and height information and number of Asian subjects.
Magalhães *et al*. (2003)[53]	So= location of household (urban/rural), # of dwellers in household, per capita income; At= weekly frequency of leisure PE.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Multivariate logistic regression model.	PA with OW among boys: per capita income. IA with OW among boys: # of individuals in household.	Location of household (urban/rural); per capita income; # of dwellers per household; frequency of PE per week.	66.1	Reference population (American) may underestimate proportion of OW; Using BMI to diagnose OW.
Monteiro *et al*. (2003)[78]	So=family income; Pr=gestational age, intra-uterine growth, birthweight, EN at 2 and 4 years; Fa= mother's EN before pregnancy.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Poisson Regression Model with robust variance.	PA with OW: overweight at birth without intra-uterine growth delay; z score of Weight/Height and Height/Age rates at 2 and at 4 years; fast weight gain up to 2nd year of life.	Family income; mother BMI; order of birth.	84.4	Selective follow-up loss (higher among individuals of lower income).

Monteiro *et al.* (2004)[19]	De=ethnicity, order of birth; So= current and year of birth family income; Di=consumption of fat; Co=smoking, hours of TV/ day; Psi=trace of anxiety; Fa=current and previous to pregnancy EN of mother; Pr=birthweight, EN at 20 and 43 months, duration of breastfeeding.	Assessed / BMI over percentile 85 associated with skin fold over percentile 90/ NHANES (1974/5).	Multivariate logistic regression model, with inclusion of hierarchized variables.	PA with OW among boys: mothers' pre-gestational BMI; income over 2 minimum wages in 1982 and presence of trace of anxiety. PA with OW among girls: mothers' pre-gestational BMI.	Color of skin; age of menarch; smoking; fat ingestion; # of TV hours and moderate and intense PE / day; increase in mother´s BMI before pregnancy.	69.4	-
Taveras *et al.* (2005)[36]	De=ethnicity; Di= weekly frequency of supper with family, energy consumption; At= daily hours of PE; Co= daily hours of TV, video and computer.	Referred / BMI over percentile 85 / CDC (2000).	Multivariate logistic regression model, with estimate by GEE adjusted for cluster.	Absence of association between frequency of dinner with family (exposure of interest) and OW	Age; age^2; ethnicity; BMI Z score; level of PE; sedentarism; stage of sexual maturation at baseline; height at baseline; annual height change.	82.8	Possibility of reverse causality (obese are more on diet and dine more with family); sample size; self-referred weight and height data.
Sen (2006)[89]	De=ethnicity: So=parents' schooling, family income, having computer in household; Di=frequency of supper with family; Co= occurrence of family reunion in past year.	Referred / BMI over percentile 95/ CDC (2000).	Multivariate multinomial regression model	IA with OW: frequency of dinner with family (3 times or more/ week).	Age; sex; ethnicity; height; stage of pubertal development; family composition; parents' schooling; level of poverty; presence of computer in household and level of family proximity.	74.2	Use of referred weight and height. PE, type and amount of food consumed at supper and others meals not measured.
Delva *et al.* (2007)[61]	De= ethnicity, family composition; So= parents' schooling; Di=frequency of consumption of selected food and breakfast; At= frequency of vigorous exercise; Co= TV hours /day, hours of sleep/day; Fa= # of hours with presence of at least one adult at home after school hours.	Referred / BMI over percentile 85 / CDC (2000).	Multivariate logistic regression model, considering effect of sample design.	PA with OW among boys: hours of TV/day. IA with OW among boys: socioeconomic level and frequency of vigorous exercise; consumption of fruit, greenery and having breakfast. PA with OW among girls: hours of TV/day; IA with OW among girls: economic level; frequency of vigorous exercise; living with father and with mother.	Variables of parents and related to behavior.	74.2	Outros predictors of OW (ex: caloric ingestion, PE routines, environmental variables) were not collected; utilization of referred weight and height; indicator of socioeconomic level based only on schooling information.
Johnson *et al.* (2006)[46]	De=ethnicity; So= parents' schooling, location of household (urban/rural).	Assessed / BMI over percentile 85 / CDC (2000).	Multivariate logistic regression model.	PA with OW: living in urban area.	Sex; age.	58.3	No guarantee of temporality between exposure and outcome. Utilization of BMI for diagnosis of OW.
Ramos *et al.* (2003)[79]	Pr= birthweight; Fa= parents' EN.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Univariate Analysis	PA with OW: presence of obese parents.	-	46.7	-

Savva *et al.* (2002)[69]	So=parents' schooling and occupational status, family income, # of children in household; Di= breastfeeding and frequency of food consumption; At=frequency and daily hours of PE; Co= daily hours of TV, video and computer.	Assessed / BMI over corresponding 30.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model	PA with OW among boys: Presence of overweight or obese parents; IA with OW among boys: participating in sports teams and practicing vigorous exercise PA with OW among girls: presence of overweight or obese parents;	Age; socioeconomic level.	58.1	-
Savva *et al.* (2004)[80]	So=parents' schooling, family income, size of household; Fa= parents' EN.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model.	PA with OW: Presence of obese father.	Age at baseline; sex; area of residence; socioeconomic level; serum lipids; mother's EN.	67.2	Short follow-up time
Forrest & Leeds (2007)[47]	So=family income; Di= detailed consumption of food and nutrients; At=practicing PE.	Assessed / BMI over percentile 85 / CDC (2000).	Multivariate logistic regression model with stepwise method for selecting variables.	PA with OW: perceiving oneself as less active than peers; IA with OW: family income, ingestion of energy, fibers and nutrients (carbohydrates, protein, fat and cholesterol).	Age; sex.	38.7	No other determinants assessed (healthty diet, installations for PE, etc) for OW.
Neutzling *et al.* (2003)[14]	So=parents' schooling, socioeconomic status of family; Di=frequency of selected food consumption, # of meals/day, dieting to lose weight; At=frequency and amount of physical activity; Co=hours of sleep, daily TV hours, use of videogame and computer; Fa= parents' EN; Pr=duration of breastfeeding, birthweight, self-perception of nutritional status before 10 years	Assessed / BMI over percentile 85 / NHANES (1974/5).	Multivariate conditional logistic regression model, with inclusion of hierarchized variables.	PA with OW: BMI parents; self-perception of overweight before ten years; dieting to lose weight. IA with OW: # of meals made/ day, breastfeeding for 2 months or more (borderline statistical significance)	Birthweight; frequency of PE outside school; hours of sleep; hours of TV/ video/computer per day; habit of having breakfast; frequency of consumption of soft drinks, fruit and vegetables.	66.1	Utilization of referred weight and height of parents.
Pérez *et al.* (2006)[55]	De=civil status; So=perception of economic status of family, working hours/day; Di= food consumption; At= frequency of PE; Co=hours of sleep/day, smoking, consumption of alchool and drugs, habit of watching TV, attitudes to control weight in past 30 days; Psi=suicide behavior, anxiety.	Referred / BMI over percentile 95 / CDC (2000).	Mulitvariate polinomial logistic regression model.	PA with OW among boys: Practicing PE; dieting to lose weight. IA with OW among boys: Participating in sports teams. PA with OW among girls: exercising, dieting and taking medicine or formulas to lose weight. IA with OW among girls: trying to gain weight.	Civil status of adolescents; socioeconomic level of family (subjective assessment of adolescents).	58.1	Possibility of measurement bias for socioeconomic status of family (opinion of adolescent); different methods of measuring weight and height; possibility of existing residual confounding.

Kumar *et al.* (2004)[56]	De=ethnicity; Di=fruit, vegetables and fruit juice consumption rate, frequency of consumption of selected foods and breakfast, habit of dieting; At=practicing sports and PE at school; Co= daily TV and videogame hours.	Referred / BMI over percentile 85 / CDC (2000).	Multivariate ordinal logistic regression model.	PA with OW among boys: dieting (current or previous). PA with OW among girls: dieting (current or previous); frequency of consumption of fruit, greenery, chocolate/sweets; IA with OW among girls: frequency of consumption of breakfast.	Ethnicity.	71.0	Possibility of reverse causality, utilization of referred weight and height.
Carrière (2003)[62]	So=family income; Di=daily consumption of fruit and greenery; At= frequency and duration of PE; Co=smoking; Fa=parents smoking.	Referred / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model. Standard error estimated by bootstrap technique, to take into account sample design.	PA with OW among boys: having obese parents, parents currently smoking; IA with OW among boys: being moderately or highly active. PA with OW among girls: having obese parents, having smoked some time in life.	Age; frequency of consumption of fruit/greenery; consumption of cigarrettes; family income.	79.0	Small number of obese girls; referred information subject to memory bias (practicing PE), presence of parents at time of interview (possibility of measuring bias).
Lien *et al.* (2007)[48]	De=residential address; So= parents' schooling, occupational status and family income.	Referred / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model, with stepwise variable selection method.	IA with OW among boys: parents' schooling	Residence area; income (in quartleis) and occupational status of parents.	78.3	Utilization of referred weight and height, possibility of occurrence of measurement bias of parents' income and schooling information.
Moreno *et al*. (2005)[34]	So=parents' schooling and occupational status	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Univariate analysis	IA with OW among boys: Socioeconomic status	-	69.0	-
Lee *et al.* (2006)[49]	De=ethnicity; So=median income of household; Am=participation of school in government meals program, school income.	Assessed / BMI over percentile 95 / CDC (2000).	Two level logistic regression model (school and student)	PA with OW: % of students assisted by meals program (*school level*); IA with OW: household income (*student level*)	*Student level*: sex, ethnicity, grade; *School level*: % of students assisted by meals programs; median family income.	48.3	-
Klein-Patalat *et al*. (2003)[50]	De=presence of father and mother at household; So=parents' schooling and family income; Fa=parents' EN; Am=location of school (economic level of region); size of community.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model	IA with OW: mother's schooling	Parents' EN.	69.3	Utilization only of BMI to diagnose OW of adolescents.
Terres *et al.* (2006)[57]	So= adolescents' schooling, parents' schooling, salary of past month; Di=being on a diet, habit of skipping meals; At= practicing PE at and outside school; Co=smoking and alcohol in past month, TV hours / day; Fa= parents' physical skills; Psi=minor psychiatric disorders.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Poisson regression model with robust adjustment of variance and control for outline.	PA with OW: dieting; habit of skipping meals; practicing physical activity outside school.	Age; mother's schooling; presence of obese parents; sexual maturation.	67.8	Neither diet of adolescents nor of parents assessed. Possibility of reverse causality given study design (cross-sectionall).

Utter *et al*. (2006)[74]	So= poverty index; Di=frequency of consumption of selected foods; At=frequency, duration and intensity of PE; Co= daily TV hours.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model.	PA with OW: watching 2 or more hours of TV/day.	Age, sex, economic level of family, frequency, duration and intensity of PE.	67.2	Did not assess types of TV programs seen, did not assess other determinants of OW (ex: family attitudes).
Silveira *et al*. (2005)[35]	De=# of siblings and order of birth; Di=energy and nutrients consumption and frequency of consumption of selected foods, having dieted for obesity; At= frequency and duration of PE; Co= daily TV and video hours, use of alcohol and illicit drugs, smoking, use of contraceptives, taking naps, relations with friends; Fa=EN of country; Pr=birthweight, duration of breastfeeding.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Multivariate logistic regression model, with inclusion of hierarchized variables.	PA with OW: presence of obese parents; obesity in childhood; having dieted for obesity in the past; habit of napping, having a best friend.	-	60.9	Possibility of memory bias (cases reporting less risk factors than controls), difficulty for assessing food consumption in a reliable and valid manner.
Knutson & Lauderdale (2006)[75]	De= ethnicity; So=family income, schooling of head of family; At=types of PE; Co= daily hours spent with TV, playing video-game, on the computer, duration of sleep.	Assessed / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model.	PA with OW: hours of TV/day. IA with OW: hours of sleep/day.	Age; age^2; ethnicity; sex; # of hours of PE, videogame, computer/day; schooling of head of family; family income.	59.4	Information on actual hours of sleep.
Cobayashi *et al*. (2005)[58]	Di= dieting to lose weight, consumption of milk; Co= habit of sleeping during the day; Psi= having a best friend; Fa= parents' EN; Pr=previous obesity.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Multivariate logistic regression model.	PA with OW: having at least one obese parent; obesity in childhood; presently/previously having dieted to lose weight; habit of sleeping during the day; not consuming milk or byproducts.	Having a best friend; bone density.	40.7	-
Raja'a *et al*. (2005)[70]	So= parents' schooling; Di= frequency of consumption of selected foods; At= having practiced PE in past 24h; Fa=presence of obesity in any member of family.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Univariate analysis	PA with OW: studying in private school; parents' schooling. IA with OW: having practiced sports or PE in past 24h.	-	50.0	-
Dutra *et al*. (2006)[60]	De= ethnicity; So=head of family's schooling; family's socioeconomic level Di=# of meals of the previous day, dieting to lose weight in past 3 months; Co= daily TV hours, smoking; Pr= birthweight.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Poisson multivariate regression model, with entry of hierarchized variables.	PA with OW among boys: family's socioeconomic level. PA with OW among girls: # daily TV hours. IA with OW among girls: # of daily meals; being on diet to lose weight.	Age; color of skin; parents' schooling.	79.0	Possibility of occurrence of reverse causality; possibility of memory bias for previous variables.

Veugelers *et al.* (2005)[51]	De=place of birth and residence, parents' civil status; So=parents' income and schooling; Di=frequency of consumption of selectd foods and eating behaviors; At=frequency of PE; Co= daily TV hours; Am= average of neighborhood; sales of soft drinks, presence of vending machines, type of meal offered, frequency of physical education classes at school; funding for recreation area and gym of school.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate multilevel, logistic regression model	PA with OW: buying snacks at school; IA with OW: having meals at home with family; practicing PE 7 days/week; attending physical education class at school; parents' schooling; average income of neighborhood.	Sex; type of food at school.	75.0	Possibility of reverse causality.
Snoek *et al.* (2007)[59]	Di= frequency of consumption of selected foods; At= PE rate (combines # of and intensity of PE); Psi=eating disorders (compulsion, impulse, restriction).	SI[#] / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model	PA with OW among boys: restrictive eating behavior. IA with OW among boys: high # of PE; having breakfast daily; high consumption of snacks. PA with OW among girls: Restrictive eating behavior, eating twice or more portions of fruit/day. IA with OW among girls: eating by external impulse, high # of PE; daily consumption of breakfast.	Age; ethnicity; schooling	72.6	Utilizing referred weight and height; Possibility of reverse causality (with cross-sectional data it is not possible to define directions of associations); consumption of snacks not assessed with validated questionnaire; self-referred PE may give socially expected answers.
Costa *et al.* (2007)[65]	So=family's economic status; Di=frequency of meals per day; At= praticing sports; Co= daily TV, video, computer hours.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Univariate analysis	PA with OW: family's socioeconomic level. IA with OW: # of meals/day	-	61.7	-
Laxmaiah *et al.* (2007)[71]	So= family income, parents' literacy and occupational status, presence of assets in household, kind of house (own/rented); Di=diet preferences and eating standards; At= participation in aerobic activities, games, exercise; Co= TV, video-game and computer hours/ day; Psi=self-image.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model	PA with OW: family's socioeconomic level; watching TV or using video-game or computer 3 ou more hours/day. IA with OW: participating for 3 or more hours / week of games and sports.	Age; sex; ethnicity; parents' occupation and schooling; eating preferences.	58.1	-

Ho *et al.* (2006) [37]	Di=frequency of consumption of selected foods; At=frequency of PE; Co=smoking, consumption of alcohol and illicit drugs, sexual behavior; Psi= delinquent behavior.	Referred / BMI over percentile 85 / CDC (2000).	Multivariate logistic regression model	No association between delinquent behavior (exposure of interest) and OW was observed.	Age; sex; ethnicity; area and region of residence.	62.9	Impossibility of tracing causal relations (cross-sectional design); limited external validity (delinquent youth may not be in school); possibility of measuing bias (delinquent behavior measured only by three indicators)
Campos *et al.* (2006) [89]	So= family's socioeconomic level; type of school.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Univariate analysis	PA with OW: socioeconomic level of families.	-	46.8	-
Nunes *et al.* (2007)[88]	So= family's socioeconomic level; Di=frequency of consumption of selected foods; At=# of hours of PE/ without; Co=# of TV hours /day	Assessed / BMI over percentile 85 / CDC (2000).	Univariate analysis	PA with OW: socioeconomic level of families.	-	46.7	Measurement of food consumption only during school hours.
Roseman *et al.* (2007)[63]	De= ethnicity; Di=frequency of consumption of selected foods and breakfast in past 7 days.	Referred / BMI over percentile 95 / CDC (2000).	Univariate analysis	IA with OW: having had breakfast, fruit, carrots and other vegetables in past seven days.	-	75.8	Study design does not allow assessing cause and effect relation, possibility of measurement bias, other confounders not measured.
Suñé *et al.* (2007)[73]	So= parents' schooling; Di= frequency of consumption of selected foods; At=frequency of PE; Co=# of TV, video or computer hours/day; Am= type of school.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate Poisson regression model, with entry of hierarchized variables.	PA with OW: studying in private school; having one or both OW parents; daily TV, video or computer hours; having moderate or light level of PE; IA with OW: studying in state school.	Sex; frequency of food consumption.	55.0	Possibility of occurrence of reverse causality; difficulty to select tool to measure PE.
Li *et al.* (2006)[54]	De=nationality, location of residence, # of individuals in family; So=parents' schooling and occupation, # of household assets, means of transportation and communication utilized; Co=leasure activities; Fa= parents' EN; Pr=birthweight.	Assessed / BMI over corresponding 25.0 aos 18 years for age and sex / Cole (2000).	Multivariate logistic regression model.	PA with OW: living in urban area; # of household assets; having one obese parents.	Sex; age.	66.1	
Moayeri *et al.* (2006)[76]	So=parents' schooling; Di= frequency of consumption of selected foods and energy consumption; At=frequency of PE and Co= TV hours /day.	Assessed / BMI over corresponding percentile 85 and 95 / CDC (2000).	Univariate analysis	PA with OW: TV hours /day	-	58.1	Possibility of information bias; Impossibility of extrapolating results for entire country; utilization of American population as reference; Study design does not allow to assess cause/ effect relationship.

Kosti, *et al.* (2007)[64]	Di= frequency of consumption of selected foods and behaviors related to food; At=frequency and duration of PE; Co= TV, computer work and videogame hours /day.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate logistic regression model	IA with OW among boys: consumption of cereal for breakfast; having 3 or more meals with snacks. PA with OW among girls: Having chicken 1 or more times/week; IA with OW among girls: consumption of cereal at breakfast; having breakfast 5 or more times a week.	Age; practicing PE outside school; # of study hours/day; # of hours in non sports activities; consumption of sweets, poultry, eggs, French fries at least once a week.	51.8	Does not establish causal relations, only suggests assumptions; under or over estimation of food consumption and absence of information on exact size of portions.
Pérez- Cueto *et al*. (2005)[90]	So=receiving allowance from parents, student working, occupational status of parents; Am=type of school.	Assessed / BMI over corresponding 25.0 at 18 years for age and sex / Cole (2000).	Multivariate regression logistic model, with automatic variable selection strategy.	PA with OW: receiving daily allowance.	Sex; age; occupation of father and mother; type of school; language spoken at home; receiving allowance.	68.3	-
Boutelle *et al.* (2007)[38]	De=ethnicity; So= parents' economic level (based on schooling, occupational status and income from government); Di= acquisition and consumption of fast-food, availability of food at home and parents' frequency of consumption of selected foods.	Assessed / BMI over percentile 85 and 95 / CDC (2000).	Univariate analysis	No statistically significant association identified between acquisition and consumption of fast-food (exposures of interest) and OW.	-	61.3	-
Richardson *et al.* (2006)[77]	De=ethnicity; So=parents' schooling; Psi= depressive symptoms.	Referred / BMI over percentile 95 / CDC (2000).	Multivariate logistic regression model	PA with OW: higher score of depressive symptoms	Age; stage of pubertal development; parents' schooling.	79.0	-
Ramos & Barros (2007)[72]	Co=smoking, use of alcohol, time spent in sedentary activities, # of sleep hours /day; Fa= parents' EN, parents smoking.	Assessed / BMI over percentile 85 / NHANES (1974/5).	Multivariate logistic regression model	PA with OW among boys: parents' BMI; having smoked sometime in life. IA with OW among boys: 9 h or more of sleep; intensity of leisure PE. PA with OW among girls: daily TV hours or in sedentary activities; parents' BMI.	Parents' schooling and other relevant factors in univariate analysis (not specified by authors).	67.8	-

* De= demographic variables; So= socioeconomic variables; Di=dietary variables and related to food consumption; At=variables related to physical activity; Co=other behaviors; Psi=psychological variables; Pr=previous variables; Fa=family characteristics; Am=environmental; OW=overweight. **PE=physical exercise [$]EN= nutritional status [#]SI= no information

Behavioral variables and OW

Among behavioral variables, 30 studies assessed dietary variables, 31 evaluated factors related to physical exercise (PE) and 29 measured other behaviors. Being or having been on a diet to lose weight or having a restrictive diet behavior had a direct association with OW in all studies analyzed [14, 35, 55-59], except for a study conducted in Brazil[60]. Attitudes related to weight loss (ex: taking pills, laxatives to lose weight without medical guidance)[55], consumption of soft drinks 3 days or more per week[40], and the habit of buying a snack at school[51] were also positively associated with OW. There was an inverse association with OW for: habit of having breakfast[59, 61-63], amount of energy, fibers and cholesterol consumed in the past 24 hours [47], consumption of fruit and greenery in the past seven days [63], habit of having cereal for breakfast[64], and having more meals during the day[14,60,65]. By comparing these findings to those found in analyses stratified by sex, a study presented discordant result among girls: being on a diet to lose weight was inversely associated with OW[60]. The habit of having dinner with family was inversely associated with OW in one of the two studies that analyzed this behavior[36, 66].

Exercising (PE) and its frequency at and outside school, especially more intense PE (vigorous and intense exercise), assessed by different tools, were inversely associated with OW in 12 studies [40, 51, 55, 59, 61, 62, 67-72]. In a longitudinal study conducted by Gordon-Larsen *et al.*[67], the increase in the intensity of PE, taken as a time-dependent variable, was also shown to protect against OW. Only two studies identified a positive association between PE and OW[55,73].

When other behaviors were assessed, a direct association was observed between the number of hours spent in front of the TV, video-game or computer and OW in all studies that showed statistical significance in the analysis of the relation[39,60,61,67,68,71-76].

The number of hours of night sleep was inversely associated with OW in two of the six studies that assessed this variable[72,75]. Smoking, using alcohol and other drugs, investigated by 11 studies, did not show association with OW, except for the study of Carrière[62], that observed a positive association between OW and a smoking experience sometime in life.

Psychological variables and OW

Seven studies[19,37,44,55,57,59,77] assessed psychological variables and, of these, three presented significant associations with OW. Directly associated with OW, both in boys and girls were: a higher score of depressive symptoms[77]; presence of a food disorder characterizing a restrictive behavior[59] and the presence of trace of anxiety[19]. However, OW was inversely associated with the presence of eating disorders due to external stimuli, when only girls were taken into consideration[59].

History and family characteristics and OW

Initial living conditions and family characteristics that were directly associated with OW were: occurrence of overweight in some phase of childhood[14,40,58,78,79,]; fast weight gain up to the second year of life[78]; smoking during pregnancy[17,18], and maternal pre-gestational BMI [18]; overweight mother and/or father[17,35,44,54,58,62,69,72,73,79,80]. One article identified a direct association between parents currently smoking and OW[62]. A similar result was observed when analyses were stratified by sex. Duration of breastfeeding for two or more months had a protecting effect on OW in three studies[14,17,81]. However, in the study conducted by Salsberry & Reagan [17] this association was observed only among obese mothers.

The main limitations mentioned by authors for the articles selected were: utilization of cross-sectional data, which does not guarantee that exposure preceded outcome (even if in some articles the original design was a cohort study); utilization, in some studies, of weight and height referred by

adolescents and/or parents; compromise of external validity in some studies and incomplete adjustment because of not accounting for potential confounders in the relationship of interest.

DISCUSSION

The major socioeconomic, environmental and behavioral factors associated directly or inversely with OW among adolescents in the present revision were: socioeconomic level of families; certain behaviors related to food, mainly referring to restriction of food consumption and having breakfast; frequency and intensity of physical exercise and time spent in sedentary activities. Previous nutritional status of adolescents and nutritional status of parents also proved as relevant conditions for the occurrence of OW in adolescence.

Despite the heterogeneity observed in the design and in the selection of variables and exposure indicators, patterns of association between socioeconomic variables and OW were shown to be consistent, highlighting the difference of the direction of this association between developed and developing countries, observed in some surveys with nationwide representativeness[2,38,80]. Studies using data from the past three decades in the United States (USA) showed that the increase in the prevalence of overweight is higher in families who live below the poverty line, especially among older adolescents (15 to 17 years) and Afro-American individuals (in comparison to white and Hispanic individuals of the same socioeconomic level). In a more recent period (1999 – 2002), an inverse association between socioeconomic level and OW was observed to be statistically significant only among girls[40,82]. In Brazil, for example, in a period similar to that of the studies performed in the US, a direct relation between family income and OW was observed among adolescents and the relation is becoming weaker among girls[2].

Regarding dietary variables, a large number of studies identified the variable "dieting/or having dieted to lose weight" as a risk factor for OW. Methodological explanations may justify this finding, apparently without biological plausibility. Among the studies that identified this association, all had a cross-sectional design and/or analysis. Such design does not guarantee that exposure preceded outcome. Another explanation is the possible occurrence of systematic error in assessment, given OW adolescents would tend to give more socially expected answers, underestimating their food consumption and answering this question positively. Neumark *et al.*[83] questioned the validity and a reliability of the question "be on a diet", that could have several meanings to adolescents and they recommend performing qualitative studies to improve its understanding. In addition to methodological explanations, in the longitudinal study where this association was observed, the authors assessed characteristics associated with restrictive eating behaviors that are associated with the occurrence of OW. Adolescents with these behaviors limit their food intake, skip meals, feel very hungry and have little control over their eating and for this reason may be more susceptible to overweight[59].

We also identified eating behaviors that protect against the study's outcome, such as the habit of having breakfast and having more meals during the day. These behaviors are related to a more regular and defined meal pattern and are inversely associated with the habit of "snacking" foods with high energetic density throughout the day and, directly with vigorous physical exercise[20,56,84]. Skipping breakfast is also suggested to be directly associated with other restrictive eating behaviors[59,61].

Despite the heterogeneity observed in variables and indicators presented by studies to measure exercising and intensity of physical activity (ex.: frequency, time, king and intensity of physical activities, participating in team sports, exercising at and outside school, etc.), this behavior seems to to protect against OW (except in the studies of Pérez *et al.*[55] and Suñe *et al.*

2007 [73]. These findings are corroborated by recent systematic revisions that identified the efficacy and effectiveness of exercising and reduction in TV watching time in the prevention of OW in childhood and adolescence[23,25,26].

Few studies have identified association between psychological variables and OW. In the process of selecting studies, many articles were excluded because they assessed OW as a risk factor for psychological disorders, suggesting that psychological disorders are studied more as consequences than determinants of OW among adolescents.

Although it was not the objective of the present revision, some of the studies selected pointed toward a higher likelihood of OW among adolescents with at least one parent that was obese or that had been overweight during childhood. A survey with children also identified the presence of OW in parents as a risk factor for obesity[7]. The interaction between a complex network of genes associated with obesity and the environments that favor their expression has been appointed as the background for the occurrence of obesity among individuals of the same family [85].

Among studies selected, distinct criteria were adopted for the diagnosis of OW. Wang & Wang[86] compared the prevalences of overweight and obesity in American, Chinese and Russian adolescents, according to the first three criteria adopted in the present study. The authors observed considerable differences among prevalences and recommend care in the comparison of results when distinct criteria are used. Despite this limitation, criteria for the diagnosis of OW used internationally were considered in the present revision aimed at expanding the selection of relevant literature to comply with the objective of the study. Moreover, the objective of the present study was to revise the association between certain factors and OW and not to compare the magnitude of the condition in diverse scenarios. The agreement between results of studies that utilized different criteria for diagnosing OW corroborates the consistency of the associations described in them.

As to the quality of studies, Khan *et al.*[87] listed some aspects that should be assessed and that relate directly to the level of evidence of results found in a systematic revision: the kind of study design and care adopted while it was conducted and analysis of results. Regarding the first aspect, most (n=53) studies included in the present revision have a cross-sectional design and/or cross-sectional analyses (level of evidence considered weak, according to these authors). However, comparing the results observed in studies with cross-sectional design and/or analyses with those of longitudinal analyses, a general similarity in patterns of association was observed. It should be also pointed out that, for some factors, it is possible to guarantee preceding time relations, as, for example, for variables that assess the socioeconomic level of families and those that relate to initial life.

On the conduction of studies, great heterogeneity in the selection and methods utilized for assessment of independent variables was observed, and also in the criteria adopted for diagnosis of OW, which makes their joint analysis difficult. This limitation seems to compromise, mainly, the analysis of association between eating behaviors and consumption variables with OW. Eleven of the 25 articles that assessed food consumption did not present any information on the validity or reliability of the tool used toward that end[14,18,39,40,47,62,64,66,69,76,88]. However, for certain variables, there seems to not have been an influence of this limitation, given the similarity of the results observed, as was the case of variables related to exercise.

As to the care adopted in the analysis of results, nine studies carried out univariate analyses, without adjustment for potential confounding variables. The results of these studies, in general terms, were similar to those found in the studies that performed adjusted analyses. It should be pointed out that few studies included adjustments to correct the effect of the sample design and/or commented on the quality inspection of adjustment.

Some limitations of the present revision should be pointed out. The first one refers to the possibility of a relevant study being ignored, as only publications in English, Spanish or Portuguese were analyzed. No search was performed to identify unpublished studies or those published in annals of congresses, symposiums, etc. The second limitation refers to the interpretation of results of articles that assessed previous characteristics, given the initial objective of the present study was not to identify factors of initial life nor behaviors or nutritional status of parents; therefore, search strategies were not specified with that aim. Consequently, articles that studied this association may have been missed.

FINAL CONSIDERATIONS AND CONCLUSION

The growth in the magnitude of OW among youth of several regions of the world is an unquestionable reality. The acknowledgement of the complexity of its determinants and involvement of several sectors of society to prepare actions to promote health and prevent the condition is one of the current challenges in the global public health agenda. Despite the limitations in the comparison and analysis of selected studies, the revision points out a set of socioeconomic and behavioral factors that were shown to be associated with OW among adolescents and that are prone to intervention, and also highlights population groups in which the likelihood of the condition occurring is higher. The present authors, therefore, recommend that interventions oriented toward adolescents, both at the collective and individual level, take into account the factors herein identified, that is: socioeconomic level of families; food restriction behaviors; the habit of having breakfast; frequency and intensity of exercise, and time spent in sedentary activities. In addition to these, other factors of environmental, cultural and political nature are still little explored and should be considered, given the complexity and dynamics of the network that determines overweight in this age group still very susceptible to the changes experienced by societies.

Last, it should be pointed out that other eating behaviors, such as the consumption of certain foods and nutrients, habit of family meals, psychological variables, and environmental characteristics were little studied or did not present consistent associations between selected studies and, therefore, require further investigation.

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