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Overweight among adolescents and nutritional status of their parents: a systematic review

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Abstract *The article seeks to investigate the association between overweight in adolescents and the nutritional state of the parents and identify possible determinants. The search was carried out in the Pubmed, Lilacs, Scielo databases and Virtual Health Library (BVS), were searched regarding the period from 2004 to 2014. The descriptors were: "Adolescent", "Risk factors", "Obesity", "Parents" and "Overweight". Of the 366 articles, only 07 met al.l the eligibility criteria. Higher prevalence of overweight in adolescents was noted in studies conducted in Brazil and Greece, while the prevalence of obesity was higher in studies conducted in United States. Higher overweight prevalence in male adolescents was verified. All studies showed that the presence of overweight or obesity in the father or the mother increases the risk of adolescents developing overweight, and this risk is even greater when both parents are obese. The strong association between overweight in adolescents and nutritional status of the parents found in the selected studies is related to many factors, thus the presence of a risk factor, such as genetic predisposition, can be ameliorated by a protective factor, such as healthy eating habits.*

Key words *Adolescent, Risk factors, Obesity, Parents and Overweight*

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Introduction

Adolescence represents a period of the life cycle that is marked by intense biological and psychosocial changes. Obesity among adolescents is a major public health problem that has been on the rise in recent years[1].

Behavioral changes that have occurred in recent decades, including reduced levels of physical activity and increases in the consumption of high calorie foods, have driven an epidemiological transition, characterized by a drop in the prevalence of infectious diseases and an increase in the prevalence of chronic non-communicable diseases, among them obesity, which is currently at pandemic levels[2].

A global study using systematic analysis showed the prevalence of overweight in children and adolescents in developing countries to be 12.9% in boys and 13.4% in girls[3]. While in developed countries, the figures are even higher with 23.8% of boys and 22.6% of girls with overweight or obesity[3]. In Brazil, data from the Study of Household Budgets (POF – Pesquisa de Orçamentos Familiares) from 2008-2009 showed the prevalence of overweight in adolescents to be 21.7% for males and 19.4% for females, numbers that are worrying given the serious problems that are associated with excess adiposity[4].

The early development of obesity, in infancy or adolescence, is a strong predictor of the persistence of this infirmity in adult life and a risk factor for the development of other chronic non-communicable diseases such as cardiovascular disease, dyslipidemia, arterial hypertension, type 2 diabetes and some types of neoplasms[5].

There are a number of factors associated with the development of overweight in adolescence, among them: parental factors; inappropriate eating habits; physical inactivity; screen time; relationships with peers; socioeconomic levels; the social context in which the individual is brought up; maternal schooling and parents' nutritional status[6,7].

Studies have shown a strong association between parents' overweight and adiposity in adolescents. This association also involves genetic factors, since children of obese parents have a considerably greater risk of becoming obese and of adopting inadequate behaviors such as poor dietary habits that are passed down through generations[7-9]. Thus, this study seeks to verify the association between overweight among adolescents and the nutritional status of their parents, in order to identify possible determining factors.

Methods

This study involves a systematic review of the literature based on the following question that uses the PECO strategy[10]: "What is the association between overweight in adolescents and the parents' nutritional status, when compared with children of eutrophic individuals?". The revision was based on the PRISMA directive: Preferred Reporting Items for Systematic Reviews[11].

The bibliographic review was carried out between November 2014 and January 2015, using the following databases: Publisher Medline (Pubmed), Literatura Latino-Americana e do Caribe em Ciências da Saúde (Lilacs), Scientific Electronic Library Online (Scielo) and Biblioteca Virtual de Saúde (BVS). For the search strategy the following key terms were combined using the Boolean operators OR and AND: "Overweight", "obesity", "risk factors", "adolescent" and "parents". For the search on Pubmed, the key terms were identified using Medical Subject Headings (Mesh), published by the U.S. National Library of Medicine (http://www.nlm.nih.gov/mesh/), and the following search terms were used: ((("overweight"[MeSH Terms] OR "obesity" [MeSH Terms]) AND "risk factors"[MeSH Terms]) AND "adolescent"[MeSH Terms]) AND "parents"[MeSH Terms]. For the searches carried out on Lilacs, Scielo and BVS, the terms were drawn from the key terms at 'Descritores em Ciência da Saúde' (DeCS), available at the 'Biblioteca Virtual em Saúde' portal (http://decs.bvs.br), and the following search terms were used, respectively: obesity [subject key term] and adolescent [subject key term] and parents [subject key term], (overweight) OR (obesity) AND (risk factors) AND (adolescent) AND (parents) and (tw:(overweight)) OR (tw:(obesity)) AND (tw:(risk factors)) AND ((tw:(adolescent)) AND (tw:(parents)).

The inclusion criteria that were used were: original studies involving humans, with a representative and random sample selection, in which the nutritional status of adolescents was evaluated in line with the curves proposed by the World Health Organization (WHO)[12] or by the Centers for Disease Control and Prevention (CDC)[13] or the International Obesity Task Force (IOTF)[14] and the nutritional status of the parents was measured using Body Mass Index (BMI)[15]; with an association between excess weight in adolescents and overweight/obesity in parents, using multivariate statistical analysis; written in Portuguese, English or Spanish and published in the

last ten years (between January 2004 and December 2014).

The selection of articles was carried out by two researchers working independently, and involved three stages: reading of the title, reading of the abstract and reading of the complete article. After reading the title and abstract, the full text was read in order to identify those which fulfilled the inclusion criteria, as per the pre-established protocol.

The kappa agreement index was calculated and was found to be 0.85, which points to a high level of agreement between the researchers[16]. Any disagreements were resolved by consensus between the two readers. Once the articles had been selected, the data was extracted, following the protocol that had been defined in advance by the authors, then put into a table in Microsoft Office Excel 2007.

The articles were evaluated for quality using the STROBE check-list, translated by Malta et al.[17], containing 22 items relating to the essential points that should be described in observational studies. Each item was given a score from 0 to 1 point, and any article that scored 50% (11 points) of the overall points was considered to be of good quality.

Results

366 articles were initially identified, including 154 on Pubmed, 8 on Lilacs, 2 on Scielo and 202 on BVS. Of the articles found on BVS, only 10 were not indexed in the other databases, so 192 were excluded from the original number. The titles and abstracts were evaluated, resulting in the exclusion of 137 articles that did not meet the criteria established previously. After reading through the remaining 37 articles, seven were found to meet the eligibility criteria and were selected by both researchers (Figure 1).

The main characteristics of each of the seven studies are shown in Chart 1, in decreasing order of the score they obtained using an analysis of methodological quality. The average score obtained using the STROBE protocol was 17, with a maximum of 19.3[8,18] and a minimum of 15[19] (Chart 1).

The majority of the studies were carried out in the United States[21,22], Greece[18,19] and Brazil[8,23] and all were published in the period between 2004 and 2013[8,18,19,21-24]. The sample sizes ranged from 914[23] to 9571[22] individuals and, of the studies selected, two are prospective cohort studies[18,21], while all the others are cross-sectional studies[8,19,22-24]. The studies included members of both sexes in similar proportions, with the exception of one which was carried out in Iran and involved only female adolescents (Chart 1)[25].

The objectives and statistical analyses of the selected studies are presented in Chart 2. The

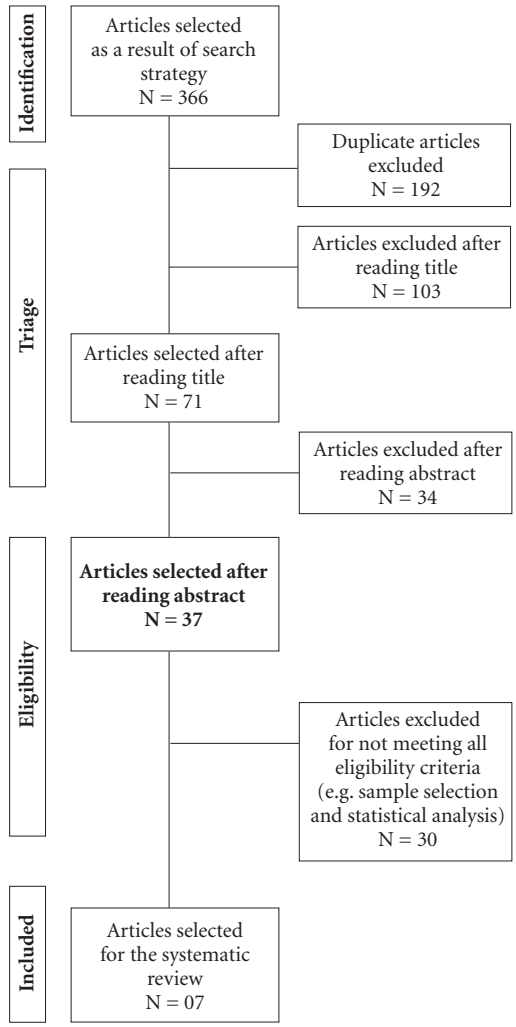

Figure 1. Flow diagram of the process of identifying and selecting the articles including in the systematic revision about the association between overweight in adolescence and parents' nutritional status, 2004 – 2014.

Source: Moher et al.[20].

Chart 1. Characteristics and scores of the quality of studies about the association between overweight in adolescence and parents' nutritional status, selected for the systematic review.

Reference	Location, year	Type of study	Population (n)	Characteristics of the population	Score
Bernardo et al.[8]	Florianópolis, Brazil, 2012	Cross-cutting	2,826	Age range = 7 to 14 years. 48% M; 52% F.	19.3
Veltsista et al.[18]	Greece, 2010	Prospective Cohort	7,219 2,826	Age = 7 years 51.8% M; 48.1% F. Age = 18 years. 45.4% M; 54.6% F.	19.3
Kowaleski-Jones et al.[21]	Ohio, United States, 2009	Prospective Cohort	1759	Age range = 16 to 21 years. 52.2% M; 47.8% F.	17.4
Maddah et al.[24]	Rasht, Iran, 2010	Prospective Cohort	2,577	Age range = 12 to 17 years. 100% F.	17
Liu et al.[22]	United States, 2013	Prospective Cohort	9,571	Age range = 6 to 17 years. 50.6% M; 49.4% F.	15.4
Marins et al.[23]	Rio de Janeiro, Brazil, 2004	Prospective Cohort Prospective Cohort	914	Age range = 6 to 14 years. 50.8% M; 49.2% F.	15.1
Birbilis et al.[19]	Ática; Etólia-Acarnânia; Heraclião; Tessalônica - Greece, 2013	Cross-cutting	2.294	Age range = 9 a 13 years. 49.7% M; 50.3% F.	15

M: male sex; F: female sex.

multivariate analysis that was most commonly used to check for an association between nutritional status of adolescents and their parents and to calculate the risk of this event was logistical regression[18,22-24]. The dependent variable in the studies was overweight and/or obesity in adolescents, and the independent variable was excess adiposity in parents. In addition, other independent variables were analyzed such as: family income, level of schooling of parents, diet, the practice of physical activity, sedentary lifestyle, location of residence, among other socioeconomic and demographic variables (Chart 2).

Chart 3 shows the principle results and methodological limitations of the selected studies. The prevalence of obesity and overweight varied according to the geographic region in which the study was developed. A greater prevalence of overweight was found in the studies carried out in Brazil[8,23] and in Greece[18,19], while the research carried out in the United States found the prevalence of obesity to be greater[21,23]. The lowest prevalence of obesity was found in a prospective cohort in Greece[18]. With regard to frequency by sex, there were found to be greater prevalence of overweight in male adolescents (Chart 3)[8,18,19,21-23].

Perinatal, behavioral, biological and socioeconomic factors were significantly associated with a greater risk of excess weight in adolescents and these include: excess of pre-gestational weight; smoking during pregnancy; rapid weight gain during childhood[8]; skipping meals[24]; male sex[8,18,19,21-23]; overweight in parents[8,18,19,21-24]; black parents[21]; living in low income areas[24]; low level of schooling of parnets[8,21,23]; and lower family income[21,22].

All the studies showed that the presence of overweight or obesity in the father or mother increases the risk of adolescents developing excess adiposity[8,18,19,21-24] and that this risk is still greater when both parents are overweight[8,18,22]. In the prospective cohort study carried out in Greece, the adolescents were found to have a five-fold greater risk of being obese when both parents were obese, when compared with children of eutrophic parents (Chart 3)[18].

The main methodological limitations of the studies cited were: use of self-referred anthropo-

Chart 2. Objective and statistical analysis of studies selected for the systematic revision.

Reference	Objective	Statistical Analysis
Bernardo et al.[8]	To measure the association between parents' NS, sociodemographic and dietary variables with overweight/obesity in schools.	Poisson's Regression. DV: Overweight/obesity in schools; IV: Parents' NS and demographic and dietary factors; CI 95%.
Veltsista et al.[18]	To determine the prevalence and monitoring of overweight and obesity in a representative sample of Greek youths and to relate with childhood and parental factors.	Multivariate logistical regression. DV: Overweight/obesity in adolescence IV: Parents' NS, location of home, education levels of parents and practice of PA. CI 95%.
Kowaleski-Jones et al.[21]	To check for an association between three measures of maternal BMI and overweight in adolescence.	Multivariate analysis. DV: Overweight in adolescents. IV: Maternal BMI
Maddah et al.[24]	To check the prevalence of overweight/ obesity among female school children by location of home, mother's socioeconomic and education levels in Rasht; to explore the contributions played by certain lifestyle factors in the family context.	Logistical regression. DV: overweight in adolescents IV: overweight/ obesity of parents; BW, socio-economic factors and PA. CI 95%.
Liu et al.[22]	To analyze the similarities between BMI and body weight among parents and children	Logistical binary and multinomial regression. DV: obesity in adolescents; IV: obesity in parents. Mode adjusted for sociodemographic factors and socioeconomic variables.
Marins et al.[23]	To investigate the relationship between NS of parents and overweight in children and adolescents who reside in Rio de Janeiro, Brazil	Logistical regression. Univariate analysis (association between overweight in children and adolescents with socioeconomic and demographic variables).
Birbilis et al.[19]	To identify the association between overweight and/or obesity in school children with parents' BMI, perinatal, socioeconomic and demographic factors	Multivariate regression. DV: overweight/obesity in adolescence IV: NS of parents, demographic and perinatal factors. Adjusted OR. 95% CI.

OR= *odds ratio;* CI = Confidence Interval; NS: Nutritional status; DV: Dependent Variable; IV: Independent Variable; BMI: Body Mass Index; PA: Physical activity; BW: Birthweight.

metric data[8,18,19,21,22,24] and the inability to establish a causality relationship (Chart 3)[8,19].

Discussion

Obesity is a chronic disease with multifaceted causes that is characterized by an excess of adiposity on the body, that has a negative impact on health[26]. It is linked to biological, genetic and environmental factors, and is caused by a positive energy balance, whereby the individual ingests more energy than he or she expends through organic processes[25]. It is a risk factor for the development of Chronic Non-Communicable Diseases (CNCDs), including cardiovascular disease which is the principle cause of mortality globally. In Brazil, approximately 30% of deaths are attributed to heart-related illness[27].

The high prevalence of overweight found in the studies of Brazilian adolescents may be related to the nutritional transition which the coun-

Chart 3. Principle results and methodological limitations of the studies selected for the systematic revision.

Reference	Principle Results	Methodological Limitations
Bernardo et al.[8]	Overweight in adolescents: 25.4% M: 18.7% F. OR and CI 95% - father overweight: 1.53 (1.13, 2.07); OR and CI 95% - mother overweight: 1.41 (0.99, 2.01); OR and CI 95% - father and mother overweight : 1.83 (1.27, 2.65).	Self-reported weight and height of parents. Reverse causality.
Veltsista et al.[18]	7 year old children: Overweight: 16.1% M; 19.2% F. Obesity: 6.2% M; 5.8% F. 18 year old adolescents: Overweight: 19.1% M; 7.9% F. Overweight: 3.6% M; 1.0% F. OR and CI 95% - father or mother overweight: 3.34 (1.79, 6.24); OR and CI 95% - father and mother overweight: 5.03 (2.70, 9.38). In the transition from childhood to adolescence, the prevalence of overweight increased among boys and reduced among girls.	Self-reported weight and height.
Kowaleski-Jones et al.[21]	Overweight among adolescents: 17% M; 13% F. OR and CI 95% - mother overweight: 1.16 (1.11, 1.20)	Self-reported weight and height.
Maddah et al.[24]	Overweight among adolescents: 18.6%. Obesity among adolescents: 5.9%. OR and CI 95% - father obese: 2.0 (1.25, 3.36); OR and CI 95% - mother obese: 2.1 (1.31, 3.42).	Self-reported weight and height of parents.
Liu et al.[22]	Overweight among adolescents: 16.2% M; 14.9% F. Obesity among adolescents: 20.6% M; 14.8% F. OR and CI 95% – father obese: 2.1 (1.6, 2.8); OR and CI 95% – mother obese: 1.9 (1.5, 2.4); OR and CI 95% – father and mother obese: 3.2 (2.5, 4.2).	Self-reported weight and height. 22% - 23% of children were excluded, which affected the age of the sample and may result in sample bias.
Marins et al.[23]	Overweight among adolescents: 26.9% M; 20.7% F. Obesity among adolescents: 9.7% M; 6.7% F. OR and CI 95% - father overweight: 1.0 (0.7, 1.40); OR and CI 95% - mother overweight: 1.4 (1.04, 1.93).	Not reported
Birbilis et al.[19]	Overweight among adolescents: 31.3% M; 29.7% F. Obesity among adolescents: 13.7% M; 9,5% F. OR and CI 95% - father obese: 2.25 (1.45, 3.48); OR and CI 95% - mother obese: 2.14 (1.28, 3.60).	Reverse causality. Self-reported weight and height of parents.

OR= *odds ratio;* CI = Confidence Interval; M: male sex; F: female sex.

try's population has passed through. According to Gaino et al.[28], in the last 30 years, there has been a significant increase in the consumption of industrialized foods, with increases of: 317.6% in the consumption of prepared food products; 584.6% in the consumption of guarana flavored fizzy drinks; and 966.6% of yoghurts. These increases are cause for concern since they are associated with a concomitant increase in the incidence of obesity in the Brazilian population.

In the Greek studies[18,19], elevated levels of overweight were found that can also be attributed to changes in dietary habits and in the practice of physical activity, arising from socioeconomic changes that have occurred in recent decades[19].

Among the articles chosen for the present systematic revision, the greatest prevalence of obesity was among American adolescents. Liu et al.[22] and Kowaleski-Jones et al.[21] carried out studies of adolescents in the United States and observed

that socioeconomic variables demonstrated the greatest association with excess weight in adolescents, since those with greater family income and lower levels of maternal schooling had a greater prevalence of overweight and obesity. According to Frederick et al.[29], the prevalence of obesity in American adolescents has, in recent years, decreased amongst the population with the highest socioeconomic levels while it has gradually increased among those in the lowest income bracket. This may be related to low levels of physical activity, due to a lack of spaces that might allow for the practice of physical exercise near to their homes, and also to food errors, since healthy foods such as fruits and vegetables are more costly than fast food and may not be available to purchase near to where adolescents live.

In this revision, male adolescents showed greater prevalence of overweight, when compared with their female counterparts. This finding is consistent with those from other studies in the literature. In the National Survey of School Health (Pesquisa Nacional de Saúde do Escolar - PeNSe), which was carried out in schools in Brazilian state capital cities, a greater prevalence of overweight was found among boys (24%) in the 11 to 19 age range, when compared with girls (22.1%) of the same age[30]. Similar results were reported in a longitudinal study of American children and adolescents, among whom the prevalence of obesity was 23.5% among boys and 17.8% among girls in the 8th year of school and with an average age of 14.1 years[31]. One of the factors that may explain the greater frequency of overweight among boys is that adolescent girls tend to monitor their weight more and are more aware of their body images and therefore of their weights. In this way, although both sexes face similar environmental risk factors, boys show a greater tendency towards overweight and obesity.

In the studies selected, perinatal factors such as excess weight during pregnancy, maternal smoking and accelerated growth during childhood increased the risk of adolescents displaying overweight or obesity. In a literature review, Godfrey et al.[32] (2010), confirmed that children of obese mothers, independently of their birthweight, showed a greater probability of having excess weight and consequently a greater risk of developing CNCDs. Skipping meals was related to overweight/obesity among adolescents. Terres et al.[5] carried out a cross-sectional, population-based study of adolescents in Pelotas, Rio Grande do Sul state and reported similar findings since adolescents who reported skipping meals were found to have a 2.54% greater risk of being obese. Lower levels of schooling among parents, lower income and living in low-income areas were positively associated with excess weight in adolescents. These variables are inter-related, since low levels of paternal and maternal schooling reduce the chance of finding well paid jobs, leading to lower family incomes which can influence where people live.

Among the several factors that are related to overweight and obesity in adolescence in this systematic revision, parents' nutritional status was found to have a strong influence[7,33]. Power et al.'s[34] longitudinal study of Britons born in 1958 showed an inter-generational transmission of adiposity. In this birth cohort study, an association was found between high BMI of parents and children across three generations.

The significant association between overweight in adolescents and overweight or obesity in their parents, when compared with the children of eutrophic parents, can be explained, at least in part, by behavioral factors. A 2012 study carried out by Morton et al.[35] showed that families that have transformational behaviors had health food consumption levels and greater levels of physical activity among adolescents. The level of physical activity of adolescents appears to be directly related to the practice of physical activity by their parents, as confirmed by Cheng et al.[36] in a study of adolescents aged between 14 and 19 in Brazil, indicating that having parents who are sedentary can be a determining factor leading to intra-family overweight.

The food habits of previous generations are also related to children's nutritional status. Alia et al.[37] found that the consumption of fruits and vegetables by parents was related to lower weight among adolescent children, showing that one of the strategies for reducing the prevalence of excess weight in individuals in this age range would be to reeducate parents and children about food habits.

Genetic factors have a significant impact on the nutritional status of parents and children, however more research is required on the relevant mechanisms involved. A study carried out in Japan found evidence that points to paternal transition of obesity induced by a diet rich in fats, which can be passed through genomes and is related to the genes Peg3 and Igf2[38].

The conclusion that can thus be drawn is that the significant association between overweight in adolescents and parents' nutritional status, reported in the selected studies, is related to several factors. In this way, the presence of a risk factor

such as genetic predisposition for example, can be counter-weighted by a protective factor such as health food habits.

Regarding methodological shortcomings of the selected articles, the majority of studies refer to the use of self-reported data on weight and height, however anthropometric measures show high levels of agreement with standard measures[39]. Studies such as the Surveillance of Chronic Illnesses by Telephone Interview (VIGITEL - Vigilância de Doenças crônicas por Inquérito Telefônico)[40], have used self-reported weight and height data, which simplifies the work and reduces costs. Another limitation was that it was not possible to establish a causal relationship, however this is inherent to cross-sectional studies.

To summarize, the studies shows that adolescents whose parents were overweight have a greater risk of being overweight or obese when compared with eutrophic peers. This risk is greater when both parents are obese. The percentage contribution of environmental and genetic factors in this associated is not defined in the literature, although it is known that both have a role to play. The selected studies show that several factors in addition to parents' weight are related to overweight/obesity in adolescence, with the most important being lower family income, lower level of mother's schooling and male sex.

This findings point to the need for public policies focused on the prevention and/or treatment of overweight/obesity in adolescence. These policies need to consider biological and socioeconomic differences and must also target parents if they are to be most effective.

In addition, studies are needed that evaluate in isolation each risk factor involved in developing overweight in adolescence given that there is a tendency for this nutritional disorder to continue to adulthood.

Collaborations

All authors participated in the making of the article and, read and approved the final version. NMS Lima participated in the design and delineation of the study, data collection, execution of methodological procedure, analysis and interpretation of data and writing of the manuscript; VS Leal and JS Oliveira participated in the study design, interpretation of the data, reading and approval of the final version. MIS Andrade participated in the data collection, execution of the methodological procedure and interpretation of the data. FCTL Pinto, RCE Menezes, CS Silva and PIC Lira participated in the critical analysis reading, review and approval of the final version.

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