

EVIDENCES OF THE RELATIONSHIP BETWEEN THE INDICATORS OF THE BODY MASS INDEX AND CARIES ACCORDING TO THE DATA OF SYSTEMATIC REVIEWS

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The article represents results of systematic reviews processing regarding existence of potential relationships between body mass index indicators and caries among patients of different age groups, and outcomes of quality evaluation of evidences regarding this issue. Results of systematic reviews available for analysis allowed to summarize that the relationship between indicators of body mass index and indicators of caries prevalence or intensity is complex, non-linear by its nature and depending on the influence of many moderating factors that can provoke variations within the structure of interaction. Data extracted from systematic reviews indicate, that despite the potential existence of specific correlations between BMI and caries prevalence/intensity, unambiguous categorization of these in terms of significance and direction is currently limited based on the quality of available evidence. According to the data of systematic reviews, significant differences in caries intensity indicators in samples of children with high and average values of the body mass index can potentially be noted during early age period, as well as during the period of deciduous dentition. At the same time, in a number of scientific works, no associations were identified between different categories of body mass index and caries intensity and/or prevalence indicators, which would allow to statistically argument the influence of obesity as a risk factor for the development of caries pathology. Significant variations in the relationships between body mass index indicators and caries in patients of different age groups, noted in previous studies, may be caused by the influence of the following factors: use of different approaches for assessing the impact of obesity (indicators of caries prevalence differences, relative risk, mean differences); differences in the structure of the studied samples; differences in approaches used for research samples formation; use of different origins data (primary and secondary); implementation of research within different conditions; application of various clinical examination methods, diagnostic criteria and approaches for classification; implementation of various methods for statistical processing of the data.

Key words: body mass index, obesity, caries, systematic reviews.

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Докази взаємозв'язку між показниками індексу маси тіла та карієсу за даними систематичних оглядів

У статті наведено результати опрацювання систематичних оглядів щодо наявності потенційних взаємозв'язків між показниками індексу маси тіла та карієсом у пацієнтів різних вікових груп та проведено оцінку доказів різного рівня якості. Результати систематичних оглядів, доступних для аналізу, дали змогу резюмувати, що зв'язок між показниками індексу маси тіла та показниками поширеності чи інтенсивності карієсу носить комплексний, нелінійний характер та залежить від впливу багатьох факторів-модераторів, які можуть провокувати різні варіації в структурі взаємодії. Дані, екстраговані із систематичних оглядів, свідчать, що, незважаючи на потенційну наявність специфічних відповідей між показниками ІМТ та поширеністю/інтенсивністю карієсу, однозначна категоризація таких за значимістю та спрямованістю нині є обмеженою виходячи з якості доступних доказів. За даними систематичних оглядів значущі відмінності показників інтенсивності карієсу у вибірках дітей із високими та середніми значеннями індексу маси тіла потенційно можуть бути відзначені у ранньому віці, а також у період молочного прикусу. Водночас у низці наукових робіт не було ідентифіковано жодних асоціацій між різними категоріями індексу маси тіла та показниками інтенсивності та/або поширеності карієсу, які б давала змогу статистично аргументувати вплив ожиріння як чинника ризику розвитку каріозної патології. Значні варіації взаємозв'язків між показниками індексу маси тіла та карієсом у пацієнтів різних вікових груп, відзначені у попередніх дослідженнях, можуть бути викликані впливом таких факторів: використанням різних підходів до оцінки впливу ожиріння (показників відмінності поширеності карієсу, відносного ризику, різниці середніх); відмінностями у структурі досліджуваних вибірок; відмінностями у підходах до формування досліджуваних вибірок; використанням різних за походженням даних (первинних та вторинних); реалізацією досліджень у різних умовах; застосуванням різних клінічних методів обстеження, діагностичних критеріїв та підходів до класифікації; імплементацією різних методів статистичного опрацювання даних.

Ключові слова: індекс маси тіла, ожиріння, карієс, систематичні огляди.

Introduction. According to the WHO, since 1975 the number of people suffering from obesity has tripled. At the same time in 2016 more than 1.9 billion adults had problems with overweight, of which 650 million were characterized by clinical signs of obesity [1, 2, 3]. In March 2022, the WHO reported, that the number of obese people exceeded 1 billion people, and by 2025, the health status of 167 million people will deteriorate precisely because of being overweight or obese [3].

The processing of large amounts of epidemiological data using machine learning algorithms allowed to establish an increase in the relative risk (RR) of caries development to the level of $RR=1.56$ among obese patients, while the average number of teeth affected by caries in such patients was 2.40 ± 3.00 , and in the group of patients with normal weight – 2.02 ± 2.79 [4]. In the literature, the connection between overweight and caries is substantiated by the presence of common risk factors, the main ones of which are dietary features, such as the consumption of excessive amounts of carbohydrates, free sugars, and others [4, 5, 6]. In addition, both the development of obesity and the development of caries are associated with the complex influence of a number of behavioural and social factors, as well as with inappropriate socio-economic living conditions [5].

At the same time, a number of scientific studies have not identified any associations between different categories of body mass index and indicators of caries intensity and/or prevalence, which would allow to statistically argue the influence of obesity as a risk factor for the development of carious pathology [7, 8].

Considering the partial inconsistency of the data regarding existing relationships between body mass index and caries indicators, which are available in the literature, it is advisable to conduct analytical processing of the results of systematic reviews as formed aggregations of information optimized for targeted analysis in accordance with the set goal. The advantages of using systematic reviews as data sources for content analysis are that the studies, included in them, have already been selected according to the previously formulated inclusion criteria, and the presented evidences are categorized due to the level of their quality.

Objective. To compare and evaluate the level of evidences regarding potential associations between indicators of body mass index and caries in patients of different age groups based on data available from systematic reviews.

Materials and methods. The formation of the primary cohort of publications, that were associated with the purpose of the study and which provided evidences for various

forms of relationships between indicators of the body mass index and caries pathology, was carried out by searching them within PubMed (NCBI) database (<https://www.ncbi.nlm.nih.gov/pubmed/>) using following descriptors:

1. ("obesity"[MeSH Terms] OR "obesity"[All Fields]) AND ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR "caries"[All Fields]);

2. ("body mass index"[MeSH Terms] OR ("body"[All Fields] AND "mass"[All Fields] AND "index"[All Fields]) OR "body mass index"[All Fields]) AND ("dental caries"[MeSH Terms] OR ("dental"[All Fields] AND "caries"[All Fields]) OR "dental caries"[All Fields] OR "caries"[All Fields]).

An additional search was conducted within Google Scholar (<https://scholar.google.com/>) using similar keywords: "body mass index", "obesity", "caries".

After the formation of the primary cohort of publications, the following inclusion criteria were used to form the study sample: 1) compliance of the publication with the criteria for a systematic review; 2) representation of the results of more than one targeted study, devoted to the research of relationships between indicators of the body mass index and caries pathology.

All publications, included in the study sample, were analyzed in detail, and the data extracted from them were categorized and systematized in the spreadsheet editor Microsoft Excel 2019 (Microsoft Office 2019, Microsoft). The main results of the analyzed systematic reviews and the identified relationships between them are presented in descriptive form in the «Results» section of this article.

Results. One of the first systematic reviews devoted to the associations between caries and obesity, conducted by Kantovitz K.R., found that out of all available publications, that matched the inclusion criteria, only three studies demonstrated high quality evidences (level A evidence), and only one study confirmed the existence of direct associations between the two above-mentioned pathologies based on high quality evidence [9]. In 2013 Silva A.E.R. and colleagues identified 13 targeted publications, that demonstrated evidences of an appropriate quality level regarding the relationship between caries and obesity, among which 6 scientific studies confirmed the positive associations between BMI indicators and caries intensity [10].

A meta-analysis of scientific studies, published between 2004 and 2011, found associations of caries pathology with both high and low indicators of body mass indexes during the analysis of a sample of children and adolescents, which made it actually impossible to establish unambiguous types of relationships [11]. Data processing made it possible to identify, that 35% of the analyzed studies shown evidences of positive relationship between caries intensity and BMI indicators, while 19% shown evidences of a negative relationship [11]. However, the authors noted, that the data on the presence of negative types of relationships between caries and BMI were mainly reported in developing countries or among the studied samples of patients with progressive or complicated caries [11]. At the same time studies, in which BMI indicators shown a positive correlation with caries intensity, were characterized by the following features: 1) lack of representation for underweight individuals in

the studied samples; 2) the composition of individuals samples from highly developed countries; 3) application of more sensitive diagnostic methods that allowed to register caries signs at the spot stage [11]. Considering the above-mentioned facts, the authors summarized the importance of assessing the hypothesis of a non-linear type of association between BMI and DMF; therefore, to study such it is necessary to use an adapted set of statistical methods for data processing, taking into account the peculiarities of their distribution [11].

Hayden C. (2012) and colleagues determined that the factors of children's origin from the so-called industrialized countries, as well as cofactors of age and socio-economic status of the family, are significant moderators in the structure of the association between caries intensity and obesity in children [12].

A systematic review of 14 cross-sectional studies, 1 case-control study, and 1 prospective cohort study stated, that the results presented by the researchers were inconsistent, as 8 publications did not indicate presence of statistically significant associations between BMI and caries, in 6 publications such association was observed and statistically substantiated, while in 2 studies DMF and BMI were characterized by a negative correlation [13]. Shivakumar S. and colleagues emphasized, that the inconsistency of the results of different investigations, analyzed in the systematic review, can be explained by the fact, that most scientific studies did not provide an assessment of the confounders impact, such as socio-economic factors, features of diet and oral care, level of prevention and provision of dental care for the population [13].

The systematization of data, provided by Chen D. (2018) did not allow to identify significant differences in caries prevalence in groups of children with normal weight and deviations from the average weight adjusted for age [14]. In the sensitivity analysis, however, it was noted, that obese children were characterized by a higher frequency of caries diagnosis during the primary dentition compared to a sample of children with normal weight. In addition, a higher prevalence of caries in children with signs of obesity was noted among residents of countries with a high level of income in both the primary and permanent dentition [14].

Application of a random effects model for the aggregated data revealed that overweight and obese children were characterized by statistically higher caries intensity compare to the sample of children with normal weight; at the same time, a low level of family income and education level were associated with the two above-mentioned pathologies [15]. Angelopoulou M. and colleagues (2019) in the meta-analysis received similar results, confirming, that overweight and obese children are characterized by a higher risk of caries development at an early age [16].

A systematic review by Alshehri Y.F. and colleagues (2020), which assessed the relationship between body mass index and caries in the Kingdom of Saudi Arabia, identified two studies, confirming the positive nature of the associations between these two pathologies in children, and the same number of studies confirming the positive nature of the associations between obesity and caries in adults [17]. At the same time, in six studies that analyzed a sample of children, the character of the relationship between caries and

BMI was categorized as negative, and two studies provided on the samples of obese adults were characterized by a lack of necessary data to make unequivocal conclusions. Based on the obtained results, the authors categorized the relationship between BMI and caries as complex, implying the influence of many moderator factors that can cause variations in the structure of the interaction [17].

Analysis of 18 publications, included in a systematic review of Aceve-Martins M. and colleagues from 2022 found, that samples of children with lower and higher BMI did not differ by caries intensity in the primary dentition [18]. However, conduction of the sensitivity analysis with the exclusion of low-quality studies made it possible to verify a statistically significant difference in the DMF indicators among children with high and low BMI values (difference of means -0.42 ; 95% CI, -0.74 , -0.11) [18].

In the work of Achmad H. and colleagues (2021), it was stated that despite the fact that according to previous studies the relationship between body mass index and the frequency of caries diagnosis in children still exists, however, it is currently impossible to categorize specific correspondences between BMI and specific caries intensity [19].

The conducted analysis of the selected systematic reviews revealed a lack of high-quality evidences regarding the existence of well-defined types of relationships between body mass index and indicators of caries prevalence and intensity. Significant variations in the relationships between body mass index indicators and caries in patients of different age groups, noted in previous studies, may be caused by the influence of the following factors [20]: use of different approaches to assess the impact of obesity (indicators of differences in caries prevalence, relative risk, difference in mean, etc.); differences in the structure of the researched samples; differences in approaches used to form research samples; use of the data with different

origins (primary and secondary); implementation of research in different conditions; use of different clinical examination methods, diagnostic criteria and approaches for classification; implementation of different methods for statistical data processing. In addition, the formation of relationships of a certain direction between indicators of the body mass index and indicators of the prevalence or intensity of caries can be influenced by the peculiarities of the distribution of target data in the structure of the studied samples. The results of systematic reviews available for analysis allow to summarize, that the relationship between indicators of the body mass index and indicators of the prevalence or intensity of caries is obviously complex, non-linear and depends on the influence of many moderating factors, that may cause different variations in the structure of the interaction. Data extracted from systematic reviews indicate, that despite the potential existence of specific correlations between BMI and caries prevalence/intensity, unambiguous categorization of these in terms of significance and direction is currently limited based on the quality of available evidence.

Conclusions. The relationship between body mass index indicators and caries intensity indicators is characterized by pronounced statistical variations, and can be interpreted as not being definitively determined and as such, which requires further detalization and clarification in the course of high quality studies. The available data indicate, that the relationship between body mass index indicators and caries intensity indicators is complex, nonlinear, and largely depends on the influence of a number of confounders. According to the data of systematic reviews, significant differences in caries intensity indicators in samples of children with high and average values of the body mass index can potentially be noted during early age period, as well as during the primary dentition period.

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