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Childhood Body Mass Index (BMI) and the Risk of Infection: A Narrative Review

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Abstract

Context: Infectious diseases are still one of the main causes of morbidity and mortality in children, especially in developing countries. In various studies, the weight of children has been found to be influential in the risk of occurrence of these diseases or their severity, and sufficient information on this matter can be important in improving the management and prognosis of patients. This study aimed to determine the impact of being underweight or obese on the risk of infection in children

Evidence Acquisition: The ISI Web of Sciences, Scopus, PubMed, and Google Scholar databases were reviewed for relevant articles published from 2010 to 2022. The keywords used included: Infections, body mass index, obesity, thinness, underweight, and child.

Results: Studies show that underweight children are associated with an increased risk of various parasitic, viral, and bacterial infections or their severity. Being overweight and obese have received less attention, but they have been shown to be effective in some respiratory and urinary infections in children.

Conclusions: According to obtained results, being underweight or obese has been linked to an increased risk of various parasitic, viral, and bacterial infections or their severity in children. Therefore, determining the weight of children, even in emergency cases, and considering it, along with other initial evaluations of children with infection, can be effective in improving the management and prognosis of these children.

Keywords: Infections, Body Mass Index, Obesity, Thinness, Underweight, Child

1. Context

The effect of the child's nutritional status and weight on endocrine and metabolic disorders is known and is considered a risk factor for many related diseases, such as diabetes (1, 2). The relationship between severe malnutrition in children, reduced immune system function, and a higher probability of contracting infectious diseases is also known. The lack of protein and micronutrients affects the hematopoietic and lymphatic organs and reduces immune functions (3). Several studies have been conducted on the nutritional status, weight, the function of the immune system, and the risk of infection in children. However, the findings are conflicting in this regard. Given the prevalence and risks of infectious diseases in children, as well as their role in societal health, and the importance of understanding factors influencing the increased incidence, risks, and complications of these diseases, this study, was designed to review the research on the relationship between the nutritional status, weight, and the risk of infectious diseases in children.

2. Evidence Acquisition

Based on the results of related studies, this is a review of the relationship between children's weight as an indicator of the nutritional status and the risk of infectious diseases. The ISI Web of Sciences, Scopus, PubMed, and Google Scholar databases were reviewed for relevant articles published from 2010 to 2022.

The keywords used included: Infections, body mass Iindex (BMI), obesity, thinness, underweight, and child. Studies on the relationship between weight or BMI, the risk of infection, and the corresponding mechanism in children were studied and analyzed.

3. Results

Evidence of the role of children's and adolescents' weight in the risk of infection is stated below.

3.1. Several Studies on Infants and Children Have Shown a Higher Risk of Infection with Low Weight

Parasitic infections: Higher prevalence of low BMI in children with parasitic intestinal infections has been shown in several studies (4-7). Alemneh et al. concluded that the prevalence of Ascaris was 2.25 times higher than Giardia in underweight children (5).

The relationship between stunting and parasitic intestinal infections has also been shown (8-11). Vonaesch et al. identified being overweight [weight-for-height z-score (WHZ) > 2 SD; aOR: 3.21; 95% CI: 1.50; 6.90 of overweight compared to normal weight] as being significantly associated with stunting (9).

Viral infections: Tembo et al. showed in a study of African children aged 3 weeks to 2 years that cytomegalovirus DNA was independently correlated with HIV infection and being underweight (12).

During a study on children and adults with influenza and other respiratory viruses (metapneumovirus, coronavirus, parainfluenza, rhinovirus), Moser et al. showed that underweight or obese adults with respiratory viruses, especially influenza, were more likely to be hospitalized (13).

In a hospital study in Oklahoma, children with a BMI of less than 5% were hospitalized more often for respiratory infections than children with a normal weight, even after taking into account the role of age and sex. Moreover, the probability of hospitalization in overweight (BMI > 85%) or obese (BMI > 95%) children is not different from that in normal weight children (14).

Bacterial infections: In the study of Roine et al., the role of being underweight in the prognosis of children with meningitis was reviewed in three regions: Finland, Latin America, and Angola. In Finland, the prevalence of underweight was very low, and meaningful analysis was impossible. Still, in Angola and Latin America, children's lower weight-for-age z-scores (WAZ) were associated with worse clinical conditions during hospitalization, slower recovery, and higher mortality. However, with multivariate analysis, in Angola, severely underweight had lower odds than the severity of the disease to increase the probability of death. In contrast, Latin America had the highest odds among all the examined variables (15).

Cies et al. conducted a study on patients aged 2 to 19 undergoing clean orthopedic surgery and receiving at least one dose of antibiotics before surgery. They discovered that being underweight (BMI 5th percentile for age and gender) and having surgery for more than 2 hours increased the risk of surgical wound infection (SSI). Children weighing more than 70 kg who received the standard dose of 1 gram of cefazolin compared to children weighing less than 70 kg who received the appropriate dose based on the weight of this antibiotic are at increased risk for surgical wound infection with methicillin-susceptible staph (MSSA SSIs) (16).

3.2. The Effect of Overweight and Obesity on the Risk of Infection or It Is Severity Has Been Less Investigated

Prins-van Ginkel et al., in a study as part of the prevention and incidence of asthma and mite allergy population-based cohort study, showed that an increase in BMI z-score was associated with an increase in cases of infections reported by the Parents of the studied children and adolescents. These results showed a clear relationship with the severity of the infection (17).

In a study of inpatient case databases in the United States, on patients aged 2 to 20 years, the risk of urinary tract infection was significantly higher only in obese female patients (> 95th percentile of weight) (18). In a similar study in Korea, urinary tract infections were more prevalent in underweight boys (weight-for-age or BMI-for-age in < 5th for age and sex) and overweight or obese girls (weight-for-age or BMI-for-age in the 85th to < 95th, and in the ≥ 95th percentiles for age and sex) (19).

In a review of 3,960 8-year-old children participating in the Dutch PIAMA Birth Cohort study, obese 8-year-old children (BMI greater than 30 kg/m^2) were 5.29 times more likely to develop bronchitis and also took more antibiotics. The association with flu, ear, and throat infections was insignificant, and moderate overweight did not show any relationship with health outcomes (20).

Kraft et al. studied 592 children with severe burns above 30% and reported that although BMI above 85% impaired the catabolic response and the acute phase after burns, it did not increase the cases of sepsis or death (21). Even weight gain in adults can protect against severe bacterial infections (22).

Also, obesity, urological diseases, and infectious diseases are closely related to each other. Obese boys may suffer from a small penis, overactive bladder, urine incontinence, poor body image, decreased quality of life, and anxiety. These issues affect the immune system and increase the risk of urinary tract infections in obese children (23, 24).

Grier et al. indicated that obesity could increase the risk of urinary tract infection (UTI) by 45% in girls, but this result was not significant in boys (18).

A cohort study by Tripathi et al. revealed that obesity was associated with several infectious diseases and that a high proportion of hospitalized children due to covid-19 were obese (25).

Of course, it should be noted that different weight measurement methods each have an error rate in determining children's weight (26).

3.3. Mechanisms Effective in Increasing the Risk of Infection with Weight Loss or Gain

In interpreting the role of weight loss in increasing the risk of infection, it should be noted that weight loss can be caused by confounding factors or be accompanied by them. This increases the risk of infections, such as chronic organ diseases (such as heart or lung diseases that cause weight loss), malnutrition, or poverty. Sometimes parasitic infections can also lead to weight loss. Deficiency of protein, vitamins, salts, and micronutrients affects the hematopoietic and lymphatic organs, endangers the innate and adaptive immune functions, and increases the possibility of infections; even prescribing some of them helps improve infections (3, 27, 28). Malnourished children have lower T cells and helper-suppressor cell ratios (T4/T8) in their whole blood compared to well-nourished children (29). Also, they have lower levels of essential cytokines for Th1 differentiation (IL-12, IL-18, and IL-21) and lower levels of TNF, IFN-γ, and IL-1, 2, and the function of their phagocytic system is also reduced (30, 31). All these changes can increase the risk of infection.

Obesity, related to parental obesity (32), may sometimes be associated with problems such as type 2 diabetes or MODS, which effectively increase the incidence of infection. However, obesity also causes disorders in the immune system: Changes in cytokine synthesis, reduction in antigenic response, and reduction in the function of natural killer cells and macrophages; disruption in the integrity of lymphatic tissue due to fat accumulation; and changes in the secretion of adipocytokines such as leptin or adiponectin (33-35).

Since chronic diseases such as type 1 and type 2 diabetes mellitus could increase the risk of infection (36), continuous exercise in type 1 and type 2 diabetes mellitus could effectively inhibit the physiological hormone process leading to obesity and reducing body weight (37, 38). Therefore, exercise is recommended for decreasing infection in diabetic, overweight, and obese children.

4. Conclusions

Several studies have investigated the relationship between childhood BMI and the risk of infection. Although weight gain can protect against severe bacterial infections in adults, being underweight or obese has been linked to an increased risk of various parasitic, viral, and bacterial infections or their severity in many studies of children. Therefore, determining the weight of children, even in emergency cases, as an estimate and considering it, along with other initial evaluations of children with infection, can be effective in improving the management and prognosis of these children.

It should be noted that the current study had several limitations. Most of the studies included in this article were retrospective cross-sectional studies, and a small percentage of included studies were prospective or interventional. On the other hand, the results of studies in this field are contradictory, and it is recommended to conduct prospective studies with a larger sample size to prove the relationship between childhood BMI and the risk of infection precisely.

Footnotes

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