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Global Mechanism of Childhood Obesity and Response Strategies of Various Countries

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Abstract:

Since modern times, childhood obesity has become a major concern for nearly every family worldwide. The resurgence in the wake of the COVID-19 pandemic has heightened the need for further investigation. The analysis found that in developed nations, childhood obesity prevalence has plateaued, but it continues to be deeply associated with socioeconomic and racial inequities, and policies are often hampered by commercial policy capture. On the other hand, developing countries such as China are grappling with the dual burden of sharply increasing obesity and the coexistence of under-nutrition and over-nutrition due to the "nutrition transition." From a biological perspective, genetic predispositions such as intrauterine developmental imprinting and the leptin-melanocortin pathway are pivotal in determining the individual vulnerability. This analysis shows that childhood obesity cannot be classified as a purely nutritional phenomenon; instead, it emerges as a complex socioecological global issue shaped by commercial determinants, socioeconomic inequities, and intricate biological systems. This analysis demonstrates the need for integrated biological, social, and ecological systems approaches to inform equitable and sustainable global health policies.

Keywords: Childhood obesity; developed and developing countries; bio-socio-ecological model; nutritional transition; health policy.

1. Introduction

Childhood obesity has evolved from an isolated health issue to one of the most severe global challenges of the 21st century. Over the past few decades, its incidence has continued to rise, posing a comprehensive threat to children's health - even in childhood, almost all organs such as the heart, liver, and bones may be affected by it. The global trend of overweight and obesity has significantly intensified since 1980. Affected by income, socio-economic status and other factors, the growth of developed coun-

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tries before the COVID-19 epidemic has gradually slowed down, but during the epidemic period, the prevalence rates in the United Kingdom (on behalf of developed countries) and China (on behalf of developing countries) have rebounded rapidly, highlighting its complexity and sustainability [1,2]. As a systemic disease, obesity doubles the risk of premature death and significantly increases the incidence of chronic inflammation and metabolic diseases in adulthood, becoming a core challenge in the global public health field.

In developed countries, the obesity rate among children in the United States has remained high for a long time, and the overall incidence rate has steadily increased over the past few decades, affecting about 20% of children and adolescents. Its notable feature is racial and ethnic differences - the obesity rates of African American and Hispanic children are significantly higher than other groups, reflecting a deep correlation between social resource allocation and health equity. In Europe, a divide exists where some countries maintain exceptionally high obesity rates, while others are increasing rapidly. Here, low-income groups are always the most affected, underscoring the impact of economic class on health. Represented by China, developing countries have experienced a steep rise in obesity rates among children over the last few decades, although the pace of growth seems to have slowed or leveled out in recent years. There are differences that are reflected in age, sex, and geography: for primary school students, the most acute issue is obesity, which is relatively high in the north for boys, who have slower growth rates while girls are improving; the long-term high obesity rate in the northern region is becoming more stable, while the eastern region is rapidly increasing due to a surge in economic activity. It is worth noting that although the overall obesity rate is stabilizing, the incidence of metabolic diseases such as fatty liver and hypertension is still increasing, forming a dual burden of „obesity metabolic abnormalities“ [2].

The epidemic has become a catalyst for exacerbating the inequality of childhood obesity. Taking the UK as an example, the obesity rate among children aged 4-5 quickly rebounded to pre-pandemic levels after the pandemic, but the obesity rate among older children aged 10-11 remains high. Even more concerning is that the obesity rate among children in the poorest areas is growing at twice the rate of affluent areas, further widening the health gap. This difference is due to factors such as school closures, reduced outdoor activities, and increased consumption of unhealthy food during the pandemic, and the impact on vulnerable groups is more persistent: behind it is the concentrated outbreak of social structural problems such as family resources and digital divide.

There are still significant gaps in existing research: in the United States, over half of clinical trials on childhood obesity do not report racial or ethnic information of participants, and the representation of groups such as Asians and Native Americans is severely inadequate, making it difficult for intervention measures to adapt to multicultural backgrounds [3]. In China, although data show that the gap in obesity rates between urban and rural areas has narrowed or even reversed, there is a lack of long-term follow-up research to support this conclusion, and policymakers still face the dilemma of „insufficient evidence“. Based on this, this paper focuses on three core objectives: firstly, to compare the differences in epidemiological characteristics of childhood obesity between developed and developing countries. The second is to analyze the pathogenic mechanisms at multiple levels of biology, society, and ecology. The third is to combine the intervention experience of various countries, propose targeted policy recommendations and future research directions, and ultimately construct an integrated analysis framework from macro to micro.

2. Intervention Practices and Case Analysis in Typical Countries

2.1 Developed Countries

The intervention in the United States focuses on „public health community linkage“ and introduces policies such as soda tax and school nutrition improvement, but the effect is limited. The 2012-2013 review showed that school intervention could only reduce children‘s BMI by 0.16-0.33kg/m ², making it difficult to reverse the overall trend [4]. The core issue lies in the dependence of policy implementation on local resources, and the lobbying and resistance of food companies weaken their intervention power, leading to a disconnect between policy formulation and implementation.

Europe, on the other hand, focuses on „food environment regulation“, reducing the accessibility of unhealthy foods through policies such as food improvement, marketing restrictions (such as children‘s advertising control), and packaging positive labeling. Although progress has been made in food improvement monitoring, the government‘s inadequate control over dominant enterprises has resulted in serious policy implementation gaps, making it difficult to break the imbalanced pattern of „commercial interests public health“ [5,6]. While developed countries illustrate the limits of policy implementation under commercial pressure, developing countries face a different yet equally complex challenge shaped by globalization and nutritional transition.

2.2 Developing Countries

The obesity epidemic in China is closely related to the infiltration of „Westernized“ diets. Hong et al.‘s research suggests that the „nutritional transition“ (from traditional high fiber diets to high-fat, high sugar diets) and the expansion of Western fast food culture are the core reasons for the increase in childhood obesity rates. Behind this transformation is the dual drive of globalization and economic development - food multinational corporations change children‘s taste preferences through marketing penetration, traditional food culture is eroded, and „intergenerational transmission of unhealthy eating habits“ is formed. Unlike developed countries, China faces a dual burden of „malnutrition and obesity coexisting“, and intervention needs to balance „ensuring food safety“ and „curbing the spread of obesity“. This means that it cannot simply replicate the policy models of developed countries, but needs to explore „gradual reforms“ that are adapted to local conditions [2,7].

3. Analysis of Biological-Social-Ecological Mechanisms

3.1 Biological Risk Factors for Childhood Obesity

An individual‘s body shape at birth has a profound and lasting impact on their future metabolic health. This imprint, formed in the intrauterine environment, can be independent of a child‘s subsequent obesity. This so-called „Developmental Origins of Health and Disease“ theory has strong clinical support in the field of childhood obesity. The most direct and substantial evidence stems from a large retrospective two-cohort study [8,9]. In this study, they examined more than 40,000 overweight and obese children from two large databases, one in Sweden and the other in Germany, Austria, and Switzerland. Results showed a clear independent association of longitudinal cardiometabolic risk with birth body shape. The study found that children categorized as small for gestational age (SGA) at birth exhibited disproportionate health risks in the future—health risks that would be worse even if they were obese. SGA children, as compared with age-matched children born at normal size (AGA), were at significantly elevated risk of developing future hypertension (20% OR = 1.20), 33% worse blood sugar control (elevated HbA1c) (OR = 1.33), and 21% worse liver function (elevated ALT) (OR = 1.21). This strongly supports the hypothesis that intrauterine growth restriction may be a critical biological mechanism driving the adverse metabolic phenotype.

From this theoretical angle, a review strengthens this argument [10,11]. The article elaborates and expands systematically on the first 1000 days of life, that is, from conception to two years, as a pivotal and sensitive period of development. Throughout these stages, a baby’s and a fetus’s organs and metabolic systems are particularly pliable. Factors related to the environment, like the nutritional status of the mother, whether it is undernutrition, overnutrition, or imbalance, can alter the expression of critical metabolic genes via epigenetic mechanisms like DNA methylation, which does not alter the genetic code. This epigenetic alteration may endure for a long time, thus permanently modifying the person’s future risk for obesity and metabolic health long after. These findings suggest that biological imprints established during fetal and early life stages set the baseline of obesity risk. However, not all children exposed to the same intrauterine or early nutritional environments develop obesity, indicating that additional medical and genetic etiologies may further explain inter-individual variability [12].

3.2 Defined Medical and Genetic Etiologies

In some children, severe obesity is not only a medical concern but also stems from a single, identifiable medical condition, with genetic predispositions being one of the most common causes. This highlights the importance of biological systems that govern the appetite and energy homeostasis in the pathogenesis of obesity. They applied a systematic diagnostic framework, which incorporated genetic evaluation, to all children with severe obesity at a pediatric obesity tertiary referral center. This study showed single identifiable causes in 19% of the patients. From those, genetic obesity was found in 13%, which included 13 distinct genetic syndromes. The study’s most striking finding involves unsyndromic genetic obesity. It was noted that mutations within the leptin-melanocortin pathway were quite common, and within that, variants of the melanocortin 4 receptor (MC4R) were the most frequent. This pathway is integral to the hypothalamic neural circuitry that controls appetite and energy homeostasis. MC4R obesity is associated with a profound dysregulation of appetite, characterized by severe, relentless hunger and a trajectory of extreme obesity that begins in early childhood. This suggests that some children with obesity may be diagnosed with the condition owing to neuroendocrine dysregulation with a specific genetic alteration. Despite the genetic and medical evidence and aetiology, the social and ecological frameworks that surround these factors often have a greater influence, for better or worse, tend to have an oversimplified approach to biological frameworks. It is, therefore, crucial to shift the focus from

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the biology of individuals and investigate the role of socio-economic and cultural frameworks in shaping the phenomenon of childhood obesity.

3.3 Socioeconomic Status and Racial Disparities

The communal and cultural context of children, specifically the transformation of their food culture, are important meso-level factor influencing the risk of obesity. Economic and commercial interests are actively working to transform the food culture of children everywhere, increasing the likelihood of obesity. In developed countries, children are surrounded by fast food and ultra-processed food. Lobstein et al. reviewed and published research in The Lancet that suggested the food industry has systematically increased the availability of ultra-processed and energy-dense low-nutrient food products targeted at children[13]. The article included analyses of children's television advertising from the US, Europe, and Australia, all of which found that soft drinks, sugary cereals, salty snacks and fast food television advertising have been dominant for decades. This pervasive marketing, by influencing children's food preferences and consumption habits, has accelerated the obesity epidemic.

Simultaneously with this, in developing countries, there is a rapid shift from traditional diets towards "Westernized" diets. This is illustrated with a study on China [2]. In the discussion section, the article points to the "nutrition transition" and the growth of Western fast food as two primary factors driving increases in childhood obesity in China. This points to the fact that globalization and growth are resulting in the erosion of traditional high-fiber, low-fat food cultures, and instead, introducing high-fat, sugar, and energy-dense food cultures, which is the cultural community factor driving the childhood obesity phenomenon in developing countries. In terms of globalization, Lobstein et al. focus on the phenomena of food multinationals rapidly penetrating the low and middle-income countries, "undermining the healthy transition from breastfeeding to family meals" and instead fostering the consumption of commercially processed baby food and sugary drinks, and in the process, altering children's taste and eating preferences and setting unhealthy dietary habits and preferences for a lifetime[13]. Nevertheless, analyzing social or biological factors in isolation cannot fully explain the persistence and inequality of the epidemic. A comprehensive understanding requires integrating these mechanisms to reveal how biology, genetics and socioecological environments interact over the life course [13].

4. Conclusion

For now, the rate of childhood obesity is continuously accelerating globally. The cause of this phenomenon is different in the developed country and the developing country. Even though research on childhood obesity is extensive, most studies are confined to a single level of analysis, overlooking the integrative macroscopic social system, cultural shifts, biological systems, mechanism interventions, and equity considerations. Noting as an interesting comparison how strategic priorities and challenges differ among various countries regarding the global problem of childhood obesity. Developed countries, such as the United States and most European countries, tend to focus more on public health and community-level interventions. These studies, however, expose a common paradox where, even in better-resourced developed countries, policies are often limited in their formulated goals because of poorly implemented strategies, industry pushback, inertia, or stagnant policy frameworks. In comparison, developing countries, including China, face the unique problem of fostering economic growth while addressing the associated health concerns. The rapid "nutrition transition" and the "Western fast-food culture" have led to an astonishing increase in obesity rates in China. This unique context suggests that the policy models of developed countries cannot simply be replicated in developing countries, which are still grappling with undernutrition. This is the tangible illustration of the "double burden" of global health. Taken together, the evidence highlights that childhood obesity is not a single-dimensional issue, but rather a complex socioecological phenomenon rooted in deep socioeconomic inequality, global commercial determinants, and multi-layered biological systems that impact individuals over the lifespan. Therefore, future strategies must transcend fragmented approaches and move toward an integrative framework that bridges macro-societal and micro-biological levels, while also incorporating cross-country perspectives. Only by acknowledging these interdependent factors and fostering adaptive, equity-centered interventions can policymakers and researchers hope to create sustainable progress in addressing the global challenge of childhood obesity. However, there is a general lack of long-term, high-quality follow-up studies targeting interventions in developing countries. While studies provide a good overview of the epidemiological trends and risk factors for childhood obesity in China, there remains limited evidence regarding which interventions are effective and cost-effective in the long term in developing countries like China. This leaves policymakers in these countries often relying on the experience of developed countries, whose evidence bases and cultural contexts are vastly different, when selecting intervention strategies. This leads to significant uncertainty regarding their applicability and effectiveness. Even in developed

countries with relatively mature research systems, such as the United States, interventions and clinical studies often lack cultural sensitivity, leading to a critical need for further exploration of strategies that are generalizable across racial/ethnic groups. This is a core finding across multiple publications.

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