Research Progress on the Correlation between Environmental Phthalate Exposure and Thyroid Hormone Level

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Abstract: Environmental phthalates are frequently used in toys, food packaging, medical supplies, and other plastic goods. Because they are easily released from plastics, they might be a concern to the natural system and public health. This study focuses on the impact of phthalate esters, a widely used plasticizer, on the environment and its relationship with human thyroid hormones. As environmental endocrine disruptors, phthalates can destroy the stability of ecosystems and lead to changes in their functions, thus posing a potential threat to ecosystem health and biodiversity. In addition, phthalates may also have adverse effects on thyroid tissue and function, increasing the risk of thyroid diseases. Therefore, it is very important to strengthen the management and supervision of phthalate esters to ensure the safety of ecosystem and human health. The results of this research can provide scientific basis for evaluating the potential health risks of phthalate esters exposure, and can also provide reference for the implementation of future environmental policies and health management strategies.

Keywords: Diethylhexyl Phthalate; Exposure; Thyroid; Hormones; Correlation

1. Introduction

As a widely used plasticizer, phthalate esters are used to make various plastic products such as medical supplies, daily necessities, food packaging, toys and coatings [1]. Because covalent connections between phthalates and plastic molecules do not exist, phthalates are easily liberated from plastic items and reach the environment [2]. Epidemiological and toxicological studies have clearly pointed out that phthalates, as an environmental endocrine disruptor, have many potential harmful effects, including reproductive toxicity, immunotoxicity, embryonic toxicity, hepatotoxicity and carcinogenicity, and can also affect the hormone balance in human body [3]. An in-depth understanding of the relationship between phthalate esters and human thyroid hormone levels and thyroid diseases is helpful to comprehensively analyze the relationship between phthalate ester exposure and thyroid hormone levels in different populations, so as to reveal the potential risk factors of thyroid diseases, provide scientific basis for public health departments on phthalate ester exposure and its potential health risks, and provide reference for government departments to formulate or revise regulations and policies related to phthalate esters to ensure public health and safety.

2. The Impact of Phthalate Esters on the Ecological Environment

Phthalate esters, classified as environmental endocrine disruptors, are omnipresent in the environment and exert a far-reaching influence on ecological systems. Research indicates that they elicit both singular and comprehensive effects on aquatic organisms, thereby potentially instigating alterations in aquatic communities and posing a risk to aquatic ecosystems. These effects extend to reproductive toxicity in aquatic organisms, such as Daphnia magna, potentially leading to population decline and disrupting ecological equilibrium [4]. Furthermore, studies have unearthed the existence of intergenerational effects of phthalates, signifying that phthalate exposure may impede the reproductive capabilities of offspring [5]. Phthalates are routinely detected and exhibit persistence in soil, consequently precipitating potential harm and pollution within soil ecosystems. This poses a latent threat to microorganisms and ecological functions within the soil matrix [6]. Moreover, the presence of phthalate esters

exerts an influence on niche distribution and organismal interactions within ecosystems, thereby exerting a multifaceted impact on ecosystem stability and function [7]. In summary, the repercussions of phthalates on ecosystems encompass a spectrum of effects, ranging from microbial degradation and reproductive toxicity to soil ecological integrity, aquatic biotoxicity, and the intricate interplay between niches and ecosystems. These findings underscore the critical significance of managing and mitigating phthalate exposure to safeguard ecosystem health and preserve biodiversity.

3. Phthalate Esters and Thyroid Hormones: A Relationship

3.1 Preliminary Study: Adverse Effects of Phthalates on Thyroid Function

An increasing amount of evidence demonstrates the harmful effects of phthalates on thyroid tissue and function, however the specific underlying processes are yet unknown [8]. Epidemiological studies consistently show that exposure to phthalates increases the risk of thyroid-related conditions, such as benign nodules and thyroid carcinoma. [9]. Huang PC conducted a comprehensive study involving 166 children, meticulously assessing serum phthalate metabolite levels alongside thyroid hormones T3, T4, and FT4. This investigation revealed a clear negative correlation between these variables. Similarly, Huang HB led a population-based cross-sectional analysis, meticulously examining urinary metabolic biomarkers of phthalate esters in relation to thyroid hormones T4 and FT4, which disclosed a pronounced negative association between phthalate esters and T4 levels [10]. In concurrence with these findings, Yao Huiyuan's meticulous research further affirmed the inverse relationship between phthalate esters and TT4 and FT4 levels [11]. Further insights into the intricate interplay between phthalates and thyroid function were derived from Wu et al.'s work, shedding light on the potential impact of phthalate-laden food consumption on children's serum TSH levels. This discovery underscores the multifaceted nature of phthalates' influence, possibly extending to the regulation of TSH levels [12]. Adding complexity to the discourse, Huang and his research team conducted an in-depth investigation into serum thyroid hormone levels and urinary phthalate metabolites. Their meticulous analysis unveiled a noteworthy correlation between these parameters, suggesting a plausible linear relationship between phthalate exposure and thyroid hormone levels [13]. These cumulative findings emphasize the urgent need for further research to clarify the complex processes by which phthalates cause adverse effects on thyroid function. Such investigations not only deepen our understanding of the physiological consequences of phthalate exposure but also carry significant implications for public health and regulatory policies. As scholars and experts, it is our responsibility to delve deeper into this critical nexus between environmental toxins and thyroid health, thereby providing a robust foundation for evidence-based interventions and protective measures.

3.2 Occupational Exposure: The Effect of Phthalates on Thyroid Gland in Certain Population

In the pursuit of unraveling the intricate link between phthalates and thyroid function, Wang's pioneering research spotlights a distinct demographic individuals immersed in the plastic recycling industry [14]. Wang's study employed a meticulous approach, carefully assessing serum thyroid hormone levels and urine metabolite concentrations within this population. The results revealed a stark contrast, with occupationally exposed workers exhibiting significantly elevated levels of phthalate metabolites compared to their non-exposed counterparts, a statistically significant difference. This observation underscores the profound influence of the occupational environment on the interplay between phthalate exposure and thyroid hormone levels. Building upon this foundation, Hui Gao's research delved deeper into the complex web of interactions between phthalates and thyroid function [15]. Gao's findings presented compelling evidence of a negative correlation between exposure to phthalate esters and the thyroid hormone TT4. This revelation further emphasizes the adverse effects of phthalate metabolites on thyroid function, adding depth to our understanding of these compounds' impact. Expanding the scope of investigation to include the vulnerable population of pregnant women, Wu Wanke's

research undertook a comprehensive study across different gestational groups [16]. Wu's meticulous examination unveiled a consistent negative correlation between phthalate ester metabolites and thyroid hormone TT4 levels. This remarkable finding suggests that the consequences of phthalate exposure extend beyond the immediate and may have a lasting impact on the thyroid function of pregnant women. Collectively, these recent studies contribute significantly to our expanding knowledge of the intricate and multifaceted relationship between phthalates and thyroid health. As scholars and experts, it is crucial to acknowledge the complexities inherent in this association, recognizing the nuanced impact of occupational exposure, the enduring influence on thyroid hormones, and the potential ramifications for vulnerable populations. These findings underscore the critical importance of continued research in this field and the potential necessity for targeted interventions to mitigate the adverse effects of phthalate exposure on thyroid function.

3.3 Intergenerational Effects: Long-term Effects of Phthalates on Thyroid of Mothers and Newborns

The intricate relationship between phthalate esters and thyroid health remains a subject of intense scrutiny, with recent studies shedding valuable light on the nuanced impact of these ubiquitous compounds. Huang and his esteemed colleagues initiated a meticulous investigation involving 98 pregnant women, aiming to uncover the consequences of phthalate ester exposure during pregnancy on thyroid hormone levels. Their findings established a significant connection, indicating that exposure to phthalate esters during pregnancy exerts an influence on maternal thyroid hormone levels. This observation underscores the multifaceted nature of phthalate exposure, encompassing maternal thyroid health and laying the foundation for a broader understanding of its implications. Expanding our horizons, Huang HB's research delved into the intricate interplay between phthalate exposure and thyroid hormone levels in both mothers and their offspring. This comprehensive analysis revealed that early phthalate exposure in children was associated with a decrease in thyroid hormone levels, emphasizing the potential long-term consequences of early-life exposure to these compounds and adding complexity to our comprehension of thyroid health across generations. Building upon this foundation, Kuo FC's insightful work delved into the metabolic impact of maternal phthalate exposure on newborns, shedding light on the intricate regulatory role of phthalate metabolites on newborn thyroid function. Their findings underscored the possibility that maternal phthalate metabolites on newborn thyroid-stimulating hormone (TSH) activity, offering yet another dimension to the intricate relationship between phthalates and neonatal thyroid health. Simultaneously, Yao HY's thorough study efforts widened the discussion's focus by clarifying how phthalates may affect pregnant women's and their unborn children's thyroid health. These insights underscore the pressing need for ongoing research in this field and the importance of adopting a multidisciplinary approach to comprehend the intricate mechanisms underlying the influence of phthalate esters on thyroid health across generations. In light of these recent findings, it is abundantly clear that the intricate interplay between phthalates and thyroid health encompasses various dimensions, from maternal thyroid function to neonatal well-being. As scholars and experts, it is imperative that we recognize the profound implications of these studies, not only for advancing scientific knowledge but also for informing the development of robust environmental policies and targeted health management strategies.

4. Conclusions

The precise orchestration of thyroid function holds a pivotal role in human health, regulating metabolism, influencing growth and development, and maintaining physiological equilibrium. However, contemporary scientific research is increasingly focused on the concerns arising from widespread exposure to environmental chemicals, with phthalates taking center stage as a prominent area of investigation. This necessitates a thorough exploration of the intricate interplay between phthalates and thyroid health, transcending scientific inquiry to influence medical practice and public health policy. This exploration aims to uncover the mechanisms through which ubiquitous phthalates, commonly present in everyday products, may impact thyroid

function. The thyroid, a linchpin in the endocrine system, governs metabolic processes, energy expenditure, and the synthesis of crucial hormones like thyroxine (T4) and triiodothyronine (T3). Any disruption to this delicate balance can set off a cascade of effects throughout the body.

The implications of phthalate exposure extend beyond mere academic curiosity. The findings derived from these studies have the potential to inform medical practice, empowering healthcare providers to better understand and manage thyroid-related health conditions. Furthermore, these revelations prompt a call to action for policymakers to bolster their oversight of environmental pollutants, including phthalates. Such regulatory measures are crucial not only for safeguarding individual health but also for advancing the well-being of entire populations. In summary, the convergence of phthalates and thyroid health represents a juncture where scientific inquiry, medical practice, and public health policy intersect. We emphasize the urgency of further research in this domain to elucidate the intricate mechanisms at play and shed light on the potential risks associated with environmental exposures. Only through collective efforts can we protect the health of individuals and broader populations, mitigating thyroid-related health issues stemming from chemical exposures.

Acknowledgements

Research project of basic research business expenses of provincial colleges and universities in Heilongjiang Province (2018-KYYWF-0121).

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