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Breastfeeding and maternal risk of type 2 Diabetes Mellitus: A Literature Review

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ABSTRACT

Breast-feeding offers plenty of benefits for both infants and mothers, however, most studies have mostly been concerned with the health of infants (1) (2).

As far as infants are concerned, breastfeeding is associated with nutritional advantages and a reduced risk of acute otitis media, atopic dermatitis, gastrointestinal infections, lower respiratory tract diseases, asthma, obesity, sudden infant death syndrome (3) or even childhood leukemia (4).

The health outcomes of the breastfeeding mother include reduced risk for breast, endometrial and ovarian cancer are well documented (5) (6) (7).

In our article we will focus on the impact of breast-feeding on lowering the risk of diabetes mellitus in mothers.

KEYWORDS: breast-feeding, lactation, diabetes mellitus, women's health

BACKGROUND: Breastfeeding provides numerous health benefits for both infants and mothers. With type 2 diabetes mellitus becoming more and more common, understanding how breastfeeding seems to lower a maternal risk of this disease is crucial. This review examines the association between breastfeeding and maternal diabetes risk, highlighting the importance of promoting breastfeeding for maternal health.

MATERIAL AND METHODS: A literature review was undertaken to gather and assess relevant studies elucidating the relationship between breastfeeding and the maternal risk of diabetes mellitus. The review predominantly focused on scholarly sources available through prominent medical databases, including PubMed, ScienceDirect, and ClinicalKey. Keyword searches were meticulously crafted, incorporating terms such as "breastfeeding," "diabetes mellitus" and "women's health".

CONCLUSIONS: Breastfeeding emerges as a significant factor in reducing the risk of diabetes mellitus in mothers. Its effects are mediated through multiple mechanisms, including improvements in glucose metabolism, energy balance, lipid metabolism, and cardiovascular health. Promoting breastfeeding as a public health priority can contribute to better maternal outcomes and disease prevention efforts. Further research is needed to understand the long-

term effects of breastfeeding on maternal health and to develop targeted interventions for high-risk populations.

1. Introduction

The World Health Organization and American Academy Of Pediatrics recommend exclusive breastfeeding for the first 6 months of life and introduction of solid foods at 6 months together with continued breastfeeding up to 2 years of age or beyond (8).

In Poland 86% of children are estimated to have been breastfed for at least some period of time (9). To increase breastfeeding rates we might advise and acquaint pregnant women with the beneficial effects of lactation on not only maternal, but also on infant health (10).

Research on influence of breast-feeding has significantly advanced in recent years, leading to the discovery of its role in prevention of many diseases for both mother and newborn.

This article delves into the research exploring how breastfeeding affects the development of type 2 diabetes mellitus, aiming to offer a comprehensive analysis of the current understanding of how breastfeeding can potentially reduce the risk of diabetes mellitus.

Type 2 diabetes is a significant global health concern, contributing to the rise of metabolic diseases that lead to both microvascular and macrovascular complications. The World Health Organization reports that approximately 422 million individuals worldwide are affected by diabetes, with the majority residing in low- and middle-income countries. Furthermore, diabetes directly accounts for 1.5 million deaths annually. Over the years, there has been a steady increase in both the number of diabetes cases and its prevalence, underscoring the importance of identifying both risk factors and protective factors associated with type 2 diabetes mellitus for the formulation of effective prevention strategies (11).

While the influence of diet and exercise on the risk of type 2 diabetes is well-documented (12), less attention has been given to the potential impact of a woman's decision to breastfeed her children on her future risk of diabetes. Hence, investigating the relationship between breastfeeding and diabetes risk becomes pivotal in comprehensively understanding the factors contributing to the development of this metabolic disorder.

2. The Mechanisms Behind Breastfeeding Impact on the Risk of Diabetes Mellitus:

2.1 Breastfeeding is associated with improved insulin sensitivity and glucose tolerance

Breast feeding has a positive effect on glucose metabolism. Lactation significantly lowers total area under the glucose tolerance curve, lowers fasting serum glucose and 2- hour glucose level in women with recent gestational diabetes (13). In women with Gestational Diabetes Mellitus lactation also improves insulin sensitivity and it is associated with higher lactation intensity (14). During lactation, the body faces heightened demands for glucose to support milk production. To meet these increased needs, the body primarily ramps up glucose production by accelerating glycogenolysis, the breakdown of stored glycogen into glucose. However, there isn't a significant rise in the generation of glucose from non-carbohydrate sources, known as fractional gluconeogenesis (GNG), during this period. Additionally, lactating mothers may utilize free fatty acids (FFA) and β -hydroxybutyrate as alternative energy sources to supplement their glucose needs. These adaptive mechanisms ensure that lactating women can meet the demands of milk production while maintaining metabolic stability (15).

The Spanish study investigated the impact of breastfeeding on maternal glucose dynamics in women exhibiting normal glucose metabolism. Utilizing continuous glucose monitoring, 26 postpartum women were monitored over a three-month period. Analysis revealed that during postprandial phases, glucose levels were notably lower when influenced by breastfeeding compared to non-breastfeeding intervals. This disparity was particularly evident between 50 and 105 minutes following meal initiation. Conversely, fasting glucose concentrations did not exhibit significant differences between breastfeeding-influenced and unaffected periods. The findings suggest that breastfeeding episodes correlate with a delayed reduction in postprandial maternal glucose levels among women with normal glucose metabolism, highlighting a potential acute influence of breastfeeding on maternal glucose regulation (16).

2.2 Breastfeeding increase energy consumption:

Breast-feeding increase energy requirement of 400-600 kcal/d. The energy requirement was measured by TEE- total energy expenditure, milk energy output and energy mobilization from tissue stores (17).

Studies implied that milk volume and loss of kcal are followed by child's potential growth. (18). Higher caloric needs can prevent mother's obesity and help lower the risk of diabetes mellitus (15).

During gestation, there is a significant accrual of visceral adipose tissue, coupled with an exacerbation of insulin resistance and an elevation in lipid and triglyceride concentrations. Remarkably, these metabolic perturbations exhibit a more rapid and thorough reversal during lactation. Lactation serves as a pivotal mechanism in the postpartum period, acting to reestablish maternal metabolism, thereby facilitating a return to pre-pregnancy metabolic homeostasis (19). Extended lactation correlates with a more thorough depletion of accumulated fat stores in women. Conversely, the absence of lactation prolongs the persistence of adverse metabolic changes, thereby heightening the risk of developing metabolic diseases.

2.3 Breast-feeding reduce weight gain and abdominal fatness

Numerous studies have proved the correlation between lactation and greater weight loss after pregnancy (20,21).

The possible mechanism of reducing fat during lactation could be attributed to the energy balance calculations. The study indicates that lactating women had sufficient energy available for maintenance and activity needs, despite consuming energy intakes less than current recommendations. This suggests that lactation may lead to a negative energy balance, where the energy expended in milk production exceeds the energy intake from the diet. Consequently, the body may mobilize stored fat to compensate for the energy deficit, resulting in gradual weight reduction and a decrease in body fat percentage over time. Additionally, the continuous demand for milk production may stimulate metabolic processes that promote fat utilization, thus further contributing to the reduction in body fat during lactation (22).

Other study has shown that women who exclusively breastfed for more than 6 months exhibited lower postpartum weight retention at 3 years compared to those with shorter durations of exclusive breastfeeding or those who did not exclusively breastfeed. These findings suggest that longer duration of exclusive breastfeeding may have a beneficial effect on postpartum weight retention (23).

Breastfeeding and exercise may play significant roles in controlling long-term weight after pregnancy. The findings indicate that women who breastfed and engaged in aerobic exercise had significantly lower weight gains over time compared to those who did not. Specifically, women who lost all pregnancy weight by 6 months postpartum were found to be lighter at follow-up than those who retained weight, suggesting that successful postpartum weight loss is associated with better long-term weight management. These results underscore the importance of breastfeeding and exercise as potentially effective strategies for preventing long-term obesity after pregnancy (24).

Even women who were overweight before the pregnancy can experience greater weight loss during breastfeeding. Additionally, the findings highlight the importance of considering maternal prepregnancy BMI status when assessing the impact of lactation on postpartum BMI changes. Furthermore, individual differences in psychological eating behavior traits play a significant role in shaping maternal BMI trajectories, suggesting the potential for tailored interventions to support postpartum weight management. These results underscore the multifactorial nature of postpartum weight changes and emphasize the need for personalized approaches that consider both physiological and psychological factors (25).

2.4 Breast-feeding can lower cardiovascular risk factors:

In an analysis of the Nurse's Health Study cohort, the relationship between the duration of lactation and the incidence of myocardial infarction (MI) in parous women was investigated. A total of 89,326 participants from the Nurses' Health Study were followed over a period totaling 1,350,965 person-years. The results showed that compared to women who had never breastfed, those who breastfed for a total of 2 years or more in their lifetime had a 37% lower risk of coronary heart disease (CHD), even after adjusting for age, parity, and stillbirth history. After further adjustment for early-adult adiposity, parental history, and lifestyle factors, the risk reduction remained significant at 23%. This suggests that a longer duration of lactation is associated with a reduced risk of CHD in parous women (26).

In the CARDIA study, the aim was to examine how physical activity (PA) and lactation collectively influence cardiometabolic risk. The findings underscored that maintaining above-average levels of PA throughout adulthood, coupled with a lactation duration of ≥ 3 months, was associated with reduced cardiometabolic risk scores. Score was calculated by

standardizing and aggregating several individual risk factors, such as waist circumference (WC), the average of systolic and diastolic blood pressures (mean BP), fasting blood glucose, insulin levels, triglycerides, and negative HDL-C. Elevated scores indicate a higher degree of cardiometabolic risk. Notably, individuals who exhibited either behavior - higher PA or ≥ 3 months of lactation - demonstrated lower risk compared to those who did not engage in either behavior.

Further insights from the results revealed that participants with above-average PA and sustained lactation had more favorable cardiometabolic profiles. Specifically, they exhibited lower risk scores compared to those with lower PA levels and shorter lactation duration. This association remained significant even after accounting for various factors such as age, race, education, smoking, medication use, alcohol consumption, and baseline body mass index.

These findings suggest that adopting and maintaining a lifestyle characterized by higher levels of PA and a longer duration of lactation could play a crucial role in reducing cardiometabolic risk among parous women. Such behaviors may offer significant protective effects against the development of cardiometabolic diseases in this population (27).

CENTRAL ILLUSTRATION Achieving at Least 3 Months of Lactation and Above Average Physical Activity Was Associated With Lower Cardiometabolic Disease Risk in Parous Participants

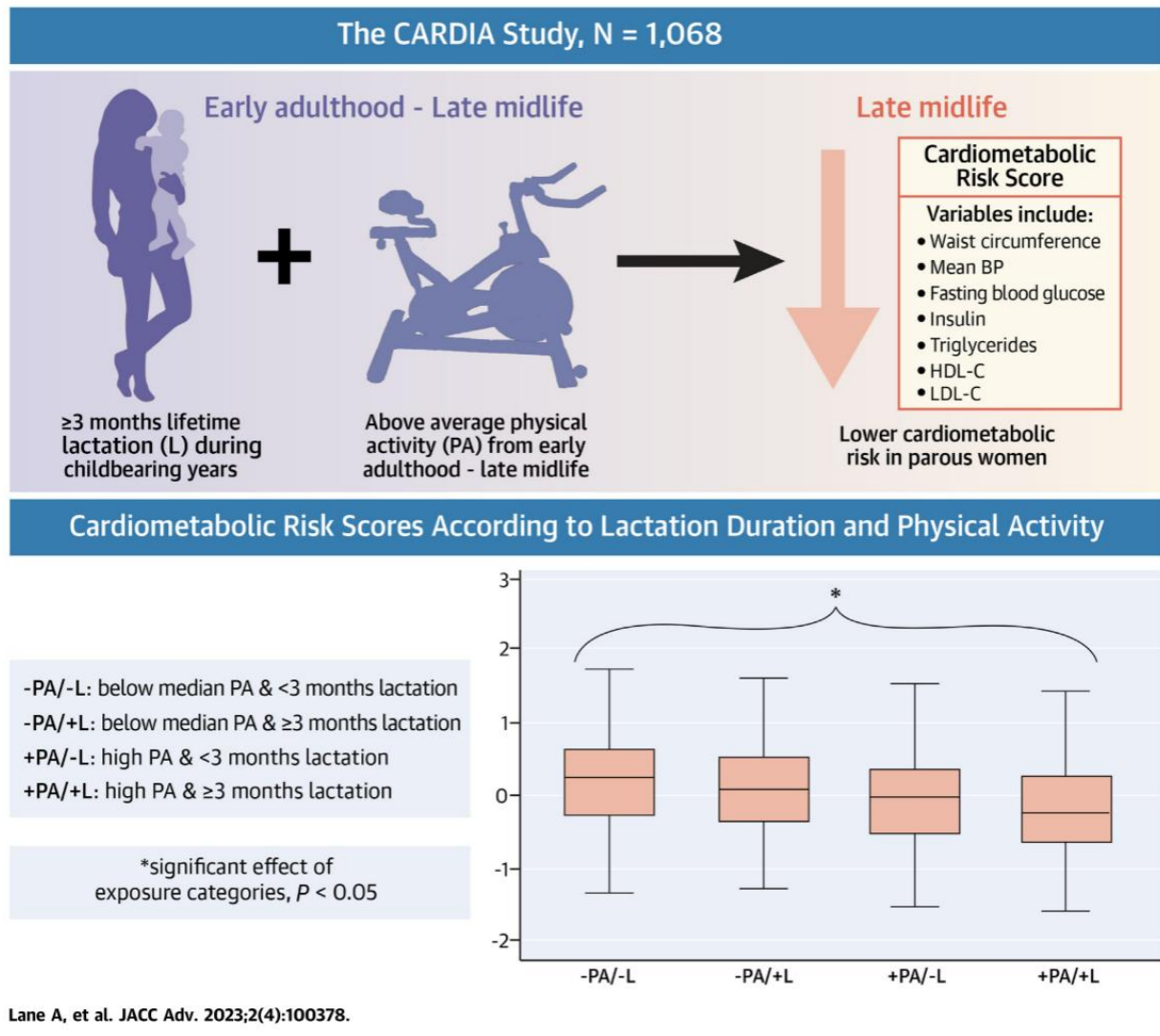


Figure 1: Lane A, et al. JACC Adv. 2023;2(4):100378 (27)

The prospective observational study examined the relationship between lactation and hypertension risk in premenopausal Korean women over a six-year period. Results showed that lactation was associated with a decreased risk of hypertension, with varying durations of lactation demonstrating protective effects. Additionally, the study highlighted an interaction effect between obesity and lack of lactation, indicating an increased hypertension risk in obese women who did not breastfeed. Overall, the findings suggest that lactation may serve as a protective factor against hypertension in premenopausal women (28).

2.5 Breast- feeding improve lipid metabolism

During lactation, there is a significant shift in lipid metabolism to facilitate milk production, necessitating the mobilization of lipids. Studies conducted within cohorts have demonstrated that lactation is linked to decreased levels of triglycerides (29).

High-density lipoprotein (HDL) plays a crucial role in lipid metabolism. Its role is to induce reverse cholesterol transport. It is protecting cardiovascular system by its antioxidant, anti-inflammatory, vasodilatory, antithrombotic, immunomodulatory function (30). Studies have shown that breast-feeding is elevating serum HDL cholesterol (13).

Breastfeeding also has a positive influence on the level of low-density lipoprotein (LDL) cholesterol, which increases more in non-lactating women compared to lactating women. This indicates that lactation may have a protective effect against the unfavorable changes in LDL cholesterol levels typically observed during and after pregnancy (31).

In a large-scale study, researchers observed that longer duration of breastfeeding correlated with elevated maternal levels of ghrelin and PYY three years postpartum. Ghrelin and PYY are both gut peptides responsible for regulating appetite and are linked to a decreased risk of metabolic disorders and diabetes mellitus.

Pancreatic PYY, specifically, is a hormone released by the intestine after a meal, playing a crucial role in suppressing appetite (32). It has been noted that obese individuals tend to produce less PYY than those with a normal weight, suggesting a compromised satiety response. Interestingly, overweight individuals still exhibit a normal appetite response to infused PYY, unlike the leptin resistance often seen in obesity.

The study also revealed a modest positive correlation between breastfeeding duration and the levels of ghrelin and PYY. These gut-secreted hormones modulate appetite by influencing hypothalamic pathways involved in hunger and satiety. While low PYY levels and high ghrelin levels trigger hunger during fasting, postprandial increases in PYY and decreases in ghrelin help suppress appetite. Paradoxically, lower ghrelin levels are associated with obesity, insulin resistance, hypertension, and type 2 diabetes in cross-sectional studies (33) (34).

Long-term lactation and the resultant negative energy balance may potentially lead to alterations in fasting ghrelin levels that endure even after weaning, thereby diminishing the risk of metabolic diseases. Alternatively, it's conceivable that women with higher baseline ghrelin levels could produce more milk, enabling them to sustain breastfeeding for a longer

duration. In this scenario, extended breastfeeding periods would serve as an indicator of reduced maternal metabolic risk (23).

The results of the SWIFT study demonstrated that lactation intensity had a notable influence on lipid metabolism among women with a history of gestational diabetes mellitus (GDM). Specifically, higher lactation intensity was associated with beneficial changes in lipid profiles, characterized by reduced levels of glycerolipids and elevated levels of phospholipids/sphingolipids at the study baseline. However, these lipid modifications were transient and attenuated within 1-2 years postpartum following the discontinuation of lactation. Interestingly, women who did not develop incident type 2 diabetes (T2D) exhibited more pronounced lipid alterations in response to lactation. Moreover, a predictive metabolic signature comprising 10 analytes was identified, demonstrating superior predictive accuracy for future T2D onset compared to conventional clinical variables. These findings underscore the substantial impact of lactation on maternal metabolic pathways and its correlation with T2D risk, offering valuable insights for developing preventive strategies tailored to women with a history of GDM (35).

3. Benefits from longer lactation

A large cohort study investigated the relationship between lactation duration and postmenopausal cardiovascular disease risk factors. Data from 139,681 postmenopausal women revealed dose-response relationships between cumulative lactation months and various cardiovascular risk factors. Women with over 12 months of lactation had lower odds of hypertension, diabetes, hyperlipidemia, and cardiovascular disease compared to non-breastfeeding women, even after adjusting for sociodemographic, lifestyle, and family history factors. Additionally, women with a single live birth who breastfed for 7-12 months had significantly reduced risk of postmenopausal cardiovascular disease compared to those who never breastfed. These findings suggest that increased duration of lactation may have long-term protective effects against cardiovascular disease among postmenopausal women (36).

A positive relationship was found between higher levels of lactation intensity and improved fasting glucose, along with reduced insulin levels during the 6-9 weeks postpartum period. These findings suggest that lactation might offer beneficial effects on glucose metabolism and insulin sensitivity, potentially lowering the risk of diabetes following gestational diabetes mellitus (GDM) pregnancy (14).

Extended duration of lactation is linked to enhanced insulin and glucose response in women with a history of GDM. Women who breastfed for a longer period, especially those breastfeeding for 10 months or more, demonstrated improved insulin sensitivity and secretion indices, lower fasting and post-OGTT insulin concentrations, and a reduced incidence of impaired glucose intolerance. These findings suggest that lactation duration may serve as a protective factor against insulin resistance and secretion defects in women with prior GDM, potentially reducing their risk of developing diabetes later in life (37).

The duration of lactation is associated with a lower prevalence of metabolic syndrome (MetSyn) in midlife, parous women. The findings suggest that women with a history of lactation had significantly lower odds of MetSyn compared to those who did not breastfeed. Additionally, there was a dose-response relationship between lactation duration and MetSyn prevalence, indicating that longer durations of lactation were associated with further reductions in the likelihood of MetSyn. Adjusting for various factors such as age, smoking history, parity, ethnicity, socioeconomic status, physical activity, caloric intake, and high school body mass index, the association between lactation and lower MetSyn prevalence remained significant. Therefore, the study suggests that the protective effect of lactation against MetSyn may be attributed to both the act of breastfeeding and the duration of lactation, highlighting the importance of promoting breastfeeding for maternal metabolic health (38) (39).

4. Conclusions

The association between breastfeeding and maternal risk of diabetes mellitus emerges as a multifaceted relationship with profound implications for women's health. Our comprehensive review of existing literature reveals compelling evidence supporting the notion that breastfeeding confers substantial benefits on maternal metabolic health, particularly in reducing the risk of diabetes mellitus.

Breastfeeding exerts its protective effects through various mechanisms, including improved insulin sensitivity and glucose tolerance, increased energy consumption leading to weight loss and reduced abdominal fatness, modulation of lipid metabolism favoring healthier lipid profiles, and attenuation of cardiovascular risk factors. These physiological adaptations collectively contribute to a lower prevalence of diabetes mellitus among breastfeeding mothers.

The findings from our review underscore the importance of promoting breastfeeding as a key strategy for maternal health and disease prevention. Given the rising global burden of diabetes mellitus and its associated complications, including cardiovascular disease, initiatives aimed at encouraging and supporting breastfeeding should be prioritized in public health agendas. Healthcare providers play a pivotal role in educating pregnant women about the myriad benefits of breastfeeding, emphasizing its potential long-term impacts on maternal well-being.

Furthermore, our review highlights the need for continued research to elucidate the underlying mechanisms linking breastfeeding to reduced diabetes risk, particularly in populations at high risk, such as women with gestational diabetes mellitus (GDM) or those with a family history of diabetes. Longitudinal studies examining the sustained effects of breastfeeding on maternal metabolic health over extended periods are warranted to provide further insights into the durability of these protective effects.

Breastfeeding represents a powerful and accessible intervention that holds considerable promise in mitigating the risk of diabetes mellitus in women. By fostering a supportive environment for breastfeeding initiation and continuation, policymakers, healthcare professionals, and communities can contribute to improving the health outcomes of women worldwide, thereby advancing the goal of maternal well-being and disease prevention.

AUTHOR CONTRIBUTION

Conceptualization: Agnieszka Fugas and Magdalena Pach; Methodology: Justyna Dobrzańska; Software: Agnieszka Nowak; Check: Zuzanna Chmielowiec, Aneta Michalczywska and Natalia Wierzejska; Formal analysis: Karolina Smykiewicz; Investigation: Mariola Dziedzic; Resources: Aneta Michalczywska; Data curation: Alicja Partyka; Writing - rough preparation: Justyna Dobrzańska; Writing - review and editing: Agnieszka Fugas and Agnieszka Nowak; Visualization: Karolina Smykiewicz; Supervision: Magdalena Pach; Project administration: Mariola Dziedzic; Receiving funding - no specific funding.

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CONFLICT OF INTERESTS

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