Review Article

The protective effects of breastfeeding on chronic non-communicable diseases in adulthood: A review of evidence

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Abstract

Chronic non-communicable diseases (NCDs), including cardiovascular diseases, cancers, chronic respiratory diseases, diabetes, etc., are the major causes of mortality in the world, notably in low- and middle-income countries. A growing body of evidence suggests that NCDs have a complex etiology resulting from the interaction of genetic factors, gender, age, ethnicity, and the environmental factors. It is well-documented that chronic diseases in adulthood origins in early life. In recent years, much attention has been focused on primordial and primary prevention of NCD risk factors. There are many biological and epidemiological studies on beneficial effects of breastfeeding during infancy on chronic diseases in adulthood, particularly on hypertension, obesity, diabetes, hypercholesterolemia, and cardiovascular diseases. This review article aims to summarize the current literature on the long-term effects of breastfeeding on prevention of NCDs and their risk factors.

The current literature is controversial about these effects; however, a growing body of evidence suggests that breastfeeding has protective roles against obesity, hypertension, dyslipidemia, and type II diabetes mellitus during adulthood. In addition to its short-term benefits, encouraging breastfeeding can have long-term beneficial health effects at individual and population levels.

Key Words: Breastfeeding, chronic diseases, diabetes, dyslipidemia, hypertension, obesity, prevention

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INTRODUCTION

Chronic non-communicable diseases (NCDs) are an emerging global health problem. These diseases have a long and slow process, and mainly include cardiovascular diseases (48%), cancers (21%), chronic respiratory diseases (12%), and diabetes (13%).[1] According to the 2008 World Health Organization (WHO) report, NCDs are responsible for 63% of all-cause mortality in the world, and are forecasted to reach 69% by 2020.[2] Currently, NCDs have a share of 80% of the burden of diseases in the developed countries, and 70% in developing countries.[3-5] Based on the WHO report in 2011, 90% of mortality in Iran has been because of NCDs.[1] It is well-documented that some factors such as genetics, gender, and age cannot be accountable for high prevalence of these diseases alone, and in addition to these risk factors, modifiable environmental and lifestyle factors also play an important role in this process.[6]

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The major risk factors of chronic NCDs include smoking, hyperlipidemia, hypertension, hyperglycemia, obesity, and sedentary lifestyle. Because of the high costs of treatment of NCDs, prevention and early control of their risk factors would be much more efficient and cost-effective than their treatment. A growing body of evidence supports the origins of adult NCDs from early life. Therefore, in recent years, much attention has been focused on primordial and primary prevention of chronic NCDs and their risk factors.[7,8] Breast feeding is considered as one of the protective factors against NCDs. Some epidemiological and biological studies have documented the long-term beneficial effects of breastfeeding on chronic diseases.[9]

This review aims to summarize the current studies on long-term effects of breastfeeding on major NCDs and their risk factors.

Breastfeeding and hypertension

Hypertension has a crucial role on the process of coronary heart diseases and stroke.[10] Some factors in early life may influence the development of hypertension in adulthood.[11-13] The effect of breastfeeding on hypertension has attracted much interest because of the differences between breast milk and artificial formulas, mainly in terms of their content of sodium and fatty acids. It is documented that breastfeeding can affect systolic and diastolic blood pressures[14] in adulthood.[15,16] The effect of breastfeeding on blood pressure in adulthood can be partly explained through the following mechanisms: (1) reduced sodium intake in infancy,[17] (2) high content of long-chain unsaturated fatty acids in breast milk, which is an important component of the tissue membrane system, as coronary endothelial system,[18] (3) protection against hyperinsulinemia in infancy,[19] as well as prevention of insulin resistance in early life,[20] adolescence,[21] and adulthood.[22] However, conflicting results exist in this regard, and many studies did not confirm this effect.[23] In general, the results on the protective effects of breastfeeding on hypertension are still conflicting, and remain to be determined in longitudinal studies with long-term follow up.

Breastfeeding and obesity

Findings of studies on the association between breastfeeding and obesity in adulthood[24] showed that breast milk is a protective factor against obesity.[24-27] Compared to artificial formulas, this effect could be explained by existing differences in macro-nutrients,[28,29] even though the accuracy of this relationship is still uncertain.[27] In addition to its various beneficial effects, encouraging the intake of breast milk could be part of an important general strategy in preventing the global epidemic of obesity and related health consequences. Various biological mechanisms some stress behavioral patterns, and some physiological influences may explain the protective role of breast feeding on obesity. In respect to behavioral patterns, it could be proposed that breastfeeding improves feeding method and affects infant's appetite and satiety, and eventually would enhance children's appetite in later years of life. Moreover, there are physiological differences between breast milk and artificial formulas in terms of their nutrients and hormone contents. For instance, protein content of baby formulas is higher than that of breast milk, and leptin exists in breast milk, but not in artificial formulas.[30] Due to their high fat and protein contents, baby formulas would lead to increased secretion of Insulin Growth Factor-type 1 (IGF-1), and subsequently to stimulation of adipocytes, which eventually result in excess weight.[31] Early differences in nutrients intake would lead to long-term effects on metabolic systems; this may be mediated through changes in appetite and metabolism.[30] *In vitro* studies have shown that factors, which specifically exist in breast milk as specific hormones like leptin, could change growth factors and prevent formation of adipocytes.[32,33] Moreover, breastfeeding affects the intake of calorie and protein,[34] insulin secretion,[35] balancing fat reserves, and adipocyte size.[36] The effect of breastfeeding is found to be independent from dietary patterns and physical activity in adulthood.[27] Many studies show that only long-term breastfeeding influences obesity in adulthood. Therefore, it can be concluded that feeding in infancy can affect obesity and its subsequent diseases in adulthood. However, there are still conflicting results of studies in relation to breastfeeding and obesity, and some studies did not confirm such association.[37] This important issue deserves more attention in future birth cohort studies.

Breastfeeding and diabetes mellitus

The study of Bore *et al*.[38] showed that fasting blood glucose level is inversely proportional to long-chain polyunsaturated fatty acids in skeletal muscle membrane. These fatty acids are found in breast milk and not in artificial formulas.[39] It seems that changes in skeletal muscle membrane have an important role in development of insulin resistance, and subsequent hyperinsulinemia, which gradually leads to defects in beta cells and ultimately to type II diabetes.[40] Various studies[41-43] have shown that infants fed with artificial formulas have higher levels of insulin than breast-fed infants; in turn it would lead to modulation in releasing glucagon and insulin. These changes also lead to early development of insulin resistance and type II diabetes. These two mechanisms are suggested to be the possible underlying mechanisms of the protective role of

breastfeeding against type II diabetes.[44] The existing evidence proposes that breastfeeding during infancy may prevent the development of type II diabetes in later years of life.[45-48] Furthermore, composition of breast milk is vastly different from artificial formulas,[49] particularly because the protein and energy, as well as the volume of milk consumed by breast-fed infants are much lower than artificial formulas.[50] It is suggested that the protective effects of breastfeeding against the risk of obesity in adulthood could also influence the insulin and glucose metabolism.[51] The results of epidemiological studies are controversial in this regard.[52,53] However, many studies have confirmed the protective role of breastfeeding against type II diabetes mellitus. This effect is considered to be because of the difference in composition of breast milk and the difference in hormones of insulin, motilin, intro-glucagon, neurotencin, and pancreatic polypeptide in breast milk and artificial formulas, which in turn would lead to lower subcutaneous fat deposition in breastfed infants.[54] Finally, according to the current evidence, this hypothesis is implied that type II diabetes is planned from early infancy.[49] Future longitudinal studies shall determine the clinical significance of such associations.

Breastfeeding and hypercholesterolemia

High concentrations of total cholesterol and low-density lipoprotein (LDL)- cholesterol is a risk factor for coronary heart diseases.[55] It seems that the feeding type during infancy affects their levels.[56] The cholesterol content of breast milk is evidently higher than many artificial formulas. This high intake of cholesterol from breastfeeding may have long-term effects on cholesterol endogenesis, this may be mediated through diminishing the regulation of hydroxymethyl glutaril liver coenzyme A.[57] This effect has been also observed in animal studies that high cholesterol level in infancy is associated with low cholesterol level in older ages.[58] The enzyme of hydroxymethyl glutaril coenzyme A is a restrictive enzyme in cholesterol biosynthetic pathway from acetate; its inhibitors have a blood cholesterol reducing effect.[59] It is documented that compared to formula-fed infants, the breast-fed ones have higher mean blood cholesterol in infancy, similar levels in childhood, and lower in adulthood.[60] These differences may be because early exposure to breast milk cholesterol affects long-term cholesterol metabolism.[61] In many studies, low blood cholesterol concentration observed in adulthood has been associated with breastfeeding in infancy. The composition of breast milk is different from artificial formulas in many ways, for instance, in addition to breast milk high content of cholesterol, it contains hormones, particularly leptin and tri-iodotronin.[62] It should be acknowledged that in addition to these mechanisms, breastfeeding may affect eating habits in later years of life, and this may be another influencing factor on cholesterol level in adulthood.[60]

Breastfeeding and cardiovascular diseases

Some studies have shown that breastfeeding in infancy can affect risk factors of cardiovascular diseases in adulthood.[63,64] Breastfeeding may have protective effects on major risk factors of cardiovascular diseases, as elevated total cholesterol level, hypertension[65,66] LDL level,[67] and obesity.[60] A large body of evidence shows that breastfeeding could affect high-density lipoprotein (HDL) cholesterol level in adulthood.[68,69] The results are inconclusive in this regard. The duration of breast feeding is also important in its protective role against cardiovascular diseases (Ref); however, our study among adolescents did not confirm such association[70]; possibly these effects would develop over longer periods of time.

CONCLUSION

Generally, the importance of primordial and primary prevention of chronic NCDs is justified by the high prevalence of such diseases and their risk factors, which mainly origin from early life. The current literature is controversial about the association of breast feeding with NCDs and their risk factors; however, a growing body of evidence suggests that breastfeeding has protective roles against obesity, hypertension, dyslipidemia, and type II diabetes mellitus during adulthood. Therefore, encouraging breastfeeding can have short-term and long-term beneficial health effects at individual and population levels.

REFERENCES

1. World Health Organization. Global status report on noncommunicable diseases 2010. Geneva: World Health Organization; 2011.
2. World Health Organozation. The World Health report: Todays challenges. Geneva: World Health Organozation; 2003.
3. Murray CJ, Lopez AD. The global burden of disease: A comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020. Cambridge (MA): Harvard University Press; 1996.
4. Bradshaw D, Buthelezi G. Health Status 1996. In: South African Health Review 1996. Durban: HST; 1997.
5. Boutayeb A, Twizell EH, Achouayb K, Chetouani A. A mathematical model for the burden of diabetes and its Complications. Biomed Eng Online 2004;28;3:20.
6. Maurage C. Children's nutrition and health in adulthood. Appetite 2008;51:22-4.
7. William CL, Squillace MM, Bollella MC, Brotanek J, Campanaro L, Dagostino C, *et al*. A comprehensive health education program for preschool children. Prev Med 1998;27:216-23.
8. Arbeit ML, Johnson CC, Mott DS, Harsha DW, Nicklas TA, Webber LS, *et al*. The Heart Smart cardiovascular school health promotion: Behavior correlates of risk factor change. Prev Med 1992;21:18-32.
9. Davis MK. Breastfeeding and chronic disease in childhood and adolescence. Pediatr Clin North Am 2011;48:125-41.

10. Lewington S, Clarke R, Qizilbash N, Peto R, Collins R; Prospective Studies Collaboration. Age-specific relevance of usual blood pressure to vascular mortality: A meta-analysis of individual data for one million adults in 61 prospective studies. Lancet 2002;360:1903-13.
11. Lever AF, Harrap SB. Essential hypertension: A disorder of growth with origins in childhood? J Hypertension 1992;10:101-20.
12. Stary HC. Lipid and macrophage accumulations in arteries of children and the development of atherosclerosis. Am J Clin Nutr 2000;72(5 Suppl):1297-306.
13. Martin RM, Ness AR, Gunnell D, Emmett P, Davey Smith G; ALSPAC Study Team. Does breastfeeding in infancy lower blood pressure in childhood? The Avon Longitudinal Study of Parents and Children (ALSPAC). Circulation 2004;109:1259-66.
14. Lawlor DA, Najman JM, Sterne J, Williams GM, Ebrahim S, Davey Smith G. Associations of parental, birth, and early life characteristics with systolic blood pressure at 5 years of age: Findings from the Mater-University study of pregnancy and its outcomes Circulation 2004;110:2417-23.
15. Owen CG, Whincup PH, Gilg JA, Cook DG. Effect of breast feeding in infancy on blood pressure in later life: Systematic review and meta-analysis. BMJ 2003;327:1189-95.
16. Martin RM, Gunnell D, Smith GD. Breastfeeding in infancy and blood pressure in later life: Systematic review and meta-analysis. Am J Epidemiol 2005;161:15-26.
17. Fomon S. Infant feeding in the 20th century: Formula and beikost. J Nutr 2001;131:409-20.
18. Forsyth JS, Willatts P, Agostoni C, Bissenden J, Casaer P, Boehm G. Long chain polyunsaturated fatty acid supplementation in infant formula and blood pressure in later childhood. BMJ 2003;326:953.
19. Axelsson IE, Ivarsson SA, Raiha NC. Protein intake in early infancy: Effects on plasma amino acid concentrations, insulin metabolism, and growth. Pediatr Res 1989;26:614-7.
20. Langenberg C, Hardy R, Kuh D, Wadsworth ME. Influence of height, leg and trunk length on pulse pressure, systolic and diastolic blood pressure. J Hypertens 2003;21:537-43.
21. Singhal A, Fewtrell M, Cole TJ, Lucas A. Low nutrient intake and early growth for later insulin resistance in adolescents born preterm. Lancet 2003;361:1089-97.
22. Ravelli AC, van der Meulen JH, Osmond C, Barker DJ, Bleker OP. Infant feeding and adult glucose tolerance, lipid profile, blood pressure, and obesity. Arch Dis Child 2000;82:248-52.
23. Fall CH, Osmond C, Barker DJ, Clark PM, Hales CN, Stirling Y, *et al*. Fetal and infant growth and cardiovascular risk factors in women. BMJ 1995;310:428-32.
24. Poulton R, Williams S. Breastfeeding and risk of overweight. JAMA 2001;286:1449-50.
25. Parsons TJ, Power C, Manor O. Infant feeding and obesity through the Life course. Arch Dis Child 2003;88:793-4.
26. Frye C, Heinrich J. Trends and predictors of overweight and obesity in East German children. Int J Obes Relat Metab Disord 2003;27:963-9.
27. Owen CG, Martin RM, Whincup PH, Smith GD, Cook DG. Effect of infant feeding on the risk of obesity across the life course: A quantitative review of published evidence. Pediatrics 2005;115;1367-77.
28. Dewey KG. Is breast feeding protective against child obesity? J Hum Lact 2003;19:9-18.
29. Dietz WH. Breast feeding may help prevent childhood over-weight. JAMA 2001;285:2506-7.
30. Metzger MW, McDade TW. Breastfeeding as obesity prevention in the United States: A sibling difference model. Am J Hum Biol 2010;22:291-6.
31. Jeanne MS. Breastfeeding and obesity: A meta-analysis. OJPM 2011;3:88-93.
32. Hauner H, Rohring K, Petruschke T. Effect of epidermal growth factor (EGF),platelet-derived growth factor (PDGF) and fibroblast growth factor (FGF) on human adipocyte development and function. Eur J Clin Invest 1995;25:90-6.
33. Petruschke T, Rohring K, Hauner H. Transforming frowth factor beta (TGF-beta) inhibits the differentiation of human adipocyte precursor cell in primary culture. Int J Obes Relat Metab Disord 1994;18:532-6.
34. Heinig MJ, Nommsen LA, Peerson JM, Lonnerdal B, Dewey KG. Energy and protein intakes of breast-fed and formula-fed infants during the first year of life and their association with growth velocity: The DARLING Study. Am J Clin Nutr 1993;58:152-61.
35. Lucas A, Sarson DL, Blackburn AM, Adrian TE, Aynsley-Green A, Bloom SR. Breast vs bottle: Endocrine responses are different with formula feeding. Lancet 1980;1:1267-9.
36. von Kries R, Koletzko B, Sauerwald T, von Mutius E, Barnert D, Grunert V, *et al*. Breast feeding and obesity: Cross sectional study. BMJ 1999;319:147-50.
37. Hediger ML, Overpeck MD, Kuczmarski RJ, Ruan WJ. Association between infant breastfeeding and overweight in young children. JAMA 2001;285:2453-60.
38. Baur LA, O'Connor J, Pan DA, Kriketos AD, Storlien LH. The fatty acid composition of skeletal muscle membrane phospholipid: Its relationship with the type of feeding and plasma glucose levels in young children. Metabolism 1998;47:106-12.
39. Koletzko B, Agostoni C, Carlson SE, Clandinin T, Hornstra G, Neuringer M, *et al*. Long chain polyunsaturated fatty acids (LC-PUFA) and perinatal development. Acta Paediatr 2001;90:460-4.
40. Arslanian S. Type-2 diabetes in children: Clinical aspects and risk factors. Horm Res 2002;57 Suppl 1:19-28.
41. Lucas A, Sarson DL, Blackburn AM, Adrian TE, Aynsley-Green A, Bloom SR. Breast vs. bottle: Endocrine responses are different with formula feeding. Lancet 1980;1:1267-9.
42. Aynsley-Green A. The endocrinology of feeding in the newborn. Baillieres Clin Endocrinol Metab 1989;3:837-68.
43. Salmenpera L, Perheentupa J, Siimes MA, Adrian TE, Bloom SR, Aynsley-Green A. Effects of feeding regimen on blood glucose levels and plasma concentrations of pancreatic hormones and gut regulatory peptides at 9 months of age: Comparison between infants fed with milk formula and infants exclusively breast-fed from birth. J Pediatr Gastroenterol Nutr 1988;7:651-6.
44. Horta BL, Bahl R, Martinés JC, Victora CG. World Health Organization. Evidence on the long-term effects of breastfeeding Systematic reviews and meta-analysis. Geneva: World Health Organization; 2007.
45. Ravelli AC, van der Meulen JH, Osmond C, Barker DJ, Bleker OP. Infant feeding and adult glucose tolerance, lipid profile, blood pressure, and obesity. Arch Dis Child 2000;82:248-52.
46. Young TK, Martens PJ, Taback SP, Sellers EA, Dean HJ, Cheang M, *et al*. Type 2 diabetes mellitus in children: Prenatal and early infancy risk factors among native canadians. Arch Pediatr Adolesc Med 2002;156:651-5.
47. Martin RM, Ebrahim S, Griffin M, Davey Smith G, Nicolaides AN, Georgiou N, *et al*. Breastfeeding and atherosclerosis: Intima-media thickness and plaques at 65-year follow-up of the Boyd Orr cohort. Arterioscler Thromb Vasc Biol 2005;25:1482-8.
48. Rich-Edwards JW, Stampfer MJ, Manson JE, Rosner B, Hu FB, Michels KB, *et al*. Breastfeeding during infancy and the risk of cardiovascular disease in adulthood. Epidemiology 2004;15:550-6.
49. Owen CG, Martin RM, Whincup PH, Smith GD, Cook DG. Does breastfeeding influence risk of type 2 diabetes in later life? A quantitative analysis of published evidence. Am J Clin Nutr 2006;84:1043-54.
50. Pettitt DJ, Forman MR, Hanson RL, Knowler WC, Bennett PH. Breastfeeding and incidence of non-insulin-dependent diabetes mellitus in Pima Indians. Lancet 1997;350:166-8.
51. Stumvoll M, Goldstein BJ, van Haeften TW. Type 2 diabetes: Principles of pathogenesis and therapy. Lancet 2005;365:1333-46.
52. Lonnerdal B, Havel PJ. Serum leptin concentrations in infants: Effects of diet, sex, and adiposity. Am J Clin Nutr 2000;72:484-9.
53. Wallensteen M, Lindblad BS, Zetterstrom R, Persson B. Acute C-peptide, insulin and branched chain amino acid response to feeding in formula and breast fed infants. Acta Paediatr Scand 1991;80:143-8.
54. Lucas A, Sarson DL, Blackburn AM, Adrian TE, Aynsley-Green A, Bloom SR. Breast vs bottle: Endocrine responses are different with formula feeding. Lancet 1980;1:1267-9.
55. Law MR, Wald NJ, Thompson SG. By how much and how quickly does reduction in serum cholesterol concentration lower risk of ischaemic heart disease? BMJ 1994;308:367-72.

56. Owen CG, Whincup PH, Odoki K, Gilg JA, Cook DG. Infant feeding and blood cholesterol: A study in adolescents and a systematic review. Pediatrics 2002;110:597-608.
57. Wong WW, David LH, William I, Antone RO, Peter DK. Effect of dietary cholesterol on cholesterol synthesis in breastfed and formula-fed infants. J Lipid Res 1993;34:1403-11.
58. Devlin AM, Innis SM, Shukin R, Rioux MF. Early diet influences hepatic hydroxymethyl glutaryl coenzyme A reductase and 7 alpha-hydroxylase mRNA but not low-density lipoprotein receptor mRNA during development. Metabolism 1998;47:20-6.
59. LaRosa JC, He J, Vupputuri S. Effect of statins on risk of coronary disease: A meta-analysis of randomized controlled trials. JAMA 1999;282:2340-6.
60. Owen CG, Whincup PH, Kaye CG, Martin RM, Smith GD, Cook DG. Does initial breastfeeding lead to lower blood cholesterol in adult life? A quantitative review of the evidence. Am J Clin Nutr 2008;88:305-14.
61. Owen CG, Whincup PH, Odoki K, Gilg JA, Cook DG. Infant feeding and blood cholesterol: A study in adolescents and a systematic review. Pediatrics 2002;110:597-608.
62. Leeson CP, Kattenhorn M, Deanfield JE, Lucas A. Duration of breast feeding and arterial distensibility in early adult life: Population based study. BMJ 2001;322:643-7.
63. Martin RM, Ben Shlomo Y, Gunnell D, Elwood P, Yarnell JW, Davey Smith G. Breast feeding and cardiovascular disease risk factors, incidence, and mortality: The Caerphilly study. J Epidemiol Community Health 2005;59:121-9.
64. Rich-Edwards JW, Stampfer MJ, Manson JE, Rosner B, Hu FB, Michels KB, *et al*. Breastfeeding during infancy and the risk of cardiovascular disease in adulthood. Epidemiology 2004;15:550-6.
65. Owen CG, Whincup PH, Gilg JA, Cook DG. Effect of breast feeding in infancy on blood pressure in later life: Systematic review and meta-analysis. BMJ 2003;327:1189-95.
66. Martin RM, Ness AR, Gunnell D, Emmett P, Davey Smith G; ALSPAC Study Team. Does breast-feeding in infancy lower blood pressure in childhood? The Avon Longitudinal Study of Parents and Children (ALSPAC). Circulation 2004;109:1259-66.
67. Ravelli AC, van der Meulen JH, Osmond C, Barker DJ, Bleker OP. Infant feeding and adult glucose tolerance, lipid profile, blood pressure, and obesity. Arch Dis Child 2000;82:248-52.
68. Singhal A, Cole TJ, Fewtrell M, Lucas A. Breastmilk feeding and lipoprotein profile in adolescents born preterm: Follow-up of a prospective randomised study. Lancet 2004;363:1571-8.
69. Rudnicka AR, Owen CG, Strachan DP. The effect of breastfeeding on cardiorespiratory risk factors in adult life. Pediatrics 2007;119:1107-15.
70. Izadi V, Kelishadi R, Qorbani M, Esmaeilmotlagh M, Taslimi M, Heshmat R, Ardalan G, Azadbakht L. Duration of breast-feeding and cardiovascular risk factors among Iranian children and adolescents: the CASPIAN III study. Nutrition 2013;29:744-51.

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