The Developmental Origins of Health and Disease (DOHaD) hypothesis: relevance for community nursing

Abstract

Nutrition during the first 1000 days of life from conception is important for health in all stages of life. The Developmental Origin of Health and Disease (DOHaD) has confirmed that nutrition and growth are important in health and survival in infancy and childhood, but it is also important for health and longevity in adulthood. Specific nutrients are important throughout pregnancy and the roles of folate (in neural tube development), iron (prevent of anaemia and hence the minimisation of perinatal haemorrhage), iodine (central nervous system) and calcium (bones) are well documented. Nutrition always has a U-shaped response curve and growth that is too slow (undernutrition) or too rapid (overweight) are detrimental to health. Early nutrition and developmental influences are important factors in many chronic conditions including diabetes, obesity, hypertension, heart disease, osteoporosis and chronic renal disease. Community nurses have had and continue to have an important role in the promotion of early health and the prevention of chronic disease through the promotion of appropriate nutrition (especially breastfeeding) and growth.

Keywords: Infant feeding, Developmental Origin of Health and Disease (DOHaD), breastfeeding, chronic disease prevention.

Introduction

The Developmental Origins of Health and Disease (DOHaD) hypothesis is now established as an important explanation of how early life experiences can influence later health, both in childhood and in the middle and later stages of life. Appropriate early nutrition and development are important in providing some protection against chronic disease. Meticulous assessment of infants and mothers and record keeping by community nurses have been the keys to development of the evidence base.

Method

A literature search was undertaken for papers on DOHaD published in English in the PubMed and Web of Science databases. A literature search revealed in excess of 10,000 papers and 2000 reviews on DOHaD in the last decade. These papers represent both animal and human studies. It is not possible to do experiments on human infants because of the ethical issues, and so we must rely on observational studies, the situation for most nutrition studies (Binns, Lee et al. 2017).

DOHaD — history and current theory

The relationships between early growth and development and later health were first described by German paediatricians in the 1920s. The further development and promotion of the theory owes a lot to the work of Professor David Barker. He wrote about his evacuation from London during the Blitz to live with a family in rural Hertfordshire (Fall & Osmond 2013; Hanson 2015). After graduating in medicine and beginning his research career, he remembered the times in the country and returned there to search for historical infant growth records. He was able to find the record system was established by Ethel Margaret Burnside, the county's first “chief health visitor and lady inspector of midwives”. She and her nurses were appointed in response to a lack of physical fitness for the Boer War and in 1911 she established a workforce of trained nurses to attend women in childbirth and advise mothers on how to keep their infants healthy after birth. Most importantly, they kept accurate records of birthweight, growth and health (Barker 1995; Syddall, Sayer et al. 2005). In the 1960s and 1970s, the dedicated work and record keeping of community health nurses working in Hertfordshire in the first half of the 20th century enabled Professor Barker and his colleagues to further develop the relationship between birthweight (prenatal growth) and later disease.

Barker’s group followed up the original cohort, classified them according to birthweight and calculated the death rates from coronary artery disease among the 16,000 men and women born in Hertfordshire between 1911 and 1920. They found that death rates from cardiovascular disease were related to birthweight (Barker 1995; Syddall, Sayer et al. 2005). In the 1960s and 1970s, the dedicated work and record keeping of community health nurses working in Hertfordshire in the first half of the 20th century enabled Professor Barker and his colleagues to further develop the relationship between birthweight (prenatal growth) and later disease.
that growth from conception and during the first years of life was related to coronary heart disease and diabetes in middle age.

Slow early growth predisposes to chronic disease later in life as an adult. Infants who are thin or short at birth (LBW<2500 g, Ponderal index <26) or who failed to grow in infancy have an increased risk of developing chronic disease later in life. This includes coronary heart disease, hypertension, diabetes, obesity and osteoporosis. The relationship between early development and chronic renal disease was first documented in Australia (Hoy, Rees et al. 1998; Hoy, Rees et al. 1999). Research continues to document further associations. The worst long-term outcome is for small babies who have poor early growth and later in life develop obesity. The development of the DOHaD theory has led to the promotion of the importance of the first "1000 Days" of life by UNICEF and other organisations, because of the important of nutrition, growth and psychological development in this period (United Nations Children's Fund 2017).

Research is continuing to explain early life influences, including nutrition, on later health and the range of conditions, growth and development, which may include some cancers and psychological conditions. This has led to the new science of epigenetics and several journals that are now specifically devoted to research in Developmental Origins and Epigenetics (Barker 1990; Barker 2007; Barker, Barker et al. 2013; Chu, Meyer et al. 2016; Eriksson 2016).

The outcomes of nutrition and growth are usually U-shaped in nature. Optimal birthweight appears to lie between 2500 g and 4000 g. Being born too small, reflecting poor development or too heavy are detrimental in the longer term. After birth, it is now known that growth that is too slow or too fast are both detrimental to health. Breastfeeding is an important determinant of growth rates and exclusive breastfeeding for the first six months, and then continuing, provides the most appropriate growth rate and has many additional benefits related to health and survival, particularly in the first year of life. Infants who are artificially fed on formula are more likely to grow at a fast rate, are more prone to illness early in life and become obese later in life (Binns & Lee 2014).

Several mechanisms have been proposed to explain DOHaD, including epigenetic changes, metabolic programming due to rapid growth rates and alternations to the GIT microbiome. There are more than 1000 species of bacteria living in the gastrointestinal tract that make an important contribution to human health and the composition may vary with developmental influences. The microbiome influences conditions as varied as diabetes, obesity, asthma and possibly eczema, and some psychological conditions. The healthiest microbiome is established by early breastfeeding (within 30 minutes) and continued breastfeeding, preferably exclusive to around six months (Pannaraj, Li et al. 2017). Interventions that can change the composition of the microbiome include the use of prelacteal feeds, infant formula, the use of antibiotics, H2 blockers and C-section delivery.

Family support and psychological stability are important determinants of future mental health, as demonstrated in the original work by Bowlby and the recent studies on Romanian adoptees (Sonuga-Barke, Kennedy et al. 2017).

There are now many documented examples of the working of the DOHaD theory in real-life situations. Professor Barker noted the lower rates of coronary heart disease in France. He speculated that the early establishment of a community nursing service that promoted improved maternal nutrition may have contributed to appropriate growth in the first 1000 days of life and reduced heart disease rates (Barker 1999). A similar rapid decline in deaths from heart disease occurred in Australia, beginning in the 1970s (Australian Institute of Health and Welfare [AIHW] 1999). Australia was also early in establishing community nursing services, 100 years ago in Victoria and similar times in other states, and the emphasis on maternal and child care contributed greatly to improved infant nutrition and the decline in infant mortality. This was an important factor in the decline in heart disease in Australia, although other social changes that have increased the obesity rate may undo some of this improvement in the future. In Australia, Indigenous health trends have reflected the influence of early development.

Major famines such as the WWII Dutch famine and the 1959–61 Chinese Famine caused an immediate doubling of infant mortality and the infants exposed to poor nutrition as adults experienced increases in the risk of hyperglycaemia, diabetes and hypertension (Li, He et al. 2010; Li, Jaddoe et al. 2011). This association appears to be greater if a Western diet is eaten in later life. There was also increased obesity in adulthood, lesser college achievement and an increased risk of arthritis in adulthood.

The recent decline in the life expectancy in Okinawa, a prefecture of Japan, is another example of DOHaD. Okinawa was previously known as the longest living population in the world. The combination of post-WWII famine and the introduction of a Western diet by the US military has increased rates of obesity and diabetes and slowed the improvement in life expectancy (Hokama & Binns 2008; Hokama & Binns 2009). Now males in Western Australia live longer than their Okinawan brothers.

In addition to influences of general nutrition through DOHaD, it is also important to remember the importance of continuing prevention with specific micronutrients including iron, iodine, folate and, in some situations, calcium and vitamin D.

The Hertfordshire nurses also recorded the type of infant feeding in broad categories, with those being breastfed all classified together in contrast with infants who were usually given cow's milk. Those who were "breastfed" were found later in life to have healthier diets (Robinson, Ntani et al. 2013). Perhaps a coincidence, but at least an interesting one.

When discussing the legacy of Professor Barker, Thornberg outlines his contribution to understanding current disease trends. He then states:

... increasingly poor diets in young people and in women during pregnancy are a likely cause of declining health in the US population through the process known as programming (Thornburg 2015).

The only prevention service in place in Australia is the community nursing programme and it is important for it to be maintained...
and expanded to counteract the trend towards increasing chronic disease.

Conclusions
The DOHaD hypothesis has become a well-established theory that provides even more justification for strengthening the services provided by community nurses to mothers and their infants. Prenatal nutrition is most important for foetal nutrition and when this is followed by early breastfeeding, optimal early growth is the result. The Australian and WHO recommendation of exclusive breastfeeding for six months, followed by continued breastfeeding to provide optimal health benefits sounds simple. In our modern, complex and stressful lives usually lacking the support of extending families, the support role of community nurses becomes even more important.

References
Chu, DM, Meyer, KM, Prince, AL & Aagaard, KM 2016, Impact of maternal nutrition in pregnancy and lactation on offspring gut microbial composition and function, Gut Microbes, 0.
Li, JP; He, YN, Qi, L, Jaddoe, VW, Feskens, EJM, Yang, XG, Ma, GS & Hu, FR 2010, Exposure to the Chinese Famine in Early Life and the Risk of Hyperglycemia and Type 2 Diabetes in Adulthood, Diabetes, vol. 59, no. 10, pp. 2400–2406.
Robinson, S, Ntani, G, Simmonds, S, Syddall, H, Dennison, E, Sayer, AA, Barker, D, Cooper, C & Hertfordshire Cohort Study Group 2013, Type of milk feeding in infancy and health behaviours in adult life: findings from the Hertfordshire Cohort Study, British Journal of Nutrition, vol. 109, no. 6, pp. 1114–1122.