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DOHaD position paper

The time to prevent disease begins before conception

Editor's note. This position paper has been prepared by the International Society for Developmental Origins of Health and Disease (DOHaD). It is addressed to the representatives of UN Member States taking part in the UN Summit on Non-Communicable Diseases, being held at UN headquarters in New York this September.

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1 Background

There is global recognition at agency and country levels that non-communicable diseases (cardiovascular disease, diabetes, chronic lung disease and cancer) are now occurring at epidemic rates in virtually every country, and have become a leading cause of premature morbidity, disability and death (1). Although non-communicable disease prevalence rates are currently lower in most low- and middle-income countries than in their rich counterparts, the speed of the rise in obesity and non-communicable diseases in low- and middle-income countries is higher. The total burden of disease is already greater among low- and middle-income countries, because of the combined size of their populations.

While the problem is now recognised, successful interventions to control and the capacity to implement them, have not been established (2). There has been much progress in identifying and understanding adult risk factors for non-communicable diseases. These include modifiable behaviour-related risk factors such as obesity, a summary indicator of cumulative positive energy balance. Positive energy balance arises from a combination of physical inactivity, and increased energy intake, made more likely by the consumption of energy-dense diets. Smoking is an additional independent risk factor.

These risk factors directly or indirectly impact upon cardio-metabolic mediators of risk such as high blood pressure, disordered serum lipids, and glucose intolerance. There has been a strong focus on strategies to prevent disease by modifying adult behaviours, and there are agreed recommendations defining possible public health approaches to achieving this, using an array of tools within and outside the health sector (3).

Although healthier adult behaviours are clearly very important, recent research shows that nutrition and other environmental factors acting during early development (fetal life, infancy and childhood) influence susceptibility to obesity and non-communicable diseases (4-7).Thus, the health of mothers before and during pregnancy, and nutrition and growth in fetal and early post-natal life, determine the structure, function

and adaptive capacities of key organ systems. Together, these define the capability of an individual to interact with the environment.

Exposure to later environmental stressors that exceed adaptive capacity is expressed in an increased risk of non-communicable diseases in adulthood. This is especially pertinent to low- and middle-income countries, where sub-optimal environments in fetal and early post-natal life remain widespread, but where rapid economic development and transition create the conditions for excess weight gain and other adverse lifestyle changes which can overwhelm adaptive capacity.

In addition to these effects on cardio-metabolic capacity, it is known that the quality of the early life environment, not only in nutritional terms but also in the quality of parenting and social interaction, has strong effects on brain development, cognitive capacity and mental health. Thus early life deprivation leads to continuing psychosocial and educational disadvantage, and weighs against the adoption of healthy adult lifestyles (8).

The failure of current recommendations to take account of the developmental contributions to adult health and disease risk makes it less likely that we will be successful in our endeavour to control the epidemics of non-communicable diseases, especially in low- and middle-income countries. A life cycle approach is likely to add considerable value to the current focus on adult risk factor control.

Here we bring to the attention of Member States the evidence linking the pre-natal, infant and childhood environment to non-communicable disease risk, and urge them to commit to taking steps to improve maternal and child health and nutrition as an integral part of their strategy to prevent non-communicable diseases, especially in low- and middle-income countries.

2 Vulnerable periods in early life

2.1 Fetal development

Individuals who had a lower birth weight (an indicator of sub-optimal fetal growth and/or nutrition) have an increased risk of adult coronary heart disease, stroke, hypertension, type 2 diabetes, chronic obstructive lung disease, osteoporosis and mental ill health (7, 9-14). Men and women who weighed less than 2.5 kilograms at birth have approximately twice the risk of dying prematurely from coronary heart disease, or of developing type 2 diabetes, compared to those who weighed 3.5-4.0 kilograms.

It is thought that that this reflects permanent changes in the body's structure and metabolism ('programming') resulting from impaired fetal nutrition and other adverse fetal exposures (4-6). The under-nourished fetus may lack the nutrients or 'building blocks' required to construct metabolically important tissues such as muscle, and abdominal organs (liver, pancreas, kidney) and their vascular supply. It may also make adaptations, prioritising the tissues required for immediate survival (brain and body fat) and 'sacrificing' the development of the above tissues. Research in animal models show that, by affecting brain centres controlling mood and anxiety, physical activity, eating behaviour and food choices, fetal nutrition can have long-term effects on behaviour (15).

Because all these changes occur during critical windows of development, they leave a permanent deficit and vulnerability to later chronic disease. The risk is increased further if there is mismatch between the fetal and adult environments, for example if the individual is exposed to adult obesity, inadequate exercise, unhealthy diets, smoking and psychosocial stress (4-7).

The main underlying causes of fetal under-nutrition worldwide include poor maternal nutrition during her growing years, inadequate diet before and during pregnancy, and poor function of the fetal supply line (for example, the placenta)(16). Maternal under-nutrition remains a major

problem in low- and middle-income countries (17). Inadequate and poor quality diets are more common among women of low income and educational attainment, and among women who are food insecure. While current evidence of fetal influences on later health is based substantially on maternal diet and nutrition and on birth weight, there is growing evidence of the importance of other maternal and fetal exposures. For example, there is evidence linking maternal smoking during pregnancy (18) or maternal exposure to environmental pollutants such as endocrine disruptors (19), with an increased risk of obesity in the next generation. In animals, maternal stress or glucocorticoid exposure is associated with increased adiposity, blood pressure and glucose intolerance in the offspring; psychosocial stress in the mother during pregnancy as a risk factor for non-communicable diseases in humans has been little studied (20).

Maternal obesity, another form of maternal malnutrition, also adversely affects fetal development, leading to increased adiposity of the fetus and newborn baby, and a risk of early-onset obesity and diabetes in the next generation (21,22). This is exacerbated if maternal obesity is complicated by gestational diabetes (23). In developed societies many women consume poor quality and unbalanced diets, which result in nutritional deficiencies on the one hand and overweight and obesity on the other (24). Maternal obesity is also an increasing problem among urban populations worldwide, even in developing countries (25). This will contribute to an increasing burden of diabetes in the future.

The future prevention of chronic non-communicable disease will require effective policies and interventions to improve the health, lifestyle choices and nutrition of young women of childbearing age.

2.2 Infancy (the first 1-2 years of post-natal life)

Infancy is another critical window of development. Impaired nutrition and impoverished environments during these first 1-2 years of post-natal life lead to permanent growth faltering, neuro-cognitive impairment and adverse cardio-metabolic effects, which add to the increased risk of later non-communicable diseases (7). There is strong evidence that infants who are breastfed are both less likely to develop concurrent illness and to be at lower risk of adult chronic disease (26-29).

Optimal infant nutrition includes exclusive breastfeeding for the first six months, followed by the introduction of nutritious foods supplying adequate energy, protein, fat and micronutrients. In lower- and middle-income countries, many infants fail to develop to their full potential during infancy, because of inadequate quality and quantity of complementary foods (30,31). In the developed world, breastfeeding rates are unacceptably low and especially so among disadvantaged women (30). Mothers need education and support to give their infants the best possible start in life, through optimal interaction and nutrition (32).

The Ten Steps to Successful Breastfeeding and the Baby Friendly Hospital Initiative guidelines should become a minimum standard of care. International guidelines to prevent the promotion of formula feeds should be supported and strengthened. Policies supporting maternity leave for at least the first 6 post-natal months, to enable optimal mother-baby interaction and breastfeeding, should be promoted. Policies should also focus on improving the quantity and quality of complementary foods in later infancy.

2.3 Childhood and adolescence

Data from all regions of the world show that rapid weight gain after infancy, which is to say at any time during childhood and adolescence, is associated with an increased risk of adult obesity, hypertension and cardiovascular disease, and type 2 diabetes (11,12,33). This is especially true on a background of impaired fetal and infant growth. This high-risk pattern of growth is increasingly common in low- and middle-income

countries, where low birth weight and infant growth faltering are common, but where economic development is leading to rapid childhood weight gain.

There is a large body of evidence that cardio-metabolic risk factors, including adiposity, blood pressure, plasma lipids, insulin resistance 'track' into adult life – children with higher levels of adiposity, blood pressure and insulin resistance will become adults at highest risk of non-communicable diseases. Childhood and adolescence are formative periods when diet and physical activity patterns, and choices about smoking and alcohol consumption are strongly influenced by parents and peers. The increasing availability of sedentary entertainments (such as television, video games) as well as pressure to succeed academically in order to compete in modern jobs markets, mean that children spend increasing amounts of time sitting in front of television and computer screens, and less time physically active.

Achievement of an optimal growth pattern and healthy behaviours during childhood and adolescence will require better health education, increased opportunities for healthy physical activity, and policy measures to prevent the early adoption of smoking.

3 Policy context

It is now clear that achieving the Millennium Development Goals (34) and reduction in the burden of non-communicable diseases are intimately related (35). There are common underlying causes that link both. Efforts to coordinate and harmonise actions at Member State level are urgently needed. Efforts to address obesity need to be coordinated with those aimed at addressing under-nutrition. In most high burden Member States the implementation of relevant policies and actions is weak, constrained by lack of an appropriately trained workforce and delivery infrastructure (36). The Scaling up Nutrition initiative recently captured in the 1000 days programme must be expanded to include factors increasing obesity and the underlying causes that lead to both over and under-nutrition.

The Society for Developmental Origins of Health and Disease urges Member States to implement actions outlined in World Health Assembly resolutions that address infant and young child nutrition, maternal and child health services, commitments on marketing food and non-alcoholic beverages to children, and resolutions on smoking and health, with resolutions aimed at addressing non-communicable diseases.

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Acknowledgements and request

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