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# Life Course Perspective: Evidence for the Role of Nutrition

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**Abstract** The "Life Course Perspective" proposes that environmental exposures, including biological, physical, social, and behavioral factors, as well as life experiences, throughout the entire life span, influence health outcomes in current and future generations. Nutrition, from preconception to adulthood, encompasses all of these factors and has the potential to positively or negatively shape the individual or population health trajectories and their intergenerational differences. This paper applies the T2E2 model (timing, timeline, equity and environment), developed by Fine and Kotelchuck, as an overlay to examine advances in nutritional science, as well as the complex associations between life stages, nutrients, nutrigenomics, and access to healthy foods, that support the life course perspective. Examples of the application of nutrition to each of the four constructs are provided, as well as a strong recommendation for inclusion of nutrition as a key focal point for all health professionals as they address solutions to optimize health outcomes, both domestically and internationally. The science of nutrition provides strong evidence to support the concepts of the life course perspective. These findings lend urgency to the need to improve population health across the life span and over generations by ensuring ready access to micronutrient-dense foods, opportunities to balance energy intake with adequate physical activity and the need for biological, social, physical, and macro-level environments that support critical phases of human development. Recommendations for the application of the life course perspective, with a focus on the emerging knowledge of nutritional science, are offered in an effort to improve current maternal and child health programs, policies, and service delivery.

**Keywords** Environment · Intergenerational · Developmental trajectories · Health equity · Maternal and child nutrition · Epigenetics

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## Introduction

Over the past decades, nutrition science, which is traditionally defined as a biological science, with physiological, genomic, medical, social and environmental aspects [1] has accumulated rigorous evidence about the importance of dietary intake to optimal development, health, and disease prevention. The life course perspective describes how exposures to harmful and protective biological, cultural, social, behavioral and psychological factors, from preconception through old age, shape health trajectories across the lifespan and even into subsequent generations [2, 3]. As stated by Fine and Kotelchuck [3], this framework describes a process that is an interactive one, involving genes, environments and behaviors. The purpose of this paper, supported by the results of past and emerging nutrition research, is to show how each of these factors is affected by, and also determines, nutritional status.

Good nutrition is essential for health. Diets that provide optimal energy and beneficial nutrients have positive health and developmental effects that accumulate over the life span and across generations. Conversely, excessive intake of energy, or insufficient intake of protective nutrients, especially during critical periods of development, is associated with poor health and contributes to health disparities. This paper will provide examples from the science of nutrition that highlight the critical importance of nutrition to individual and population health, so that professionals in the field of maternal and child health (MCH) recognize the urgent need to fully integrate nutrition into programs, policies, and service delivery systems that promote optimal health throughout the life span and across generations.

To organize the paper, we have chosen the key concepts of the life course perspective presented by Fine and Kotelchuck [3] in a paper commissioned by the Maternal and Child Health Bureau (MCHB): timeline, timing, environment and equity (familiarly known as T2E2). Together with Fig. 1 (shown below) these concepts demonstrate how nutrition illustrates and supports the life course framework and its cumulative impact on individuals and generations:

- today’s exposures influence tomorrow’s health (timeline),
- health trajectories are particularly affected during critical periods (timing),
- inequality in health reflects more than genetics and personal choice (equity),
- the broad environment strongly affects the capacity to be healthy (environment).

The paper concludes with examples of strategies that can maximize the potential of equitable and healthy nutrition environments to improve health across generations.

## Timing

Currently, there is much interest in examining the critical periods where nutrition plays a key role in shaping the health trajectory, either positively or negatively, during the prenatal, infant, early childhood and adolescent periods. The presence or absence of optimal nutritional status of the mother and/or child is an important factor in programming the child for healthy development and long-term maintenance of organ systems. For each of these important periods, only selected nutrients will be used as examples of how nutritional status illustrates the concept of timing in optimal development and primary prevention of health risk factors.

### Preconception/Pregnancy

Positive or negative exposures during pregnancy can have immediate effects on fetal neurodevelopment. For example, the vitamin folate plays an important role in the formation of the fetal neural tube, and adequate folate status of women in the periconceptional period is critical [4, 5]. Folate plays a role both in the synthesis of DNA, and thus cell proliferation,

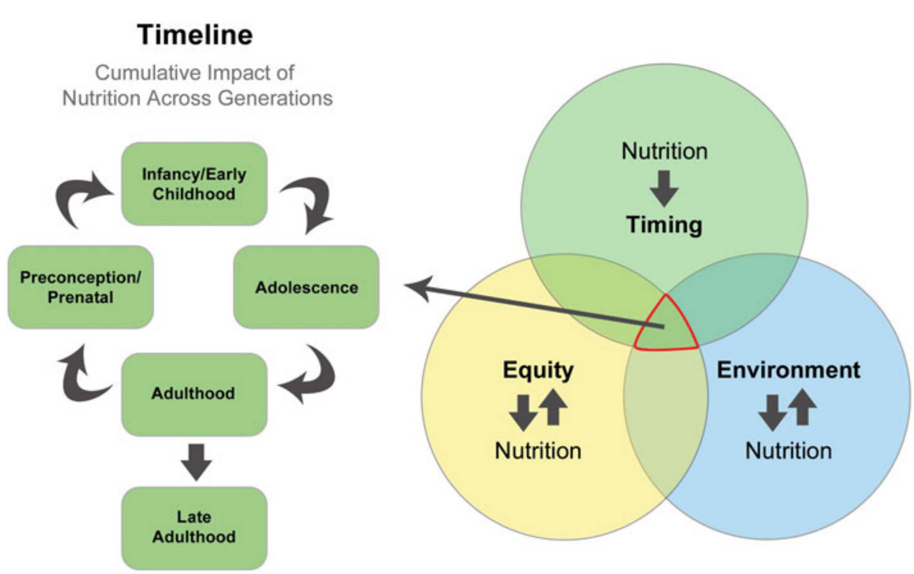


**Fig. 1** Illustration of the life course perspective applied to nutrition

and DNA methylation, one of the best-established ways in which genes encoded in DNA are regulated. Thus, folate deficiencies during the critical first weeks of pregnancy are associated with epigenetic alterations in gene expression leading to neural tube defects, especially in those women who are genetically-susceptible and/or whose need for folate is elevated [6]. Folic acid supplementation is estimated to reduce the risk of NTDs by 70 % for women who have had a child with an NTD and 50 % for women who have not [4].

Maternal intake of the long-chain omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) is also critical to optimal neurodevelopment. Omega-3 fatty acids are important structural components of cell membranes, the central nervous system, and retinal cell membrane structure [7, 8] and, when taken during the periconceptional stage, they are associated with improved embryo morphology [9]. Several studies have also shown an association between maternal dietary intake of oily fish or oils providing omega-3 fatty acids during pregnancy and visual and cognitive development, maturity of sleep patterns, and motor activity in infants [10–12].

Fetal exposure to maternal obesity and related metabolic conditions (including gestational diabetes), on the other hand, may have deleterious effects. A case–control study found that maternal metabolic conditions may increase the likelihood of neurodevelopmental problems in children [13]. Krakowiak et al. [13] propose that the mechanism by which maternal metabolic conditions affect neurodevelopment is via high blood glucose levels and consequent chronic fetal hyperinsulinemia. Fetal hyperinsulinemia causes a cascade of events that result in fetal hypoxia and iron deficiency, which in turn negatively impact fetal neurodevelopment.

It is also likely that protective or harmful fetal exposures can have long-term effects on chronic disease risk and economic productivity. Barker's [14] 'fetal origins' or 'fetal programming' hypothesis proposes that malnutrition during the fetal, infant and early childhood periods leads to permanent changes in the structure and function of organ systems, setting the stage for vulnerability to chronic disease in adulthood. Observations of children prenatally exposed to starvation during the short Dutch famine of 1944–1945 support the negative, lifelong consequences of poor nutrition during pregnancy, in spite of a presumably normal diet afterwards. Not only were these children more likely to experience coronary heart disease, decreased renal function and decreased glucose tolerance in adulthood [15], but their offspring have been shown to be born both shorter and heavier, which demonstrates the transgenerational effects early of developmental nutritional insults on future health outcomes [16].

Similarly, in a study of adults exposed to undernutrition before, during and after the Biafran famine [17], both women and men experienced a higher prevalence of overweight, hypertension and impaired glucose tolerance at 40 years of age. This suggests that fetal and infant undernutrition are closely associated with key risk factors for the development of chronic disease as adults and that nutritional challenges in early life can result in changes to epigenetic regulation of genes which are detectable up to 60 years later [18]. There is also evidence of positive effects of early nutritional protective factors in a study of Guatemalan children. Using an experimental design, children who received a higher protein, more energy-dense, supplement in early childhood had measurable health benefits and increased economic productivity [19] during the individuals' lives and improvements in at least two following generations [20].

Recent experimental studies provide additional support for the potential mechanisms underlying Barker's hypothesis. In animal models, maternal undernutrition and placental insufficiency cause a permanent reduction in nephron number, which may increase the risk for hypertension later in life, especially when combined with accelerated postnatal growth [21]. Bagby [21] proposes that this accelerated growth (due to, for example, excess formula feeding to promote "catch-up growth") creates a mismatch between body mass and nephron number. This mismatch between the capacity of body systems developed under conditions of scarcity, and the demands placed on them as the environment changes from one of inadequacy to one of excess, may increase risk for chronic conditions such as coronary artery disease, stroke, and type 2 diabetes [22]. In addition to fundamental changes in organ structure, it has also been increasingly demonstrated that epigenetic mechanisms, which are susceptible to the presence or absence of certain nutrients during critical growth periods, establish long-lasting patterns of gene expression. For example, a periconceptional multi-micronutrient supplementation intervention (vs. placebo) with malnourished Gambian women led to differential methylation of genes, some of which were associated with the immune function, in their offspring at birth and also at 9 months of age [23].

## Infancy and Early Childhood

Infancy is another critical period where "when," "what," and "how" the child is fed can promote or prevent optimal health and development. Breast milk, for example, can have many positive immediate, as well as long-term, effects on infant health and development. Breastfeeding is associated with decreases in perinatal mortality [24] and perinatal morbidity from both common (otitis media, eczema and diarrhea) and relatively rare (childhood leukemia and sudden infant death syndrome) ailments [24]. In recent years, decreases in the prevalence of chronic diseases later in life, such as asthma, obesity and type 2 diabetes have also been reported for breastfed infants [24]. This may be, in part, because breastfeeding is a protective factor against rapid weight gain in early infancy (0–3 months), which is a risk factor for increased BMI and percent body fat in adolescence [25]. Indeed, breast milk contains at least six bioactive proteins and hormones involved in appetite, energy balance and growth modulation [26], and several studies have suggested that these may be involved in the regulation of infants' energy intake and metabolism [27].

The timely provision of nutrients that are bio-available, as well as adequate, in infancy is also important in this critical window for growth and development. Here too, breast milk provides advantages, some well-described and understood, and some yet to be characterized. For example, in the past, zinc, a mineral essential for growth, was added to infant formulas in amounts equivalent to those in breast milk. However, it was shown experimentally that adding additional zinc to infant formula would improve growth in infants, and significantly so in males [28]. Further investigation revealed that the zinc in breast milk is more biologically-available than that in formula, due to the presence of previously-unrecognized factors that enhance its absorption [29, 30]. Thus, creating an infant formula that replicated all nutrients known to be in breast milk did not replicate all of the protective nutritional effects of breast milk. It is likely that there are other as yet unknown factors in breast milk that positively affect infant health and development. This example also illustrates another broader concept: the importance of a diet composed of whole foods as opposed to those that have been processed in some way. Nutrition science is not yet able to copy nature; there remain elements present in natural foods that promote health and which are still not fully understood.

Early childhood is another stage where the timing of the nutrient deficiencies can impact learning ability and affect school readiness, which in turn can alter lifelong achievement and promote inequalities [31]. The brain grows rapidly for the first 2–3 years of life, coinciding with a high iron requirement. Iron deficiency is the most prevalent nutrition problem worldwide, even in industrialized countries, because, after 6 months, even breast-fed infants need an additional source of iron [31]. Studies investigating the effects of iron deficiency and iron deficiency anemia on the development of infants and young children have concluded that there is a causal relationship between iron deficiency anemia and poor performance on measures of psychomotor and cognitive development, particularly when the anemia is severe [32]. A recent review of supplementation studies suggests that iron, provided even to non-anemic infants and young children, positively affects their psychomotor, although not their cognitive, development [33].

### Adolescence

Adolescence represents another critical time in the life course, a time of very rapid growth, second only to infancy, with increased nutrient intake required to support this growth. For example, although bone is a living tissue that is constantly being remodeled, the skeletal system accumulates about half its adult mass during adolescence [34], and usually its peak bone mass as well. There are few additional net gains in early adulthood followed by a slow, progressive net loss in bone density that starts around age thirty [35]. Thus, maximizing bone density during adolescence can reduce the risk of future fractures due to osteopenia or osteoporosis [36]. Although there are several factors that contribute to peak bone mass, such as genetics and weight-bearing physical activity, sufficient intake of nutrients such as calcium and vitamin D plays a significant role in increasing bone mineral content [37–39]. Heaney et al. [40] note that a 5–10 % difference in peak bone mass can account for up to 50 % difference in future hip fracture rate with aging. Therefore, calcium and vitamin D intake during the adolescent years can have an impact on bone health decades later.

The importance of the timing of food/nutrient intake during critical stages of the life course in the promotion of optimal health is illustrated in Fig. 2 (see below), using, as examples, the nutrients/food presented above.

## Timeline

The opportunity to affect health outcomes comes not only during critical periods during the life course, but on a daily basis as well. That is one reason why daily consumption patterns are so important to disease prevention. The United States Department of Agriculture (USDA) and the Department of Health and Human Services (DHHS) guidance [41] recommending that people eat more plant-based, non-processed foods for the primary prevention, reversal/amelioration (secondary prevention/early intervention) or treatment (tertiary prevention) of chronic disease risk factors such as obesity and hypertension are an example of how individuals can take control of these daily exposures, and make choices to support healthy habits over the long term and ultimately avoid disease. International organizations support similar recommendations [42] due to the rising phenomenon of the "double burden" of the nutrition transition where the incidence of both infectious disease (due in part to undernutrition) and chronic disease (due in part to overnutrition) are being experienced in the same household. These dietary guidelines promote optimal daily dietary intake for the primary, secondary and tertiary prevention of disease, with the potential to be effective across the lifespan.

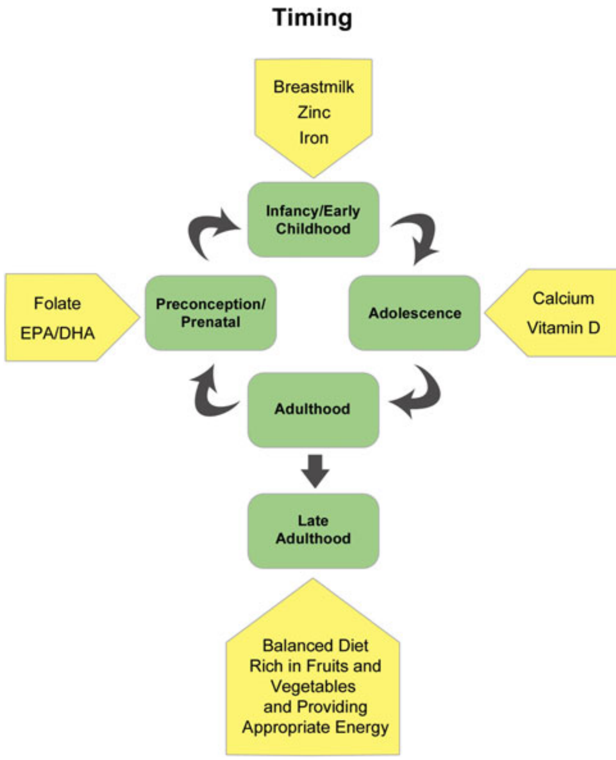


**Fig. 2** Examples of key foods/nutrients affecting critical periods

*Pre-pregnancy weight and gestational weight gain are* strong predictors of childhood obesity in offspring, childhood interventions that include a focus on healthy eating practices can reduce this risk [43]. The development of obesity, as with its prevention, is a process that occurs over time and requires multiple steps to change. Interventions, regardless of where they are conducted (home or school-based), have not only demonstrated effectiveness in reducing weight but have also shown improvements in desirable levels of leptin and adiponectin, biologically-important biomarkers for understanding disease risk [44]. Promoting desirable levels of these biomarkers, and others, at an early age is important for the prevention of obesity in the longer term.

Obesity is the most important factor in the development of type 2 diabetes, accounting for more than half of new cases; even modest weight loss has a favorable effect in preventing the appearance of diabetes [45]. An encouraging sign is new evidence that when obese children become healthy-weight adults, their risk of chronic disease is equivalent to that of never-obese individuals [46]. Without intervention (the change in the childhood behavior/environment), it is likely that the cycle would continue across generations (obese child becomes obese parent and has an obese child). These are examples of how today's exposures can affect tomorrow's health and how they manifest themselves over the lifespan.

Optimal nutrition is important across the life course for secondary prevention in individuals susceptible to genetically-related risk factors; lifelong dietary habits have been shown to mitigate these risk factors, perhaps through epigenetic mechanisms. In an epidemiological study of women with the BRCA gene, higher values on the Dietary Quality Index-Revised (DQI-R) and the Canadian Healthy Eating Index were associated with lower breast cancer risk [47]. Similarly, in a study evaluating risk factors for metabolic syndrome, women who had maintained a vegetarian diet for more than 20 years were compared to non-vegetarians. Risk factors for metabolic syndrome and the associated risks for cardiovascular disease, including lower BMI and percentage body fat, were decreased in women who had followed the vegetarian diet [48]. While the body has a certain level of developmental plasticity throughout the life course to adapt to changing nutritional patterns and environments, sustaining healthy dietary practices, beginning as early as possible, helps ensure better health outcomes later in life [49]. Sustaining healthy daily habits is key to preserving health over generations. Nutrition interventions that support these types of changes are crucial to ensuring long-term health and well-being across the lifespan as well as inter-generationally.

## Equity

Applying the life course framework, where equity is a fundamental component, to current nutrition knowledge, it is clear that current and past inequities in nutritional intake underlie current and future health disparities. Access to food adequate to achieve optimal health and function is recognized as a basic human right [50, 51]. However, food insecurity, the "limited or uncertain availability of nutritionally-adequate and safe foods" [52] remains an ongoing problem in the United States (US), despite the abundance of food available for many households. Food insecurity is a social determinant of health and related health disparities [53] and is characterized by concern about having enough food to eat, followed by reductions in diet quality, and then quantity, due to lack of money and other resources [52]. Food security at the community level results from the underlying social, economic, and institutional factors within a community that affect the quantity and quality of available food and its affordability [54]. In 2010, 48.9 million people in the US lived in food-insecure households, a prevalence of 14.5 % [52]. The impact of disparities in food security will depend on the timing and timeline of exposure. Risk for food insecurity is not evenly distributed in the population; it is more common for households living in poverty. It is also more common for households with children and households of African American or Hispanic race/ethnicity and those headed by single women [52].

Threats to community food security occur when the food environment is insecure [55]. In food-insecure communities, food may be available, but of limited nutritional value or attainable only in culturally-unacceptable ways. Healthy foods may be financially inaccessible, and the food system may be unsustainable.

The relationship between food insecurity and compromised health and nutrition, now well-documented across the life course, was first identified among adults [56, 57]. It has since been associated with poor outcomes among children including compromised health [58], low school achievement [59], and decreased intake of fruits and vegetables [60]. Among food-insecure pregnant women, increased pre-gravid weight, excess pregnancy weight gain, and risk of gestational diabetes have been reported [61]. Increased risk for obesity among people with disabilities [62] and other poor health outcomes among people with special health needs or chronic conditions such as diabetes [63] and HIV [64] have also been associated with household food insecurity. This demonstrates that the health risks among people with special needs and disabilities track with those in other minority and low-income groups because these are often one and the same population [65]. The difference is that health outcomes of people with special needs and disabilities are less frequently reported in the literature and disparities in their health risks are therefore less recognized [66].

Children with special health care needs and their families, an important MCH population, may experience financial hardships due to disruptions to education or work loss due to the needs of their child [67]. Having a child with ongoing needs for two or more health services is predictive of a shift over time to food insecurity [68]. An equity framework asks that we address food access and security issues among families of children with special health care needs.

The risk for food insecurity and its impacts vary across the life course, not only because direct effects of food insecurity on nutrition vary in timeline and with timing, but also due to variation in associated adverse effects because adverse effects associated with food insecurity, such as increased stress [69], psychological and social disruption [70], and overall lack of resources [71], vary with timing and timeline across the life course. An accumulated impact of food insecurity over the life course has also been identified [72]. For men and women who experienced hunger in childhood, lower educational attainments were reported and household income in adulthood was related to educational achievements.

Breastfeeding is associated with improved child survival and health outcomes for mothers and infants [73]. It establishes a foundation for favorable health trajectories across the life course. However, the proportion of US infants who are breastfed is low. In 2008, 35 % of infants were exclusively breastfed through 3 months of age [74]. Disparities in rates of breastfeeding are evident in the US by race, geographic region, special health care needs status, income and education level [74, 75]. If these disparities persist, and if unchecked, they may introduce disparities in long term health and developmental outcomes for children and families for generations. Coordinated strategies at the individual, community and societal level will be needed to ensure all infants access to breast milk [76].

## Environment

The discussion thus far has focused on nutrition applications of the life course concepts of timeline, timing, and equity using examples of current and emerging knowledge regarding the biological functions of nutrients (which might be called the nutritional "micro-environment"), their effects on overall health status, and the inequities in access to healthful foods that contribute to overall health disparities. The protective effects of nutrition on health can best be realized when healthful foods are accessible, acceptable, and affordable. Thus the nutrition "macro-environment" is key to supporting healthy food choices, dietary quality, and therefore nutritional status for all populations across all stages of the life course.

A comprehensive understanding of the ecological influences on what people eat includes biological, cognitive, and behavioral responses to the immediate social and physical environments and to the more distal macro-level environment that shapes food policies and related systems [77]. These levels of influence constantly interact to impact nutritional status, including dietary intake, energy expenditure, and ultimately health outcomes (see Fig. 3).

The social environment includes family members, friends, and peers who, potentially over one's lifetime, can influence food values, attitudes, and preferences, as well as food-related behaviors through role-modeling, social support, and reinforcement of social norms. Children emulate parental dietary, physical activity, and media habits, which can serve as either risk or protective factors in the development of childhood obesity [78, 79]. Parenting styles also play a role. Authoritative parenting, for example, is associated with greater fruit and vegetable intake in children and lower sugar-sweetened beverage availability in the home [80–82]. Frequency of family meals is also positively related to children's diet quality as well as academic outcomes [83, 84], while peer influences on food choices and consumption patterns become stronger during the critical time period of adolescence [85–87].

The physical environment encompasses the home, childcare and school settings, worksites, neighborhoods, and

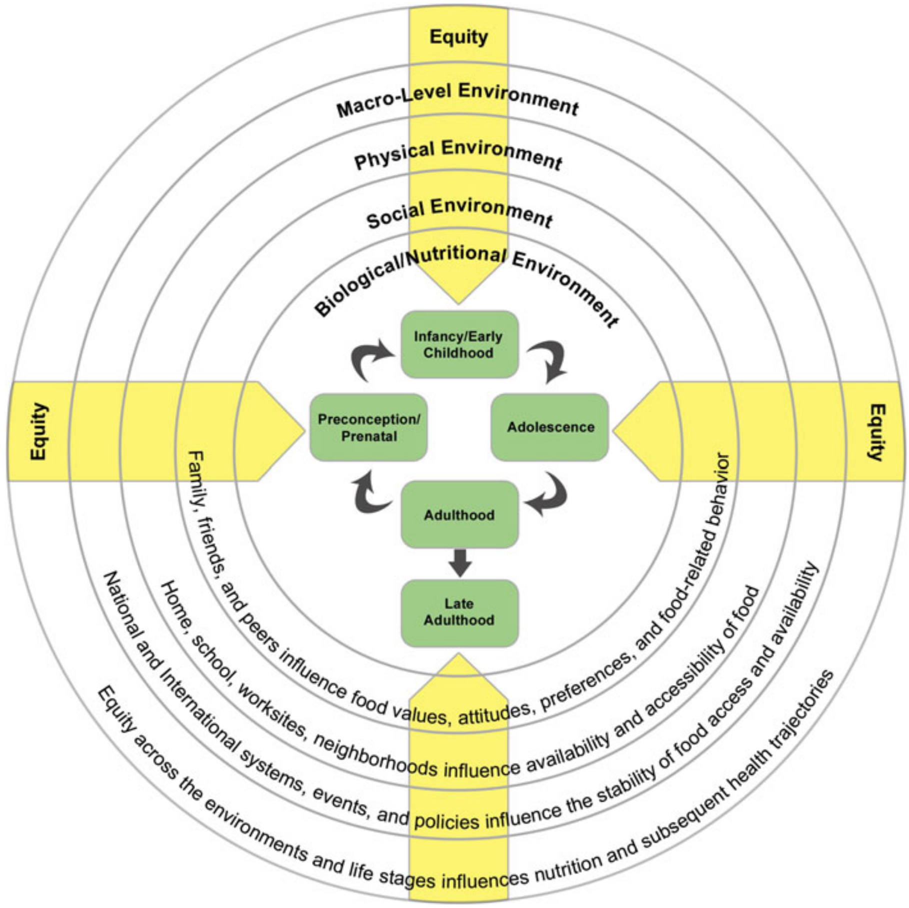


**Fig. 3** Influence of *equity* and *environment* on intergenerational nutritional status

communities, including locations where food is purchased such as grocery stores, restaurants, fast-food outlets, and convenience stores. Availability and accessibility of healthful and affordable foods in these settings are key factors in optimizing dietary quality, yet inequalities continue to persist. Studies of "food deserts"—areas with few or no grocery stores—show that dietary quality of residents in both rural and urban settings is poorer than in those residing in suburban neighborhoods with more grocery stores [88]. Conversely, areas characterized by greater access to energy-dense foods and fast foods, commonly known as "food swamps," demonstrate higher risk of poor diet and obesity [89]. Other "built" environmental factors affect access to quality food choices and availability, including transportation and walkability [90].

The macro-level nutrition environment is defined by societal and cultural norms and values, which are often expressed as policies made as a society. These policies may be protective in nature but can also present risk factors for individual decisions regarding food choice and accessibility. Marketing and media strategies used by the food and beverage industries are very successful in affecting children's food choices [91] and in influencing efforts to minimize regulations and shape food and agricultural policies. Calls to require governmental restrictions on food marketing to children have been renewed since industry self-regulation has had limited impact [92]. There are also efforts underway in several states to restrict access to foods of little nutritional value (e.g. sweetened beverages) by instituting policies such as levying taxes on their sale [93]. In addition, food policy advocates are pushing for reforms to the Farm Bill being currently debated that would limit current subsidies for corn (high-fructose sugar) and other crops used to create the inexpensive, high-calorie, low nutrient-dense foods that form the basis of the diet for many low-income Americans who cannot afford to buy healthier foods.

Other macro-level influences include policies that determine economic systems, government and political structures, food assistance programs, health care systems, land use, and transportation [77]. Federal guidelines set minimum standards for the nutritional content of child and adult care and school meals [94, 95], with recent legislation passed to strengthen these standards [96]. Lower BMI z-scores have been associated with more healthful nutrition environments in schools [97], so improved standards should prove effective in promoting more healthful dietary habits and reducing childhood obesity. National school and local worksite wellness policies [98, 99] provide opportunities for reinforcement of meal nutrition standards and greater reach to other food sources in these settings (e.g. vending, fund raisers) [100].

To most fully understand and effectively improve the nutritional health of the MCH population, the social, physical, and policy aspects of the environment must be considered in conjunction with the timing, timeline, and equity aspects within the life course framework.

## Conclusions

Based on the most recent, as well as emerging, scientific evidence in the nutrition field (especially epigenetic), it is clear that efforts to promote optimal growth, development and health among the population must span the life course and encompass multiple levels, from the individual to the national/international systems level. Good nutrition for everyone is an essential part of comprehensive preventive strategies to reduce adverse health consequences. It should be a priority across the lifespan (timeline), with targeted support during critical periods (timing) and a focus on the environmental and equity issues that put some populations, such as minority and low-income children and children with special health care needs, at higher risk than others for poor health outcomes. It must be recognized that nutrition exposures and consequent health status do not result solely from individual biology and behavior; instead, they are the result of a complex interplay between an individual and the "macro" nutrition environment, his or her social circles (family, friends, and peers), physical environment (home, school, worksite, and neighborhood), exposure to the media and other marketing strategies of the food industry, and political/policy environment (national and international systems). To address the world-wide obesity and chronic disease epidemics, MCH leaders and all health professionals need to prioritize support and funding for policies, programs and services that carefully address all aspects of the T2E2 model at individual, local community, national and international levels.

In the US, MCH leaders and health professionals can continue to ensure that the T2E2 model is comprehensively incorporated in national priority setting. Currently, Healthy People 2020 includes approximately 40 objectives directly or indirectly related to the nutritional health of the population and environment and equity issues from preconception through old age [101]. For example, the wide-ranging objectives address:

- Timeline: focus on prevention by providing more comprehensive school health education; integrating nutrition education and chronic disease screening into health care, community-based, and worksite wellness-programs.
- Timing: improving preconception and interconception nutrition; promoting breastfeeding, and assuring health-promoting foods at other critical times in the life course, such as early childhood and adolescence.
- Equity: reducing food insecurity, under- and over-nutrition, and nutrition-related chronic diseases; increasing student participation in national school meal programs.
- Environment: enhancing the quality of foods offered in preschools and childcare centers, schools and neighborhoods

Maternal and child health leaders and health professionals can also continue to identify interventions, programs and services that promote the successful achievement of aspects of the T2E2 framework. For example, evidence-based strategies that have been shown to improve initiation and duration of breastfeeding (timing) include education and social support at the individual level, change in the workplace and public policies at the community level (environment) and health care and legislative changes at the societal level (equity) [71, 100]. Recent research has demonstrated that even if nutrition is not ideal during critical periods (timing), a lifelong focus on nutrition should be maintained (timeline), as it may be possible to reverse the effects of negative exposures. For example, breastfeeding may reduce the negative impact of gestational diabetes exposure on child growth [102], and achieving a healthy weight as an adult, after being obese as a child, has been shown to decrease excess chronic disease risk [46]. At the societal level, food insecurity, an important equity issue, has been addressed by collaborating across sectors and in shaping policies to improve the economic security of individuals and communities, strengthen regional food systems, and improve the resource safety net [103]. *Food, Education, Agriculture Solutions Together* (FEAST) is an example of a community-based participatory approach that has been used successfully to improve community food systems [104]. Successful environmental interventions addressing nutritional issues include implementation of policies and strategies to improve the physical surroundings, social climate, and/or organizational systems to promote positive behavior change [77]. Examples of successful "environment" strategies include market makeovers in low-income communities to increase accessibility to fresh produce, providing electronic benefit transfer (EBT) card access at Farmer's Markets, and school gardens to promote fruit and vegetable intake [105–107].

Internationally, as part of the Copenhagen Consensus 2008, leading economists identified three nutrition interventions as being among the top five (of 40) development intervention priorities for the world [108]. These interventions fundamentally address worldwide nutrition equity issues and specifically address timing (micronutrient supplementation of children under 5 years of age with vitamin A and zinc) and timeline and environment (fortification for the general population with iron and iodine, and bio-fortification of staple crops) priorities. The 1,000 days initiative [109] is an example of an global program targeting the "timing" aspect of T2E2 by providing support for optimal nutrition from pregnancy through 2 years of age, with the idea that focusing interventions on this "high impact" window is most beneficial to society.

Finally MCH leaders and health professionals, in their efforts to maximize the positive effects and reduce the negative factors affecting the life course of individuals, as well as populations, should consider nutrition as a starting point at all levels of practice, from clinical protocols to the development of programs and policies, to address health promotion and disease prevention.

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