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REVIEW

Nutrition transition and obesity prevention through the life-course

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The aim of this paper is to discuss concepts regarding the nutrition transition (NT), the several stages it has encompassed over human history, dietary shifts it is associated with and its implications to the life-course approach for obesity prevention. NT is a phenomenon characterized by an inversion of the nutrition profile, that is, an increase in obesity and a reduction in undernutrition. Obesity and associated chronic diseases are the most important expressions of NT today. Some important dietary changes happened in the last decades as a result of the complex determinants of NT, such as urbanization, the economic growth dynamic, cultural and behavioral shifts. The NT has involved an increased consumption of caloric beverages, ultra-processed products, animal foods, edible oils and soft drinks, accompanied by a significant reduction in the consumption of fruits, vegetables, pulses and milk. Global obesity prevalence increased from 4.8% in 1980 to 9.8% in 2008 for men, and from 7.9% in 1980 to 13.8% in 2008 for women, representing 205 million men and 297 million women with obesity and 1.46 billion with overweight in 2008. The context of the NT needs to be taken into account when developing effective obesity prevention strategies across the life-course.

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INTRODUCTION

The aim of this paper is to discuss concepts regarding the nutrition transition (NT), the several stages it has encompassed over human history, dietary shifts it is associated with and its implications to the life-course approach for obesity prevention.

NT: CONCEPT AND STAGES

NT can be defined as changes in diet and physical activity, especially its structure and composition. These modifications affect public health nutrition through changes in stature and body composition.[1] NT is a phenomenon characterized by an inversion of the nutrition profile, that is, an increase in obesity and a reduction in undernutrition. Obesity and obesity-related chronic diseases are the most important NT-related public health concerns.[1–5]

According to Popkin[1] NT can be grouped in five stages: hunter/gathering, hunger, hunger elimination, non-communicable diseases and lifestyle changes. Each stage can be examined from the nutrition, demographic and economic perspectives. Our focus is on changes in nutrition profiles taking into account economic, social, cultural and demographic factors, as they are deeply interrelated. The Upper Paleolithic era represents a hunter-gathering period when humans consumed a healthy diet based on plants and lean animal protein food sources, at the same time that highly prevalent infectious diseases significantly lowered life expectancy. About 10,000 BC the advent of agriculture led to a strong loss in dietary diversity and an increase in micronutrient deficiencies and famines. The third NT stage has been linked with the industrial revolution and trade globalization. During this phase both wealth and social inequality increased, famine receded and humans' reliance on animal protein food sources increased dramatically. The fourth NT stage is characterized by the excessive consumption of hyper-caloric processed foods of very limited nutritional value and widespread sedentary environments. This is associated with the major obesity pandemic human kind is currently experiencing and that became quite evident since the early 80s. In the latter stages some attempts at slowing down the obesity epidemic have been implemented. Lifestyle changes, such as the choice of higher quality oils, have also taken place in countries in the most advanced stages of the NT.[1]

The understanding of the major role that dietary and physical activity lifestyle changes have in shaping the obesogenic environments we currently live in forms the scientific basis behind the design of effective obesity prevention initiatives across the life-course.[3,5]

NT-related dietary and nutritional status shifts have been accompanied by huge reductions in infectious and major increases in non-communicable chronic diseases. Since the first NT stage large increases in life expectancy have occurred,[1,3–5] however, as a result of the NT-related obesity epidemic the current generation may end up having a shorter life expectancy than their parent's generation.[6]

NT AND DIETARY CHANGES

According to Popkin[1] some important dietary changes have happened in the last decades as a result of the NT and its complex

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determinants, including urbanization, economic growth and globalization that have led to major demographic, cultural and behavioral lifestyle shifts. The main dietary changes observed have been an increased availability/intake of caloric beverages, ultra-processed products, animal foods, edible oils and soft drinks, accompanied by substantial reductions in the consumption of fruits, vegetables, pulses and milk.[3–4,7–11]

The urbanization process is among the most important determinants of NT-related dietary shifts. Food and Agriculture Organization (FAO) balance sheets and gross domestic product (GDP) World Bank data from 1990 for 133 countries were used to simulate two contrasting situations reflecting a low (25%) and a high (75%) level of urbanization.[7] On the basis of a predictive model, the more urbanized populations tended to consume substantially more foods/beverages with added sugars and fats. This relationship was modified by the GDP revealing that moving from a low to a high level of urbanization would imply an increase in the relative consumption of fats by 4%, and of foods/beverages with added sugars by 12%, in very low-income countries. This trend was not observed in higher income countries.[7]

Measurements based on FAO balance sheets and World Bank GDP were also used to evaluate trends in the availability of caloric sweeteners for 103 countries in 1962 and 127 countries in 2000. Caloric sweeteners availability increased 32% in general (from 232 to 306 kcal per capita per day). However, in countries classified in the lowest GDP quintile the increment was 72% (from 90 to 155 kcal per capita per day) vs 4% (from 402 to 418 kcal per capita per day) for those in the fifth quintile.[8] Recent data describing time trends regarding food intake instead of availability are scarce and are predominantly from the United States. These trends reflect NT-related behavioral and economic changes. In the United States, the increase of sweetened beverages intake between 1977 and 2006 was 76% (87.4–153.7 kcal per day) for children aged 2–18 years, while juice intake increased by 62% (33.1–53.7 kcal per day).[9]

An examination of the relationship between energy availability from fats, estimated from FAO balance sheet corresponding to 1962 and 1990, and GDP for 134 countries found that in 1962 a diet containing about 20% of calories derived from fat was quite common in countries with a GDP of around $1900 per-capita. By contrast, in 1990 the same dietary fat content was detected in countries with a much lower GDP, of around $900.[1,7] Vegetable fat (mainly edible oils) was responsible for the 10–13% increase in fat availability (from 1962 to 1990) for almost all countries analyzed. Middle- and high-income nations increased vegetable oil availability to a lesser extent (between 3 and 6%). Animal fat availability has declined tremendously between 1962 and 1990 in middle- and high-income, but not in low-income, countries. While total fat availability has decreased 3% among middle-income countries, in high-income countries it has increased by 4–5% during the same period of time (between 1962 and 1990). In summary, the trends from 1962 to 1990 revealed a substantial increase in vegetable oil availability for low-income countries, and a decrease on animal fat availability for middle- and high- but not in low- income countries.[1,7]

FAO balance sheets data show that, with the exception of Cuba, Guatemala and Venezuela, most countries in the Latin American and Caribbean Region increased the available energy for consumption between 1990 and 1999. The overall pattern shows an increased availability of processed foods and a decline in the availability of fruits, fiber and other complex carbohydrates.[10] Brazil, for example, has shown a decrease in the per capita availability of complex carbohydrate from 72% of total energy in 1964–1966 to 59% on 1994–1996, while the proportion of fat availability increased to 75% in the same period (from 16 to 28%).[10]

Other contextual cultural and individual behavioral changes, such as an increase in the portion size and snack frequency, are involved with the complex dynamics underlying the NT. The portion size of several foods increased in the United States from 1977 to 1998 based on data from three national surveys. Salty snacks increased 70% in size and 93 kcal in calorie content. French fries portion size increased 36% and soft drinks 34%.[12] The proportion of the population that consumes one or more snacks per day based on a 2-day dietary record showed an increased from 71% in 1977–1978 to 97% in 2003–2006 in the USA population.[13]

OBESITY AS A MAJOR MANIFESTATION OF THE NT

As documented by Popkin,[1] the decrease in height and the increase in micronutrients deficiencies prevalence were the main expression of NT during the Upper Paleolithic age. However, for the last several decades, obesity has become the main focus.

A comprehensive data compilation on age-standardized global obesity prevalence trends has shown an increase from 4.8% in 1980 to 9.8% in 2008 for men, and from 7.9% in 1980 to 13.8% in 2008 for women. This represents a relative increase of 104% and 74.7% for men and women, respectively, corresponding to 205 million men and 297 million of women with obesity and 1.46 billion adults with overweight. Since 1980 the rate of increase in body mass index has been 0.4 kg m^{-2} per decade for men and 0.5 kg m^{-2} for women, although among women, several countries from Oceania such as Cook Islands and Nauru have reached a much higher rate (1.8 kg m^{-2} per decade) in comparison with the average. The rate of body mass index increase for Southern and Central Latin American women was 1.3–1.4 kg m^{-2}, a pace of increase that deserves major attention.[14]

Another seminal study compared the rate of increase in overweight/obesity prevalence in nine different countries between 1985 and 1995 when the baseline surveys were conducted, and between 1995 and 2006 when a second survey wave was implemented. There are data available for children and adults of both genders. For children, Australia (1.7% per year) has now reached faster increases in overweight/obesity rates than the United States (0.7% per year). Among adult females, Australia has also become the country with the highest rate of overweight increase (1.3% per year), followed by the United Kingdom, United States and China, all with an annual rate increase of 1%. Among adult males, the United Kingdom (1.1% per year) has achieved a higher annual increase of obesity than the United States.[15]

Body mass index has strongly increased over time based on data from a comparative study for countries such as the United States, United Kingdom, China and Australia. The study assessed the increase on the 95th percentile country-specific body mass index distribution for females aged 30 years. For adult females, the increase was 2.7 units in 18 years for the United States, 5.4 units in 11 years for Australia, 3.5 units in 8 years for United Kingdom and barely changed for Chinese women (0.5 units in 9 years).[16]

Low or high birth weight and excessive weight gain in early infancy are features of the NT that are emerging as major determinants of obesity in early in life[17] and in infancy.[18] Thus, the NT has had major life-course implications.[19] For example, the NT phase associated with the industrial revolution and trade globalization is not only likely to be related with an increase in preconceptional obesity but also with excessive weight gain during pregnancy, and excessive postpartum weight retention among women.[20] At the same time, this phase is associated with the widespread availability of infant formula and hyper-caloric highly processed complementary foods for infants.[21] Thus, the 'transmission' of obesity from one generation to the next (Pérez-Escamilla and Kac, this issue) is strongly linked with the NT. This knowledge helps provide an understanding of the approaches needed for proving solutions to the childhood obesity epidemic globally.

CONCLUSIONS

Obesity is a major contemporary manifestation of NT. Understanding how to prevent and control this pandemic is one of the highest current global health priorities. Clearly scientific, policy and political issues still need to be addressed. This paper provides the context for understanding the obesogenic dietary behaviors and the obesogenic environments where hundreds of millions of individuals currently live, go to school and/or work. The NT has evolved over thousands of years, however, the speed at which it accelerated and the obesogenic direction it took about half a century ago is a major driver of the obesity pandemic. Slowing down and redirecting changes toward healthier dietary and physical activity lifestyles across the life-course following the social-ecological model (Pérez-Escamilla and Kac, this issue) are needed to be able to gain control of one of the most important global health challenges of our times.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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