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Over and Under: The Role of Urbanization on the Double Burden of Nutrition in Developing Countries

Developing countries around the world are rapidly undergoing economic transition, resulting in increasing urbanization and rural-urban migration. Urbanization is linked to direct and indirect impacts on the nutritional transition towards obesogenic diets in the developed and developing world. However, in developing countries, the nutrition transition has led to a "double burden of nutrition" which is simultaneous occurrence of under- and over-nutrition within a population (Kennedy et al., 2006). Often, the prevalence of over-nutrition is outpacing reductions in the prevalence of under-nutrition (Dearth-Wesley et al., 2008), resulting in an overlap where both problems co-exist in the same household (Doak et al., 2000) or even the same individual (Popkin et al., 1996). The severity and consequences of under- and over-nutrition have been extensively studied, showing the detrimental health effects on children and adults. The global scope of the double burden of nutrition has been widespread and identified as an emerging public health concern in numerous developing countries in Asia, Africa, the Middle East, and Latin America (Ramachandran, 2006; Pedro et al., 2006; Hassan et al., 2006; Steyn et al., 2006; Custodio et al., 2010; Motlagh et al., 2010; Raphael et al., 2005; Barquera et al., 2006). This emerging public health crisis will undoubtedly add additional strains to the economy and health care systems of developing countries.

Emerging research explores the vulnerability of the urban poor subpopulations in developing countries to the double burden (Popkin, 1994; Doak et al., 2000; Dearth-Wesley, 2008). This demonstrates that even within developing countries, Non-Communicable Diseases (NCDs) are not merely "diseases of affluence" (Rao et al., 2011) but are beginning to permeate to lower-income groups. Over- and under-nutrition are not separate processes, and interactions between the two have been found (Doak et al., 2000; Popkin et al., 1996; Custudio et al., 2010). For example, when over- and under-nutrition co-occur in the same household (Doak et al., 2000), stunting and overweight issues have been found simultaneously in children (Popkin et al, 1996; Costudio et al., 2010). Significant biological research on the interaction includes the Barker hypothesis. Barker et al assert that poor nutrition during fetal and infant development combined with subsequent positive caloric balance in childhood and adult life increases the risk of developing obesity-related problems (1993). This paper seeks to address urbanization as the prominent factor of the double burden of nutrition. A closer look at China's nutrition transition will show how the rapid development of its economy and urbanization has plunged the nation into a new stage of the nutrition transition with consequences for low-income urban households. Additionally, emerging data on the co-occurrence of over and under- nutrition within households and individuals will be explored alongside interventions to tackle this two-pronged nutrition crisis.

Analysis

I. The Impact of Urbanization on Over- and Under-Nutrition

The nutrition transition model developed by Popkin shows that there is a rapid shift in developing countries from the period termed the "receding famine pattern" to one dominated by nutrition-related non-communicable diseases (NR-NCDs) (Popkin, 2003). The annual increase in the prevalence of overweight and obesity in Asia, North Africa, and Latin America is two to five times greater than in the US and European countries (Popkin, 1999). Specifically, urban residents in lower-income countries are increasingly consuming a more obesogenic diet, consisting of increasing amounts of superior grains (e.g. rice or wheat, rather than corn or millet), animal products, sugar, processed foods, and food prepared outside the home (Popkin, 1999). Urban diet patterns are shifting due to various contextual factors directly and indirectly related with urbanization. For example a sedentary-lifestyle, increasing household income, consumption preferences, lower food prices, access to energy-dense foods, and urban planning all play a role in changing urban diets (Popkin, 1999). Therefore, the diet of urban residents exhibits this nutrition transition where higher consumption of energy-dense and high-fat foods are increasing the risk of obesity (BMI > 30#) or becoming overweight (BMI > 25-29). Being overweight and obese subsequently increases the risk of developing NR-NCDs such as cardiovascular disease, chronic diet-related diseases, coronary heart disease (CHD), various cancers, and non-insulin-dependent diabetes mellitus (NIDDM) (Popkin, 1999). The above stated health implications of over-nutrition have been studied extensively in high-income countries, but are only starting to be studied in middle- to low-income countries as NR-NCD cases increase (Rao et al., 2011).

Meanwhile, under-nutrition (BMI <18.5) is still a major public health concern in many developing countries, despite the success of countries like Brazil and China in steadily reducing the prevalence of stunting and under-weight, which are the two main indicators of under-nutrition (Dearth-Wesley et al., 2008). It is well established that reducing under-nutrition will benefit individuals, societies, and countries in proximal and distal ways (Gillespie & Haddad, 2003). With the increasing rate of rural-urban migration in developing countries, the under-nourished population will increase the burden of the health care system in the urban cities (Gillespie & Haddad, 2003).

Ii. Co-occurrence of the Double Burden in High- and Low-Income Urban Households

The double burden of nutrition is not only afflicting developing countries on a national level, but also within urban communities and households (Doak et al., 2000; Gillespie & Haddad, 2003). This co-occurrence, where there is an underweight child and an overweight adult has been documented in Brazil and China with national prevalence of 11% and 8% respectively (Doak et al., 2000). Behaviors associated with urban residence. such as increases in inactivity and an energy-dense diet can lead to over-nutrition in adults. Meanwhile, children are experiencing under-nutrition due to a difference in quality, quantity, and distribution of food within a family. These create a high prevalence of under/over nutrition households in Brazil and China's urban areas (Doak et al., 2000).

Interestingly, households of all income levels feel the disease burden in low-income countries (Doak et al., 2000). The fact that low-income urban subpopulations are also afflicted is supported by research on households in Brazil, China, and Russia, which showed that income level did not consistently predict the prevalence of over/under households (Doak et al., 2000). Therefore, using the measure of "income level" is not a reliable predictor of whether a household will have both over- and under-nutrition; both low- or high-income families are equally at risk.

Household co-occurrence might also be exacerbated among the urban poor (Raphael et al., 2005) due

to other factors such as with urban poverty and existing under-nutrition. This is consistent with findings that the prevalence of over-nutrition in lower-income households is becoming greater than in higher-income households (Popkin, 2008 & 2003). Meanwhile, under-nutrition in these low-income populations is still a problem (Popkin, 1994). Therefore, the increasing rate of urbanization in developing countries could exacerbate the co-occurrence of over- and under- nutrition when the rural populations migrate toward the poor, lower quartile of urban settings (Raphael et al., 2005). Raphael et al's study of shantytowns in Haiti show that over/under households account for 14% of the households studied, which is approximately four times the national rate of 3% of over/under households. The coexistence of over- and under-weight suggests that common risk factors – such the urban environment and diet – contribute to the simultaneous expression of over/under conditions (Doak et al., 2000). Therefore, the data from Brazil and Haiti suggest that living conditions of poor urban subpopulations increase the rate of the under/over households because in urban settings, adult overweight results from changes in food habits and lifestyle (Popkin, 2003). However, the extreme poverty of the shantytown is conducive to child under-nutrition (Raphael 2005).

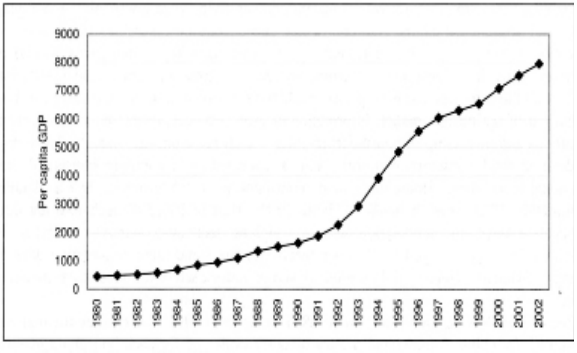
Iii. Co-occurrence of the Double Burden within an Individual: Implications of the Barker Hypothesis

The double burden of nutrition within an individual can occur when a child is stunted while being obese or overweight. Stunted children have a higher risk ratio of being overweight (Popkin et al., 1996) and the coexistence is rising in developing countries such as Equatorial Guinea (Custodio et al., 2010). The double burden of over- and under-nutrition coexistence also applies to morbidity by increasing the risk of stunting-related diseases and aforementioned obesity-related co-morbidities (Li et al., 2011; Popkin et al., 1996). The Barker hypothesis has important implications for over/under households and stunted, overweight children because under-nourished children may pose higher risk developing into over-weight adults, resulting in a double burden afflicting a single individual. Barker et al indicates how nutritional deficiencies during pregnancy and infancy have long-term effects resulting in a wide range of metabolic and physiological consequences (1993). The influential Barker's hypothesis states that under-nourished children are more likely as adults to suffer from DR-NCD, and thus under-nutrition is "a terrible time-bomb that paves the way for over-nutrition later in life" (Gillespie & Haddad, 2003). The effect described by Barker is relevant in developing countries due to the rapid acceleration of the nutrition transition among populations who faced severe under-nutrition only decades earlier (Gillespie & Haddad, 2003). As a majority of the existing research focuses either on the problems of under- or over-nutrition alone, the Barker hypothesis should be studied further to address the effect of over- and under nutrition together among the poor urban populations. If the programming hypothesis of Barker proves to be correct, a useful preventative measure against future chronic disease is to improve maternal and infant nutrition to reduce the vulnerability of under-nourished children to over-nutrition diseases later in life (Popkin et al., 1996).

Iiii. Case Study: China in the 21st (the 'st' should be smaller) century

In the past few decades, China's rapid economic changes [Figure 1] have led to increasing urbanization [Table 1]. This has transformed nutritional patterns, and subsequently the mortality and disease risk factors associated with diet. China boasts an annual growth rate of 8% in gross domestic product (GDP), the highest in recent world history (World Bank, 2001). This economic progress is connected to an adoption of an obesogenic Western diet while the healthier, plant-based traditional Chinese diet has been gradually re-

linquished (Zhai & Wang, 2006; Popkin, 1999; Du et al., 2002). China's nutrition transition has shifted from an initial famine stage after the 1949 Independence, towards the current diet high in fat and calories from processed foods, but low in fiber and micronutrients from grains, vegetables and fruits. This results in high prevalence of DR-NCDs and obesity (Du et al., 2000; Popkin, 2003; Zhai & Wang, 2006



Source: State Statistical Bureau, 1980 to 2002.

Figure 1. Trends per capita GDP (yuan), 1980-2002 (Zhai & Wang, 2006)

Table 1. Trends in Population by residence and gender, 1980 to 2000 (Zhai & Wang, 2006)

Trends in population by residence and gender, 1980 to 2000

Year	Total population, millions (at year-end)	By sex		By residence	
		Male (%)	Female (%)	Urban (%)	Rural (%)
1980	987	51.45	48.55	19.39	80.61
1985	1 058	51.70	48.30	23.71	76.29
1990	1 143	51.52	48.48	26.41	73.59
1995	1 211	51.03	48.97	29.04	70.96
2000	1 267	51.63	48.37	36.22	63.78

Data include military personnel of the Chinese People's Liberation Army, but not the populations of Hong Kong, Macao and Taiwan.
Source: State Statistical Bureau, 1980 to 2002.

Data on the dietary intake and consumption profiles of Chinese children and adults are based on a series of two major national surveys – the China Nutrition and Health Survey (CNHS) and the Chinese National Nutrition Survey (CNNS) . The CHNS is a multi-stage, random cluster sample drawing on the sample surveyed in nine different provinces that vary in geography, economic development, public resources, and health indicators (Zhai & Wang, 2006). One disadvantage is that the CNHS is not a nationally representative survey; it only surveys 9 out of 34 provinces, municipalities, autonomous regions, and special districts in China (Zhai & Wang, 2006; Dearth-Wesley et al., 2008). The CNNS uses a stratified multistage cluster random sampling method to survey the residents of sample units selected from 30 provinces (Zhai & Wang, 2006). These surveys found that obesogenic dietary trends are particularly pronounced in urban areas and have led to an increased prevalence of obesity and overweight (Zhai & Wang, 2006) [Figure 2] and the prevalence stands at 22.7% for the overall population in 2002 (NNS, 2005). Meanwhile, undernutrition still exists despite notable reductions in the prevalence of stunting and underweight in urban and rural areas (Zhai & Wang, 2006) [Figure 2]. Although the prevalence of stunting and underweight in two to five-year-old Chinese children dropped significantly between 1989 and 2000 (Zhai & Wang, 2006), under-nutrition remains as an important public health concern (Dearth-Wesley et al., 2008) and accounts for significant economic costs (Popkin et al., 2003). Additionally, the increasing numbers of overweight is far more pronounced than the decline in underweight (Dearth-Wesley et al., 2008). Therefore, China suffers from the double burden of nutrition; under-nutrition problems continue to afflict children while the burden is also shifting towards DR-NCDs and a rapid increase in the prevalence of obesity and overweight.

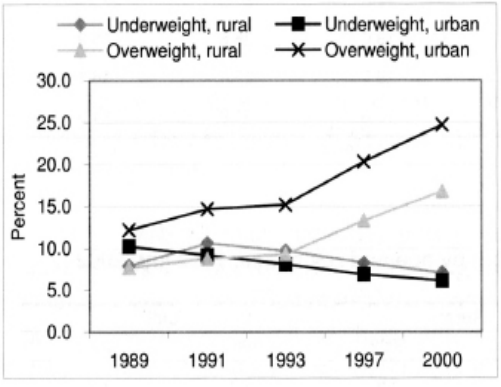


Figure 2. Trends in under- and over- nutrition in adults (18-45 years) by residence, 1989 to 2000 (Zhai 2006)

The double burden of nutrition is also predicted to shift towards the low-income urban subpopulations in China. Similar to the aforementioned examples from Brazil and Haiti, annual increase in the prevalence of overweight and obesity among low-income Chinese adults between 1991-2006 indicate a shift in the burden from the rich to the poor [Figure 3] (Du et al., 2004; Dearth-Wesley et al., 2008). Furthermore, 8.1% of households in China have both an underweight and an overweight member, and the co-occurrence of under/over did not significantly differ between high- (37.8%) and low-income (31.1%) groups [Table 2] (Doak et al., 2002). This indicates that the double burden is impacting China on national and household levels and affects the poor and the rich alike (Doak et al., 2000). This has health implications for the afflicted individuals, where such a shift will exacerbate existing inequities between China's rich and poor, placing increasing demands on the country's faltering health care system (Dearth-Wesley et al., 2008). Therefore, health policies must effectively address the health care needs of the marginalized populations in the Chinese society, and not only to the needs of China's ever-expanding and vocal middle class (Cook & Dummer, 2004).

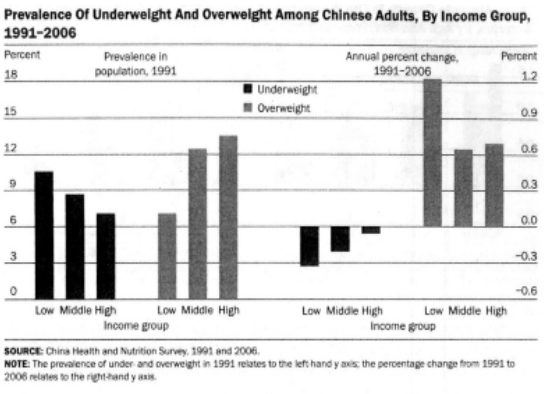


Figure 3. Prevalence of Underweight and Overweight Among Chinese Adults, by Income Group, 1991-2006 (Popkin, 2008)

Table 2. Socio-demographic characteristics and household diet of the four household types (Doak et al, 2002)

	Total under/over	Underweight household	Overweight household	weight household
Sample size (*n*)	278	923	883	1256
Urban residence (%)	39.6	24.5	40.5	26.0
Region: north (%)	36.3	21.5	50.9	37.3
Region: south (%)	63.7	78.6	49.2	62.7
Real per capita income (Yuan)	779	683	824	729
Low income (%)	31.3	36.5	30.3	33.6
High income (%)	37.8	27.2	40.3	31.9
TV ownership (%)	88.5	75.0	89.2	77.5
Motor vehicle ownership (%)	10.1	4.6	5.9	4.2
Washing machine ownership (%)	53.6	30.3	49.8	33.9
Household head has low-energy occupation (%)	21.4	11.8	24.9	15.1
Household head has high-energy occupation (%)	68.4	80.1	66.2	77.5
Mean carbohydrate (%)	61.7	64.4	61.3	63.3
Mean protein (%)	12.6	12.0	12.7	12.1
Mean fat (%)	25.3	23.0	25.6	24.0

Discussion

I. Contextual factors

In addition to diet-related factors that contribute to urbanization's impact on the double burden of nutrition, there are many other important contextual factors beyond the scope of this paper. These include

political factors such as inadequate health care access for the urban poor (Cook & Dummer, 2004) and food price policies (Guo et al., 1999), as well as economic factors such as the global food trade (Guldan, 2010) and food prices (Gillespie & Haddad, 2003). Social factors include demographic transitions towards a bigger aging population (Popkin, 1994), environmental changes such as urban planning (Rao et al., 2011), the food supply chain (Traill, 2006), and access to processed foods (Guldan, 2010). Holistic interventions that focus on addressing such contextual factors must be implemented in conjunction with diet-related strategies.

Ii. Solutions and Interventions

Governments and public health specialists need to address the double burden of nutrition in developing countries with concrete solutions that focuses on over- and under-nutrition simultaneously. I will briefly describe two diet-related interventions – food policy and traditional diet – as well as urban planning, an environment-related intervention.

Food price policy that increases the prices of pork, eggs, and edible oils are predicted to lower fat intake (Guo et al., 1999). This has practical implications that affect the issues of dietary excess and obesity during the periods of nutrition transition in China (Guo et al., 1999). However, Guo et al emphasized the need to consider the effect of prices in reducing fat intake of the rich but not adversely affecting the protein intake for the poor (1999). Therefore, food price policy interventions alone may not adequately address the complex and common underlying causes of the double burden, especially when co-occurrence exists in the same household or individual. Effective promotion of a unified, healthy diet that will lead to optimal health outcomes at both ends of the nutritional spectrum is needed. Instead of tackling under- and over-nutrition separately, countries should fight both conditions simultaneously with strong public health messages (Doak et al., 2000) promoting and reviving healthy traditional diets. Lee et al describe how lower fat intake and lower prevalence of overweight and obesity are unique aspects of the nutrition transition in South Korea (2002). This is attributed to the promotion of their healthy traditional diet. Lee et al examined the food consumption profiles of South Koreans and found higher fruits and vegetables intake accompanied with declined vegetable oils and fat intake (2002). This dramatically different dietary pattern indicates the success of the government, scholars, citizens, and nutritional specialists that have initiated numerous efforts to advertise that Western eating habits can be dangerous, while attempting to revive a traditional diet (Lee et al., 2002). The government implemented this revival through diverse publicity and education channels (Lee et al., 2002). Therefore, similar policies promoting health traditional diets should be applied to other developing countries in similar socio-cultural contexts, such as China (Du et al., 2002).

In addition to diet-related interventions, environmental interventions such as innovative urban planning strategies can be used to address the double burden of nutrition. Health researchers emphasize the need to reconnect the fields of urban planning and public health by considering urbanization as a determinant of health (Rao et al., 2011; Popkin, 2003). In fact, Rao et al outline many ways that urban planning can address the current negative health impacts by increasing physical activity, improving air quality, increasing the availability of green spaces, etc (2011). Urban planning interventions should, however, consider the impact on macroscopic levels, because the lower-income groups usually do not benefit as much from top-down urban planning.

Conclusion

The effects of urbanization intensify the double burden of nutrition currently afflicting developing countries around the globe through diet-related and

non-diet related ways. Non-diet related effects of urbanization include urban planning and limited access to healthy food products, which should be discussed further in future studies. This paper emphasized on how urbanization contributes to the nutrition transition experienced by developing countries leading to increased prevalence of overweight, obesity, and DR-NCDs, while under-nutrition is still a major health concern. With the rural-urban migration, it is foreseeable that governments in urban areas will have to be more accountable in addressing the under/over nutrition health burden. This double burden has been shown to affect countries on the national, household, and individual level, with increasing evidence that the effects may be exacerbated among the urban poor. Barker's hypothesis contributes biological support for the increased risk for under-nourished infants in acquiring DR-NCDs later in life. The implications of the double burden of nutrition are vast and become more relevant as more developing countries rapidly undergo both economic and nutrition transitions where as rural-urban migration continues to rise. It will be especially important to address the particular vulnerabilities of the urban poor, as they are the ones most likely to be neglected by policy makers. Health inequality is an important area for future research and intervention because existing health care systems in many cases do not reach the people who need it most, in both developed and developing countries. This is especially the case with regards to the double burden of nutrition, where low-income subpopulations within low-income countries are dealing with a new set of health concerns while the consequences of past ones are still a reality.

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