

Original Article

Where is Nepal in the nutrition transition?

Yagya Prasad Subedi MA, MBA¹, Debbi Marais PhD², David Newlands MA (Hons)³¹College of Life Sciences and Medicine, University of Aberdeen, Aberdeen, United Kingdom²Warwick Medical School, University of Warwick, Warwick, United Kingdom³Queen Margaret University, Edinburgh, United Kingdom

Background and Objective: Nutrition transition is rapid in developing countries, but Nepalese transition is relatively unknown. This study aimed to describe nutrition transition in Nepal over the past 40 years by identifying the shifts in the Nepalese diets and nutritional status and the underlying shifts associated with this. **Methods and Study Design:** Popkin's framework was used to identify shifts in Nepalese diet and the inter-relationship of diet with epidemiological, demographic and economic shifts. The current study used quantitative methodology including secondary data analysis based on food balance sheets, economic surveys and the government databases. **Results:** The Nepalese diet is shifting away from agricultural staple based foods to modern processed foods with higher total energy, total fat, and sugar. The prevalence of overweight/obesity and diet related non-communicable diseases are increasing. Urbanisation is rapid and nutrition transition already advanced in urban area. The Nepalese economic structure has also changed shifting away from agricultural food supply system towards modern processing based food supply system. These changes in the Nepalese diet are triggered by income and urbanisation. The trade liberalisation has made processed foods, edible oil and sugar easily available at supermarkets and fast food outlets. **Conclusion:** It is clear that Nepal has now entered into the fourth stage of nutrition transition according to Popkin's framework. As a result, overweight, obesity and the prevalence of many non-communicable diseases are all rapidly growing. A further study is recommended to identify whether urban versus rural, rich versus poor and educated versus uneducated families are experiencing the transition in similar way.

Key Words: nutrition transition, economic, demographic, epidemiology, Nepal

INTRODUCTION

Barry Popkin first defined the theory of the Nutrition Transition in 1993 by linking two historic transitions, namely demographic and epidemiological transitions, to dietary and physical activity pattern shifts, indicating that they might lead to or occur simultaneously. Nutrition transition theory suggests five broad patterns of nutritional shift - collecting food, famine, receding famine, degenerative diseases and behavioural change, which are directly connected to the historical ages of modernisation and development.¹ In the hunting-gathering society, which is known as the collecting food pattern, wild-animal meat is popular. Therefore there are few nutritional deficiencies and the density of animal protein and fat in the diet insufficient.² In the primitive society, also known as the famine pattern, people start to be involved in farming, resulting in the diet becoming focused on cereals. In the agricultural society, also known as the receding famine pattern, socio-economic stratification, i.e. rich and poor, begins to appear. The agricultural revolution occurred, changing food patterns to predominantly starchy staples, animal protein, fruit, and vegetables.³ In the urbanised industrial society, also known as the degenerative diseases pattern, diets increase in fat, sugar and processed food resulting in overweight and obesity.¹ The theory has predicted that the future ideal society will adopt an active lifestyle with more physical activity, more dietary fruit, and vegetables and less fat and processed food, which will eventually

reduce obesity and improve health.¹

The historical trends and patterns of the nutrition transition in the different regions of the world are not uniform. Different factors trigger the processes of change in different periods of history in different parts of the world. The increase in western fast food franchises, changes in the types of foods sold by local provender and an increase in the number of supermarkets are triggers. After World War II, large shifts occurred in economic structures in Western Europe and the United States of America (USA) following successful industrialisation, trade liberalisation and globalisation of the economy, followed by a rapid expansion in urbanisation and significant changes in employment patterns.⁴ Initially, the female labour force was employed in peripheral local markets and, gradually, the male population in particular, migrated to larger cities.¹ Away-from-home eating patterns, changing technological innovations, and the development of fast foods also contributed to the transition.⁵ Sugar intake increased rapidly,

Corresponding Author: Yagya Prasad Subedi, 11 Beattie Avenue, Aberdeen, AB25 3AQ, UK.

Tel: +44(0)1224480265; +44(0)7462897408;

Fax: +44(0)1224480265

Email: yagya.subedi@abdn.ac.uk; yagyasubedi9@gmail.com

Manuscript received 10 June 2015. Initial review completed 31 May 2015. Revision accepted 9 November 2015.

doi: 10.6133/apjcn.112015.10

grain consumption decreased, and meat and dairy product consumption rose.⁶ Fertility and mortality declined, life expectancy increased, and a rising number of disabilities and chronic diseases appeared.⁷

With the beginning of the 1960s, the agro-industrial revolution in the developing world started in the food and agricultural sectors, especially in the Asian region. The combination of high-yield varieties, expansion of irrigation, increased and improved input supplies and the widespread mechanization of production made more food available to consumers in developing countries.⁸ Since the early 1960s, the average calorie availability in the developing world has increased from about 1950 to 2680 kcals/person/day, while protein availability nearly doubled from about 40 to 70 g/person/day. The prevalence of undernourishment declined from 37 percent in 1970 to 17 percent in 2000, while 850 million people remain food insecure.⁹

The Green Revolution (GR) and the expansion of agriculture, its move away from small subsistence farming to large corporate farms and the concomitant move to a global food surplus. The rapid increase in agricultural output resulting from the GR came from an impressive increase in yields per hectare. Between 1960 and 2000, yields for all developing countries rose - 208% for wheat, 109% for rice, 157% for maize, 78% for potatoes, and 36% for cassava.¹⁰ However, nutritional gains of the GR have been uneven; although overall calorie consumption increased, dietary diversity decreased for many poor people, and micronutrient malnutrition persisted. In some cases, traditional crops that were important sources of critical micronutrients (such as iron, vitamin A, and zinc) were displaced in favour of the higher-value staple crops. The intensive rice monoculture systems led to the loss of wild leafy vegetables and fish. Price effects of such supply shifts also limited access to micronutrients, because prices of these foods rose.

Japan and South Korea have achieved remarkably rapid economic growth over the last four decades.¹¹ They greatly encouraged investment from multinational companies as part of the globalisation process in the 1970s.¹² Their economic structure and employment patterns have changed along with an increase in real per capita income. Western fast foods are very popular in eating-out situations as a result of changed employment patterns. Owing to this, the energy intake of food from animal sources in Japan and Korea reached a peak in the 1980s.¹³ China also achieved rapid economic growth during this time.¹⁴ It started to follow the Western pattern of economic transition only after introducing economic reform. China also invited multinational companies to invest through the trade liberalisation process¹⁵ and its economic structure, employment pattern, and per capita income have been greatly altered. The real per capita income in China has more than doubled in urban areas and tripled in rural areas.¹⁶ China began to educate its young generations at Western universities in order to import knowledge and technology from the West.¹⁷ These young generations replicated the Western diet, which was compatible with eating-out situations.¹ Rising real per capita income was associated with a noticeable increase in the proportion of energy obtained from animal fat.¹⁸

The Chinese Nutrition Transition can be divided into three distinct patterns since its independence. Before 1985, the country was transformed from one facing famine and extreme food shortages to one fulfilling its basic food needs. Between 1985 and 1990, the country was undergoing a shift toward a reduction in malnutrition. During this period, food diversity increased considerably, total energy began to increase with fats, and animal food intake increased considerably; the proportion of poultry, eggs, and milk increased drastically.¹⁹

India was progressing towards adequacy in calorie intake during the 1970s and up to the early 1980s. They showed a gradual improvement in caloric intake by an increase in consumption of cereal grains, while the intake of most other food items such as milk, oil, sugar, etc. remained largely unchanged. India is facing an "epidemic" of diet-related non-communicable diseases (NCDs), along with widely prevalent under nutrition resulting in substantial socioeconomic burden. Nutrition transition over the past 30 years (1973-2004), has resulted in a 7% decrease in energy derived from carbohydrates and a 6% increase in energy derived from fats.²⁰ A decreasing intake of coarse cereals, pulses, fruits and vegetables, an increasing intake of meat products and salt, coupled with declining levels of physical activity due to rapid urbanization have resulted in escalating levels of obesity, dyslipidaemia, subclinical inflammation, metabolic syndrome, type 2 diabetes mellitus, and coronary heart disease in Indians.

It is speculated that the process of the nutrition transition in Nepal began in the 1980s following urbanisation and the decision to open the economy to globalisation and agricultural trade liberalisation.²¹⁻²² This process was accelerated by Governmental intervention after the initiation of a basic needs fulfilment programme, followed by the poverty alleviation programme and adoption of a free market economy policy, increasing the availability and access of sugar and edible oil.²³ There is a lack of evidence on the wider and longitudinal aspects of the Nepalese transition.²⁴⁻²⁷ Therefore, this study aimed to describe the shifts that have taken place over the past 40 years and identify where Nepal currently is in each stage of economic, dietary, demographic, and epidemiological transition. The research findings would be useful for the formulation of nutrition policy at the national level and will also be relevant to design interventions at the individual level.

METHODOLOGY

This study has adopted Popkin's methodology to identify where a country is in the nutrition transition. Popkin considers proxy variables of development to identify which stage of nutrition transition the country has reached. Diet, nutritional status, economy, life expectancy, income, mortality/fertility, morbidity, age structure, residency and food supply/processing technology are 10 proxy foci previously used. Each of these proxy foci has various explanatory variables (Table 1). The 10 foci were grouped into four categories - economic, demographic, dietary and epidemiological shifts, for the purposes of analysis. Economic variables include two proxies - national income and economic structure. Demographic variables include four proxies - life expectancy at birth, mortality & fertility, age structure and residential patterns. Dietary variables

Table 1. Data sources for proxy foci and explanatory variables for shifts in the Nutrition Transition in Nepal

Proxy foci	Explanatory variables	Data sources
Economic shifts		
Income	<ul style="list-style-type: none"> • GDP • GDP per capita 	Economic surveys, Ministry of Finance
Economy	<ul style="list-style-type: none"> • Contribution on GDP: • % Agriculture, • % Industry • % Services 	Economic surveys, Ministry of Finance; and Economic indicators, Central Bank of Nepal
Demographic shifts		
Life expectancy	<ul style="list-style-type: none"> • Average life expectancy • % Population under 15 years 	Statistical annual reports, Central Bureau of Statistics
Mortality & fertility	<ul style="list-style-type: none"> • Crude death rate • Crude birth rate • IMR • Population growth 	Census surveys, Central Bureau of Statistics and the Ministry of Population, Nepal
Age structure	<ul style="list-style-type: none"> • Young and working age population ratio • Elderly and working age population ratio 	Annual reports, Ministry of Population; and Statistical Reports, Central Bureau of Statistics, Nepal
Residency	<ul style="list-style-type: none"> • % Population rural & urban • International migration 	Census surveys, Central Bureau of Statistics
Dietary shifts		
Food supply	<ul style="list-style-type: none"> • Food production index • Food supply index 	Economic surveys, Ministry of Finance
Diet	<ul style="list-style-type: none"> • Total energy (kcal) • % Macronutrient energy • % Energy from plant versus animal sources 	Food balance sheets, FAO; and Ministry of Agriculture, Nepal
Epidemiological shifts		
Nutritional status	<ul style="list-style-type: none"> • % Children underweight • % Women overweight • % Women obesity 	Demographic and health surveys; Department of Health Services
Morbidity	Prevalence of <ul style="list-style-type: none"> • Communicable diseases • Non-communicable diseases 	Annual health statistics reports (morbidity/hospital outpatients), Department of Health Services

include two proxies - food supply and dietary change. Epidemiological variables include two proxies – nutritional status and morbidity.

The accuracy/reliability of food balance sheets dietary data depend on the availability of underlying basic population statistics, supply and utilization of foods in national statistics.²⁸ In fact, there are many gaps particularly in the statistics of utilization for non-food purposes, such as feed, seed and manufacture, as well as in those of farm, commercial and even government stocks.⁹ In most cases, the assumptions for waste used in food balance sheets are based on expert opinion obtained in Nepal.²⁹

To identify the scale of economic shifts, the percentage share of agriculture, industry, and services sectors on gross domestic product (GDP) were used as explanatory variables. For income, GDP and GDP per capita of a country were considered as explanatory variables.

Life expectancy, prevalence of population under 15 years of age and longevity were taken into account to identify the scale of demographic shifts. The crude birth rate, crude death rate, natural increase, total fertility rate, and infant mortality rate were considered as explanatory variables for demographic indicators. Age structure, prevalence of population ages 0-14, 15-64 and over 65, and young and old dependency ratios were considered as additional demographic explanatory variables. Young dependency ratio is defined as the proportion of less than 15 years population compared with 15-64 years population. Elderly/old dependency ratio is defined as the pro-

portion of 65 and more years population compared with 15-64 years population. Rural, urban, and total population and net migration were used as explanatory variables for residency.

Consumption of fats, meats, poultry, dairy products, and sugar were considered as explanatory variables to identify the scale of dietary shifts. To identify the scale of epidemiological shifts, outcome variables for nutritional status were the prevalence of underweight, overweight, and obesity. Prevalence of communicable diseases and NCDs were used as explanatory variables for morbidity. The data sources for these explanatory variables were identified from global and government databases in Nepal (Table 1).

Retrospective secondary data were collected over a 40-year period from 1970 to 2010. The epidemiological data were available only after 1995. Most of the data were collected at five-year intervals. The collected data relating to GDP from various sectors, urban population, GDP per capita income, change in under 15 years population, life expectancy, mortality/fertility, prevalence of communicable diseases and chronic diseases were converted into ratio scales by considering the reference years' census population or relevant Gross National Product total figures as the denominator and the results were expressed in whole numbers.

Food supply and dietary data from food balance sheets were converted into carbohydrate, fat, and protein (grams). The percentage contribution to overall energy

Table 2. Changes in the economic structure in Nepal (1970-2010)

Economic structure	1970	2010	Annual change
Agriculture, value added in constant US\$ 2000 (% share of GDP)	1031.5 mi (59.6%)	2894.2 mi (35.9%)	2.6%
Industry, value added in constant US\$ 2000 (% share of GDP)	176.1 mi (10.2%)	14648.2 mi (18.2%)	5.4%
Services, etc., value added in constant US\$ 2000 (% share of GDP)	523.5 mi (30.2%)	3707.4 mi (46.0%)	5.0%

mi: indicates millions.

Table 3. Changes in the macronutrient distribution of total dietary energy in the Nepalese diet (1970-2010)

Sources of dietary energy (% of total energy kcal/capita/day)	1970	1990	2010
Energy from carbohydrate	74.2	72.9	70.2
Energy from protein	10.5	10.2	10.5
Energy from fat	12.4	14.5	17.3

intake was calculated as well as the proportion from animal and plant sources.

The average annual rate of change was calculated for all variables to assess the country's overall shift over the past 40 years. This rate was used to measure magnitude and direction of change. Most of the data used for the analysis were comprehensive, reliable, consistent, and robust; except migration, food supply and tourism data which the national statistics office estimated. The limitations of using secondary data were evident with this study especially for the epidemiological data, which was deemed poorer in terms of representatives (hospitals statistics, not national level), duration (only from 1995) and case reporting reliability. As only secondary data analysis was conducted, ethical approval was not required. However, this analysis formed part of a doctoral thesis with ethical approval obtained from the College Research Ethics Board (University of Aberdeen in the United Kingdom) and Nepal Health Research Council

RESULTS

Economic shifts

The national income of Nepal increased over the past four decades. The GDP of Nepal has shown an annual increase at a rate of 3.9% between 1970 and 2010. The population has also grown rapidly at a rate of 2.3% per annum. The overall GDP per capita (at constant US\$ 2005) was 145 in 1970 and increased to 269 in 2010, at an annual growth rate of 1.6%.

The three main economic sectors contributing to the GDP in Nepal are Agriculture, Industry, and Services. The Nepalese economy has traditionally been agrarian in nature. In 1970, the Agriculture sector was the highest contributor (59.59%) to the economy, which dropped to 35.9% in 2010. In 1970, Industry contributed only 10.2%, which rose to 18.2% in 2010. The highest contributor to GDP in 2010 was the Service sector, which increased from 30.3% to 46.0% (Table 2). The Agriculture sector (value added in constant US dollar) has expanded by an annual growth rate of 2.6% whereas Industry and Services sectors (value added in constant US dollar) have expanded by an annual rate of 5.4% and 5.1% respectively.

The number of international tourists in Nepal has increased by an annual rate of 5.0% between 1990 and 2010, but tourism income increased by an annual growth rate of 3.2% only.

Demographic shifts

The residency pattern in Nepal has greatly changed. The proportion of urban population, considered as a proxy of urbanisation in Nepal, increased from 4.1% in 1970 to 21.1% in 2010. This includes natural increase and migration to cities. Mortality and fertility have decreased over the past four decades; but the population is still growing. The Crude Death Rate per 1000 population has decreased from 22.2 in 1970 to 6.2 in 2010. Similarly, infant mortality per 1000 population has decreased from 167.3 in 1970 to 47.1 in 2010. Crude Birth Rate per 1000 population decreased from 43.9 in 1970 to 25.6 in 2010. Total Fertility Rate per woman has also decreased from 6.4 to 3.1 from 1970 to 2010. The overall population is still growing by 2.3% per annum.

The young population is relatively decreasing in Nepal, but the working age and elderly populations have been gradually increasing over the past four decades. From 1990 to 2010, the prevalence of young people (0-14 years) has been decreasing annually by 0.3%. A slight increase of 0.2% is found for the group aged 15-64 years. There has been an annual decrease in the young dependency ratio of 0.5%. On the other hand, the elderly population aged 65 and over, has increased by an annual rate of 0.9%. In 1970 a large prevalence of the population (41.5%) was under 15 years of age, which decreased to 36.2% in 2010.

Life expectancy has increased by 1.2% every year. In 1970 the average life expectancy of Nepalese people was 42.8 years, which had increased to 67.6 years in 2010.

Dietary shifts

Nepalese dietary patterns have changed over the past 40 years. Per capita energy intake has increased from 1795 kcal/day in 1970 to 2450 kcal/day in 2010. The percentage of total dietary energy contributed by carbohydrate and protein has decreased by 0.2% and 0.1% every year, respectively, from 1970 to 2010. The percentage of energy from fat in total energy was 12.4% in 1970 and in-

Table 4. Major Contributors to increase in dietary energy in Nepal (1970-2010)

Gross per capita supply	Average food supply (g/capita/day)									
	1970	1975	1980	1985	1990	1995	2000	2005	2010	
Buffalo/cow's butter and ghee	19	20	22	24	26	31	33	36	37	
Soybean oil	3	3	4	15	19	25	29	33	44	
Rape and mustard oil	7	7	9	11	13	15	17	19	21	
Animal meat: buffalo, goat, poultry and pig meat.	13	14	15	17	26	28	32	33	39	
Sugar & all sweets	4	5	9	17	31	33	45	48	57	

g/capita/day indicates grams for solid food or millilitre for liquid foods per person per day.

**Figure 1.** Nutritional status of women.

creased significantly ($p < 0.05$) to 17.3% in 2010 at the rate of 0.8% every year (Table 3). The percentage of energy from fat has increased at a rate of 0.8% per year between 1970 and 1990, whereas it increased to 0.9% per year during 1990-2010. Dietary Energy Supply (DES) from animal fat in Nepal was 18 kcal per person per day in 1970 and reached to almost double (34 kcal) in 2010. DES from dairy / butter in Nepal was 12 kcal per person per day in 1970 and reached to almost double (22 kcal) in 2010. DES from raw animal meat in Nepal was 6 kcal per person per day in 1970 and reached to almost double (13 kcal) in 2010. This evidence indicates that the energy from fat has increased at faster rate in recent decades.

The relative supply of edible oils, especially mustard and soybean oils, and sugar has increased in the domestic market along with imports from abroad (Table 4). The per capita carbohydrate and protein supply in Nepal has fallen over the past four decades; fat consumption in Nepal has been constantly growing. The per capita energy from

vegetable oils was 49.1 kcal in 1970, but increased significantly to 236.3 kcal in 2010 with an annual increase of 4.01% ($p < 0.05$) (Table 4). Animal fat consumption increased from 60 to 200 kcal/capita /day from 1970 to 2010 (Table 4). The energy from sugar is also an important driver of dietary energy change in Nepal. The per capita energy received from sugar and sweeteners was 15 kcal in 1970, but increased to 132 kcal in 2010 with an annual growth rate of 5.6% (Table 4).

After 1980, it is clear that there was a statistically significant increase ($p < 0.05$) in the consumption of oils, fats and sugars and this continued to increase over the next 30 years, resulting in these foods contributing the most to energy consumption. The greatest increase was in the plant oils (soybean, rape, mustard and other) increasing seven fold from 10 g/capita/day in 1970 to 65 g/capita/day in 2010. Increased consumption of butter and ghee from 19 g/capita/day to 37 g/capita/day, which was twofold, also contributed to the overall fat increase. It is

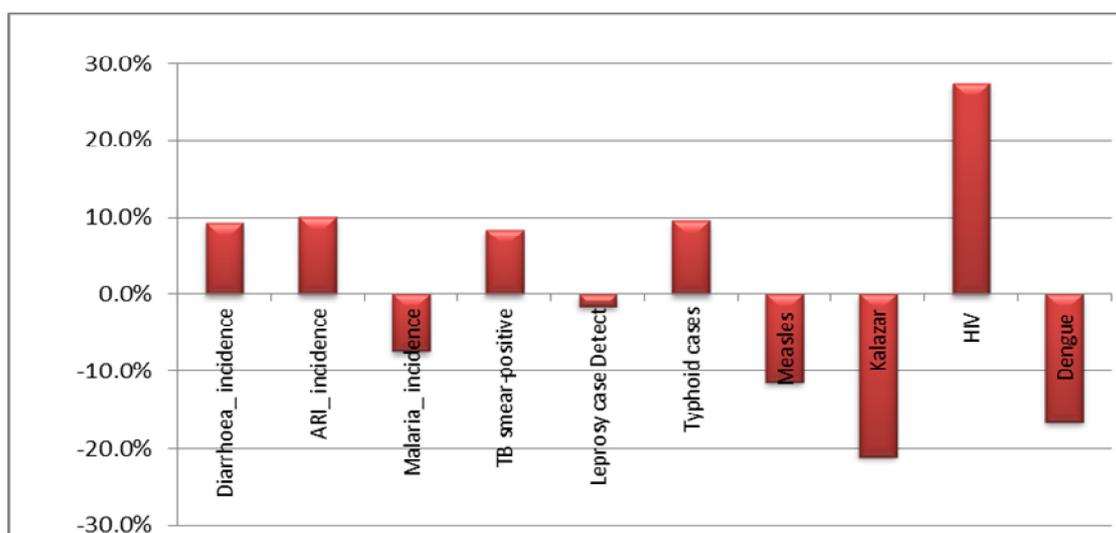


Figure 2. Rate of change of communicable diseases in Nepal (1995-2010)

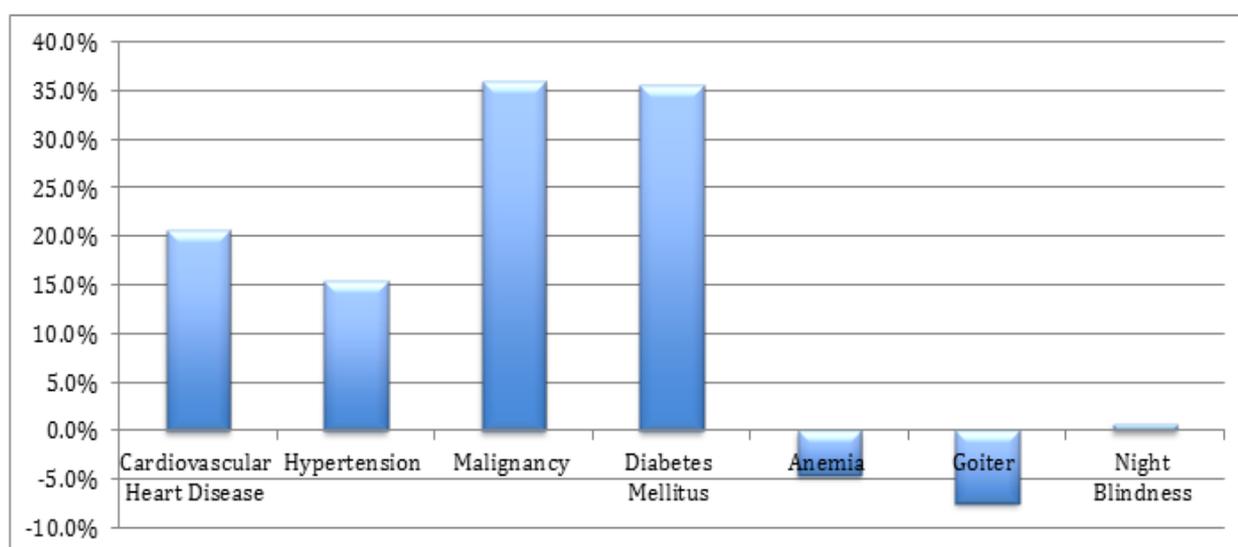


Figure 3. Rate of change of non-communicable diseases in Nepal

important to note that meat consumption, which was increased threefold from 13 g/capita/day in 1970 to 39 g/capita/day 2010, only started from 1985. Sugar and sweets consumption increased more than tenfold from 4 g/capita/day in 1970 to 57 g/capita/day in 2010.

Epidemiological shifts

The prevalence of underweight children has decreased over the past two decades, but it is still high in comparison to neighbouring countries. It was 44.1% in 1995 and decreased to 29.1% in 2010. The prevalence of stunting in children (z score <-2SD) has slightly decreased from 16.4% in 1995 to 15.3% in 2010. The prevalence of wasting in children (z score <-2SD) has decreased from 9.60% to 6.8% ($p < 0.05$).

The prevalence of overweight and obesity of women is increasing (Figure 1). The prevalence of overweight (BMI 25-29.9) women in Nepal was 2.1% in 1990 and increased to 13.4% in 2010. The prevalence of overweight (BMI 25-29.99) urban-women in Nepal was 18.3% in 1990 and increased to 26.4% in 2010. An im-

portant trend found is that the prevalence of overweight and obese (BMI ≥ 25.00) women in urban areas, specifically, has increased significantly from 20.8% in 1990 to 26.4% in 2010, whereas the prevalence of underweight (BMI <18.5) rural women has decreased from 31.9% in 1990 to 18.9% in 2010 ($p < 0.05$).

The majority of communicable diseases show a decrease over the period with an annual decreasing rate of change in leprosy (-1.6%), malaria (-7.4%), measles (-11.4%), dengue (-16.6%) and kalazar (-21.1%), whereas some still show an annual increasing rate of change like diarrhoea (9.3%), Acute Respiratory Infection (ARI) (10.1%), tuberculosis (8.5%), typhoid (9.6%) and Human Immunodeficiency Virus (HIV) (27.5%) (Figure 2). In contrast, diarrhoea and ARI were the prevailing communicable diseases in Nepal in 2010, with 40.3-50.2% of children under five years of age suffering from these diseases.

All NCDs are increasing in Nepal. The annual rates show the growth of cardiovascular diseases (20.6%), hy-

pertension (15.5%), malignancy (36.0%) and diabetes mellitus (35.6%), whereas nutrition-related diseases show an annual decreasing rate for anaemia (-4.6%), goitre (-7.4%) and a very small annual increasing rate for night blindness (0.6%) between 1995 to 2010 (Figure 3). Cardiovascular heart disease and hypertension were the most prevailing NCDs in Nepal in 2010, with 7-8 people/1000 population suffering from these diseases.

Findings

Nepal’s position in the nutrition transition has been identified by using Popkin’s spiral diagram, which is scaled from Pattern I to Pattern V (Figure 4). Popkin suggests a country with an economy moving away from agriculture towards industry sectors, participating in export and import of food, and increasing national income is considered at stage four of economic transition; therefore, we may conclude that Nepal is in the fourth stage of economic transition (Figure 4 and Table 5). A country with growing urbanisation and increasing life expectancy with morbidity with elderly population, as well as decreasing mortality and fertility with net increases population is considered at stage four of the demographic transition (Figure 4 and Table 5); therefore, we may conclude that Nepal is in the fourth stage of demographic transition.

A country with a changing dietary pattern towards fat and sugar and decreasing intake of carbohydrate with increasing fast food intake is considered at stage four of the dietary transition (Figure 4 and Table 5); therefore, we may conclude that Nepal is in the fourth stage of nutrition transition. A country with increasing NCDs and decreasing communicable diseases with high prevalence

of under nutrition as well as increasing overweight/obesity is considered as transiting from stage three to four in the epidemiological transition; therefore, we may conclude that Nepal is transiting from the stage three to four in the epidemiological transition (Figure 4 and Table 5).

Most of the explanatory variables described above indicate that Nepal is progressing towards the transitional stages from Pattern III to Pattern IV of the nutrition transition (Figure 4 and Table 5). There may be pockets of areas still in different phases. For example, primarily the remote rural poverty stricken areas may be in the stage three; and the mostly urban and peripheral areas may have transited to stage four of the nutrition transition.

DISCUSSION

It is clear that major shifts in the Nutrition Transition have occurred in Nepal since 1990; urbanisation has accelerated. The trend away from agriculture to service delivery resulted in urbanisation which then may have led to increased income, etc. This coincided with changes in the dietary pattern and an increased total energy intake. Sources of dietary energy shifted towards plant fats and sugar by replacing staple foods such as cereals, roots, and tubers. An increase in the share of energy from food other than staples such as fats and oils may generally be beneficial to under-nourished people.²A higher level of fat in the diet may be harmful to health.¹The increased intake of fat is reflected in increased overweight and obesity, especially in urban women. The prevalence of nutrition-related NCDs increased after 1995. The increased fat energy intake in the diet of rural women who had a lower

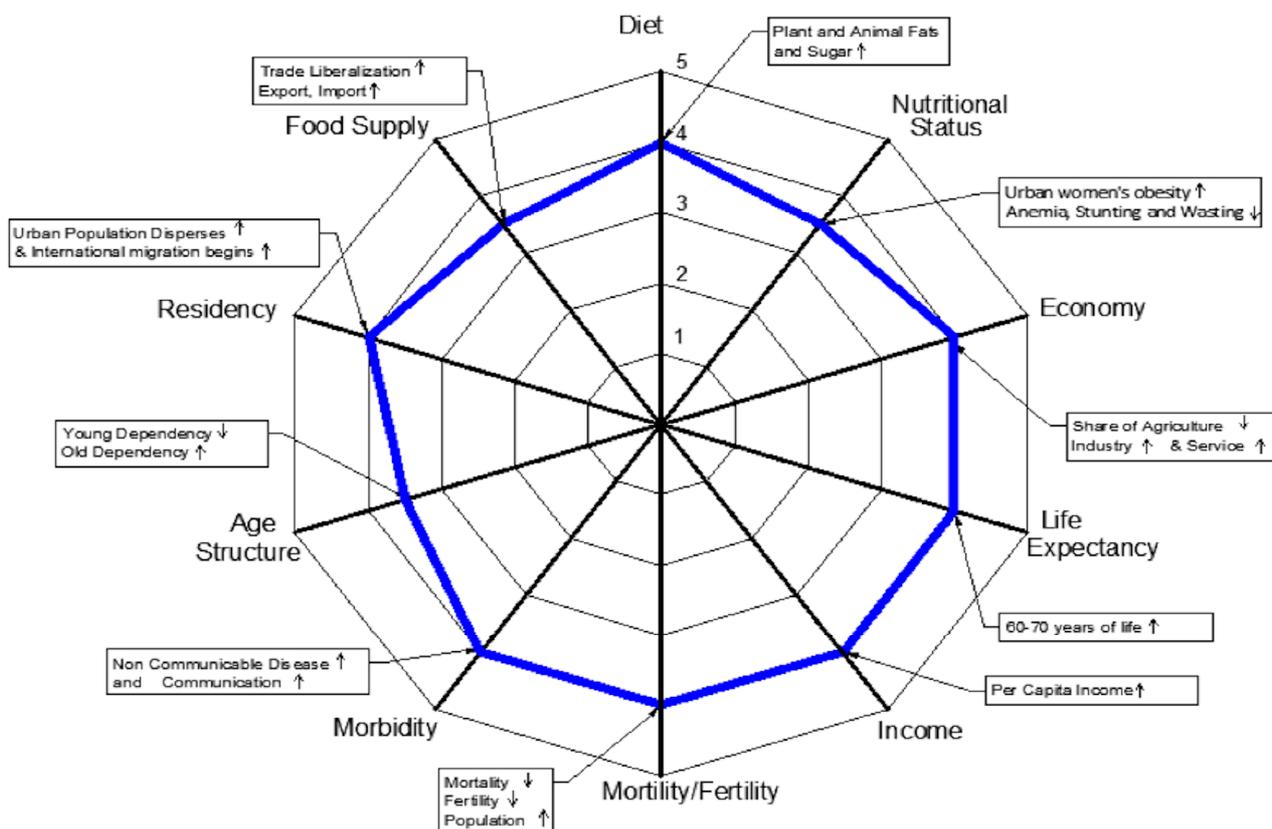


Figure 4. The current status of nutrition transition in Nepal

Table 5. Proxy variables of the nutrition transition according to patterns 1-5 indicating Nepal's status for each (highlighted block)

Patterns/variables	Pattern I: Collecting food	Pattern II: Famine	Pattern III: Receding Famine	Pattern IV: Degenerative diseases	Pattern V: Behavioral Change
Economic shifts					
Income	Survival from hunting	Subsistence in agriculture/livestock	Industrialisation and industrial employment	Emergence of services sectors and income rises	Income slows but disparity decreases
Economy	Hunter-gatherers	Agriculture and animal husbandry	Agricultural revolution (crops rotation; use of pesticides fertilizers and technology)	Expansion of Industrial sectors; and emergence of services sectors	Promotion of leisure time physical activities; and worker's efficiency and productivity rises
Demographic shifts					
Life expectancy	Low	Short life and life expectancy less than 55 years	Medium range of life - life expectancy less than 60 years	Life expectancy 60 – 70 years; under 15 population decreases	Life-expectancy more than 70 years; disability free long life
Mortality/fertility	High mortality and low fertility	High fertility and high infant and maternal mortality	Mortality declines faster, fertility slowly declines and population rises	Low mortality and fertility; and fertility below replacement	Low mortality and fertility – replacement level population
Age structure	Natural balance	High infant dependency ratio	High young people dependency ratio	Elderly dependency ratio rises	High elderly population dependency ratio
Residency	Low density of population	Dominance of rural settlements	Rural urban migration begins	Urban population disperses and international migration	Development of small and lower density cities
Dietary shifts					
Food supply	Rudimentary	Emergence of food storage technology for off seasons	Agriculture trade liberalisation; food imports/ exports across the countries	Food transformation technologies; franchising of multinational companies	Technology creates foods; responsible for human health implications
Diet	Plant, wild animals	Cereals	Starchy staples, animal protein, fruits and vegetables	Plant and animal fats, meat and fish, processed foods and sugar	Less fats and processing foods; more fruits and vegetables
Epidemiological shifts					
Nutritional status	Few nutritional deficiencies	Nutritional deficiencies	Existence of underweight and overweight	Increasing overweight and obesity	Reduced obesity and improved bone health
Morbidity	Infectious diseases	Endemic and deficiency diseases	Infectious and parasitic diseases – first expand then declines	Chronic diseases increases; and infectious diseases decrease	Increased health promotions Increase and CVDs decrease

energy intake than the recommended level, benefited from this dietary change, and the prevalence of the underweight population was decreased. In addition to this the prevalence of many communicable diseases has declined and longevity has increased.

The diet is shifting towards more energy dense foods, notably towards more meat, fat and sugar. Perhaps the increases in the western fast food franchises, local provender and supermarkets have had an influential role on dietary change. This shift has been particularly strong in urban centres, with meat and fat sectors underpinning growth. For instance, meat consumption in China went from 29 kcal per capita per day in the 1960s to about 450 kcal per capita per day today.

In 1970, India's DES from oils, fat and sugar per capita per day (337 kcal) was higher than China and Nepal; and in 2010, India's DES from oils, fat and sugar per capita per day (863 kcal) became higher again than China and Nepal.⁸ DES in India increased dramatically because of the increased consumption of plant oil and fat especially from dairy products in diet. Animal fat, meat and butter consumption in Nepal has increased gradually in Nepal from 1970 to 2010.

In 1970, India's DES from sugar and sweeteners per capita per day (188 kcal) was higher than China and Nepal; and in 2010, India's DES from sugar and sweeteners per capita per day (218 kcal) became higher again than China and Nepal. China and Nepal are far behind in DES from sugar and sweeter in comparison to India, but the energy from sugar and sweetener is gradually increasing in both countries. DES from vegetable oils fat supply was highest in India in 1970, but it is drastically increasing in all three countries and reached 157 kcal per person per day in 2010.

Typically for countries experiencing Nutrition Transition there is a significant increase in the consumption of meat – as income increases, meat as a food with significant nutritional value in cultural capital. In Nepal this may be a slight departure from what has occurred elsewhere because Nepal GDP per capita is still under the threshold level to create significant dietary effects, which is still in the least developed countries standard according to world development indicators. Hence we may argue that the dietary changes in Nepal may be induced more by urbanization effects compared with income effects.

Many of these changes are almost consistent with the shifts occurring in neighbouring countries. But the major drivers of dietary changes in India and China are slightly different. Plant fat, sugar, poultry and dairy products primarily drive changes in the Indian dietary pattern, but animal fats, particularly pig meat, drive Chinese dietary pattern change.²³ In general Nepal followed the Indian pattern driven by plant fats. Urbanisation and real per capita income seem to be two of the major driving forces for the Nutrition Transition in Nepal but tourism was also identified as a unique trigger in this region.

With the increase in the number of tourists over the past four decades, there has been an increase in the number of fast food suppliers in Nepal.²² Tourism, advertising and mass media may have influenced the changes in dietary pattern.¹ These drivers are impacting on the tradi-

tional Nepalese diet especially in terms of increased energy mainly from higher plant fat intake. It should be noted though that there could be different dietary patterns between the Mountain region and the Terai region of Nepal. The Mountain region, being in closer proximity to China, could possibly be more influenced by China while the Terai region, which is in closer proximity to India, may be more influenced by Indian dietary patterns. Further in-depth research is required to investigate this hypothesis.

The main shifts in the Nutrition Transition in Nepal coincide with major policy changes during the 1990s. These include Governmental interventions such as the basic needs fulfilment programme, the establishment of a poverty alleviation programme to increase the income of the poor, trade liberalisation, establishment of tourism promotion board and adoption of a free market economy policy.²⁰ The Nepalese Government encouraged the import of sugar and edible oil as key commodities of the basic needs fulfilment programme. Sugar and edible oil were included in the ration cards distributed by the government through the co-operative and national trading corporation.²² The government and private sectors also increased the domestic supply of these items which was previously small in Nepal.

Cereals are the most important food source for human consumption in Nepal. Developing countries surpassed developed ones in total cereal consumption in the early 1980s and now account for 61 per cent of world consumption. Consumption of sugar has been growing rapidly in developing countries, which now accounts for almost three-quarters of global consumption, up from just over half in the 1980s.²⁹

The oil crops group is made up of soybeans, groundnuts, sunflower seed, rape and mustard seed, coconuts, sesame seed, and palm seeds. This has been one of the most vibrant sectors of Nepalese agriculture in recent decades. One of the key reasons for this has been an increase in use of these products for both food and non-food purposes.^{1,9} The production, consumption and trade of oil crops in Nepal has been dominated by a small number of crops, including soybeans and rapeseed.

In conclusion, the relative availability of staple foods has decreased in Nepal. They have been essentially replaced by energy from plant fat. People have started to consume more calories than they expend. An increase in the proportion of fat in the adult diet and under nutrition in childhood has coincided with increased overweight/obesity and other NCDs in later life. Perhaps the years lost due to premature mortality in Nepal have been decreasing for communicable disease and increasing for NCDs. These trends follow the global pattern of dietary changes following increased urbanization, globalisation of supermarkets and growth of local providers. To divert these upcoming degenerative disease trends in Nepal, early preventive interventions with shared responsibilities from the government as well as international health organizations may be required. A further study is recommended to identify whether urban versus rural, rich versus poor and educated versus uneducated families are experiencing the transition in similar way.³⁰

POST SCRIPT

On 25 April 2015, an earthquake of 7.6 on the Richter scale, the worst since 1934, violently shocked 35 out of 75 districts of Nepal, killing more than 10,000 people, injuring very many more, and displacing about three million people from their destroyed or damaged houses.³¹ The initial impact of this natural disaster would be inaccessibility to food leading to hunger and food insecurity. However, there has been overwhelming support from the international community. The long-term effect on the nutrition transition may be a setback of the pace of urbanization, decrease in income level, fewer fast food outlets, etc. It is unclear whether this will change the current nutrition transition trends/patterns and how long the recovery period would be.

ACKNOWLEDGEMENT

The authors thank Food and Agricultural Organisation (FAO), Nepal Health Research Council, and respective Ministries/Departments of the Government of Nepal for providing access to their databases.

AUTHOR DISCLOSURES

There are no conflicts of interest.

REFERENCES

1. Popkin BM. Nutrition patterns and transitions. *Population and Development Review*. 1993;19:138-57. doi: 10.2307/2938388.
2. Milio N. Nutrition and health: patterns and policy perspectives in food-rich countries. *Soc Sci Med*. 1989;29:413-23. doi: 10.1016/0277-9536(89)90290-6.
3. Gordon KD. Evolutionary perspectives on human diet. In: Johnson, FE. *Nutritional Anthropology*. New York: Liss Pub; 1987.
4. Dellava JE, Bulik CM, Popkin BM. Price changes alone are not adequate to produce long-term dietary change. *J Nutr*. 2010;140:1887-91. doi: 10.3945/jn.110.125419.
5. Beydoun M, Powell L, Wang Y. The association of fast food, fruit and vegetable prices with dietary intakes among US adults: Is there modification by family income? *Soc Sci Med*. 2008;66:2218-29.
6. Miljkovic D, Nganje W, de Chastenet H. Economic factors affecting the increase in obesity in the United States: Differential response to price. *Food Policy*. 2008;33:48-60.
7. WHO (World Health Organization). *Nutrition and Overweight: Fact Sheet*. Geneva: WHO; 2010.
8. Schmidhuber J, Shetty P. The nutrition transition to 2030: Why developing countries are likely to bear the major burden? Plenary paper presented at the 97th Seminar of the European Association of Agricultural Economists, University of Reading, England, 21-22 April, 2005. [cited 2015/3/10]; Available from: http://www.fao.org/fileadmin/templates/esa/Global_perspectives/Long_term_papers/JSPSttransition.pdf.
9. FAO (Food and Agricultural Organization). *Annual report*. Rome: FAO; 1990.
10. Pingali PL. *Green Revolution: Impacts, limits, and the path ahead*, Bill & Melinda Gates Foundation, Agricultural Development, Seattle, 2012, WA 98102. doi: 10.1073/pnas.0912953109.
11. Benjamin C, Popkin BM. *The nutrition transition: diet and disease in developing world*. London: Academic Press; 2002. doi: 10.1111/j.1467-8659.2003.00225.x.
12. Dearth-Wesley T, Gordon-Larsen P, Adair LS, Siega-Riz AM, Zhang B, Popkin BM. Less traditional diets in Chinese mothers and children are similarly linked to socioeconomic and cohort factors but vary with increasing child age. *J Nutr*. 2011;141:1705-11. doi: 10.3945/jn.110.135707.
13. Popkin BM. The nutrition transition and its relationship to demographic change. In *Nutrition and health in developing countries*, Nutrition and health series, 601-615. [cited 2015/7/15]; Available from: <http://download.springer.com>.
14. Goldman D, Lakdawalla D, Zheng Y. Food Prices and the Dynamics of Body Weight. In *Economic Aspects of Obesity*. University of Chicago Press; 2011.
15. Powell L, Chaloupka FJ. Food prices and obesity: Evidence and policy implications for taxes and subsidies. *Milbank Q*. 2009;87:229-57.
16. Hu FB. Globalisation of food patterns and cardiovascular disease risk. *Circulation*. 2008;118:1913-4. doi: 10.1161/CIRCULATIONAHA.108.808493.
17. Chou S, Grossman M, Saffer H. An economic analysis of adult obesity: Results from the behavioral risk factor surveillance system. *J Health Econ*. 2004;23:565-87.
18. Bisgrove ZE. Work and income as determinants of urban Filipino women's nutrient intake from commercially prepared and home prepared foods. *Ann Arbor, Michigan: University Microfilms International*; 1991. pp. 249.
19. Popkin BM, Lu B, Zhai F. Understanding the nutrition transition: measuring rapid dietary changes in transitional countries. *Public Health Nutr*. 2002;5:947-53.
20. Misra A, Singhal N, Sivakumar B, Bhagat N, Jaiswal A, Khurana L. Nutrition transition in India: Secular trends in dietary intake and their relationship to diet-related non-communicable diseases. *J Diabetes*. 2011;3:278-92.
21. NPC (National Planning Commission). *Five year plan of Nepal*. Kathmandu: NPC; 1980.
22. Pingali P. Westernization of Asian diets and the transformation of food systems: Implications for research and policy. *Food Policy*. 2007;32:281-98. doi: 10.1016/j.foodpol.2006.08.001.
23. Vaidya A, Shakya S, Krettek A. Obesity prevalence in Nepal: public health challenges in a low-income nation during an alarming worldwide trend. *Int J Environ Res Public Health*. 2010;7:2726-44.
24. MOHP (Ministry of Health and Population, Nepal). *Non-Communicable Diseases Risk Factors Survey 2007*. Kathmandu, Nepal: MOHP; 2008.
25. Balarajan Y, Villamor E. Nationally representative surveys show recent increases in the prevalence of overweight and obesity among women of reproductive age in Bangladesh, Nepal, and India. *J Nutr*. 2009;139:2139-2144. doi: 10.3945/jn.109.112029.
26. Misra A, Khurana L. Obesity and the metabolic syndrome in developing countries. *J Clin Endocrinol Metab*. 2008;93:S9-30. doi: 10.1210/jc.2008-1595.
27. Sharma SK, Ghimire A, Radhakrishnan J, Thapa L, Shrestha NR et al. Prevalence of hypertension, obesity, diabetes, and metabolic syndrome in Nepal. *Int J Hypertens*. 2011;2011:821971. doi: 10.4061/2011/821971.
28. CBS (Central Bureau of Statistics). *Nepal Population and Housing Census 2011*. Kathmandu: CBS/N; 2012.
29. FAO. *Food and nutrition in numbers*, FAO: Rome; 2014.
30. Hawkes C, Smith TG, Jewell J, Wardle J, Hamond RA, Friel SA, Thow M, Kain J. Smart food policies for obesity prevention. *Lancet*. 2015;385:2410-21. doi: 10.1016/S0140-6736(14)61745-1.
31. Bhurtyal A, Adhikari D. *Langtang: rebirth after the catastrophe*. World Nutrition. 2015;6:482-92.