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## REVIEW OF LITERATURE

The review of literature for the present study “**Dual Nutrition Burden in Urban Women from Low Middle Income Families**” undertaken is presented under the following headings:

### **A. Dual Nutrition Burden-An Overview**

- a. Under nutrition
- b. Over-weight and Obesity and BMI
- c. Types of Obesity
- d. Nutrition Transition

### **B. Prevalence of Dual Nutrition Burden**

- a. Prevalence of dual Nutrition Burden at Global Level
- b. Prevalence of Dual Nutrition Burden at National Level
- c. Prevalence of Abdominal Adiposity
- d. Prevalence of Over-Nutrition/Obesity and Abdominal Adiposity in India

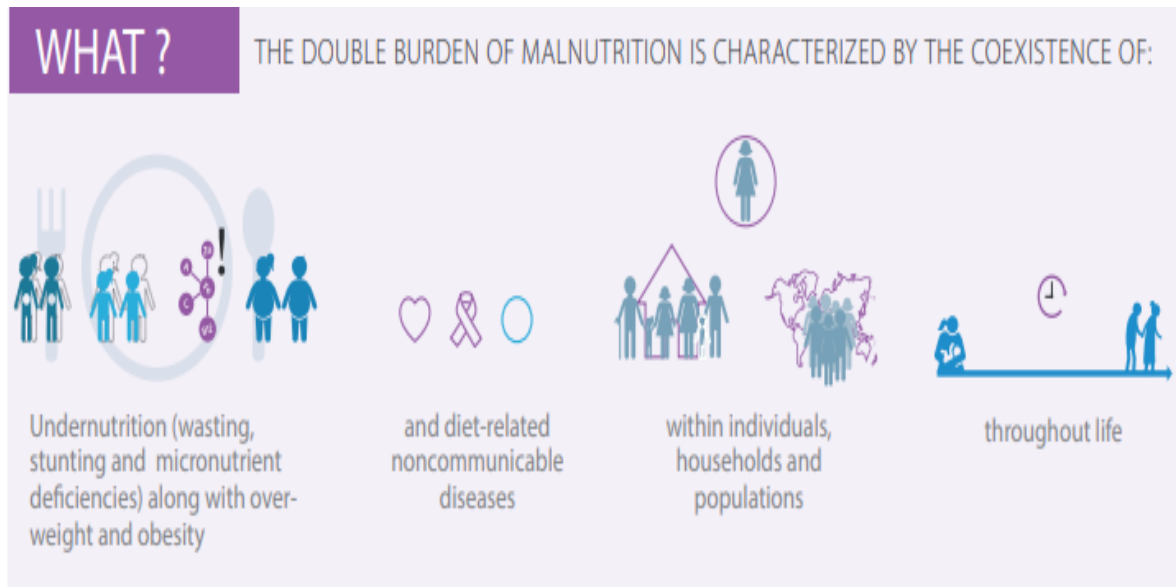
### **C. Reasons for Increasing Dual Nutrition Burden**

### **D. Measures for Prevention of Dual Nutrition Burden**

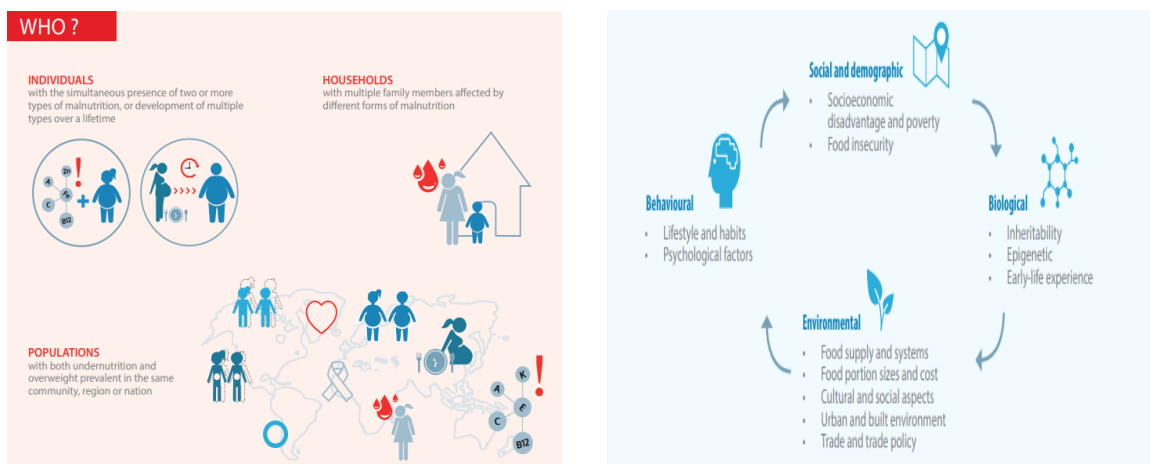
#### **A. Dual Nutrition Burden-an Overview**

Women are generally vulnerable to under nutrition especially during pregnancy and lactation where the food and nutrient requirements are more during that period. Women especially in younger age are at high obstetric risk (using the risk criteria of height less than 145 cm and weight less than 38 kg). The prevalence of micronutrient deficiencies - a study carried out by NNMB (2003) revealed that the overall prevalence of anaemia was

observed to be highest among lactating women (78%) followed by pregnant Women (75%) and adolescent girls (70%). Generally, at household level, cultural norms and practices and socio-economic factors determines the extent of nutritional status. (Rao *et al.*,2010)

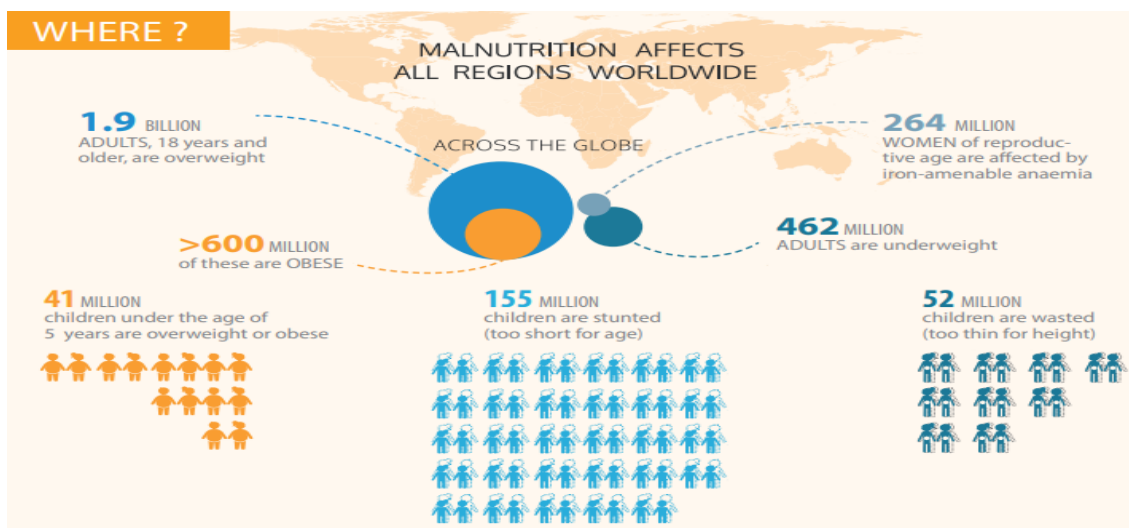


**Figure 1 Definition of Double Burden of Malnutrition (Source: WHO Report)**



**Figure 2: Who is at the Risk of Double Burden of Malnutrition (Source: WHO Report, 2005)**

The double burden of malnutrition termed as dual nutrition burden is characterized by the coexistence of under-nutrition along with overweight and obesity, or diet-related non-communicable diseases, within individuals, households and populations, and across the life course



**Figure 3: Prevalence of Malnutrition in All Regions Worldwide (Source: WHO Report, 2005)**

**a. Under Nutrition**

Undernutrition is defined as the outcome of insufficient food intake and repeated infectious diseases. It includes being underweight for one’s age, too short for one’s age (stunted), dangerously thin for one’s height (wasted) and deficient in vitamins and minerals (micronutrient malnutrition) (<https://www.unicef.org>)

**b. Over-weight and Obesity and BMI**

World Health Organization defines overweight and obesity as abnormal or excessive fat accumulation that presents a risk to health. A simple measure commonly used to classify overweight and obesity in adults is body mass index (BMI).

BMI is defined as a person's weight in kilograms divided by the square of height in meters (kg/m<sup>2</sup>). WHO identifies overweight when BMI is greater than or equal to 25; and obesity when BMI is greater or equal to 30. In Asians, the cut-offs for overweight

( $\geq 23.0 \text{ kg/m}^2$ ) and obesity ( $\geq 25.0 \text{ kg/m}^2$ ) is lower than WHO criteria due to risk factors and morbidities. However, the use of BMI does not distinguish between weight associated with muscle and weight associated with fat, and the relationship between BMI and body fat content varies according to body build and proportion. (Chan & Woo, 2010)

**c. Types of Obesity**

**Overweight** was defined as a BMI  $\geq 23 \text{ kg/m}^2$  but  $< 25 \text{ kg/m}^2$  for both genders (based on the World Health Organization Asia Pacific guidelines) with or without abdominal obesity (AO).

**Generalized obesity (GO)** was defined as a BMI  $\geq 25 \text{ kg/m}^2$  for both genders (based on the World Health Organization Asia Pacific guidelines) with or without abdominal obesity (AO).

**Abdominal obesity (AO)** was defined as a waist circumference (WC)  $\geq 90 \text{ cm}$  for men and  $\geq 80 \text{ cm}$  for women with or without GO.

**Isolated generalized obesity (IGO)** was defined as a BMI  $\geq 25 \text{ kg/m}^2$  with waist circumference of  $< 90 \text{ cm}$  in men and  $< 80 \text{ cm}$  in women.

**Isolated abdominal obesity (IAO)** was defined as a waist circumference of  $\geq 90 \text{ cm}$  in men or  $\geq 80 \text{ cm}$  in women with a BMI  $< 25 \text{ kg/m}^2$

**Combined obesity (CO):** Individuals with both GO and AO.

**Non obese subjects:** Individuals without either GO or AO (Undavalliet *al.*, 2018)

Classification of overweight in adults by the WHO

Classification	BMI	Associated health risks
Underweight	$< 18.5$	Low (but risk of other clinical problems increased)
Normal range	18.5–24.9	Average
Overweight	25.0 or higher	
Preobese	25.0–29.9	Increased
Obese class I	30.0–34.9	Moderately increased
Obese class II	35.0–39.9	Severely increased
Obese class III	40 or higher	Very severely increased

**Figure 4: Classification of Nutritional Status by the WHO**

#### **d. Nutrition Transition**

Nutrition transition is a global phenomenon. India has entered the dual nutrition burden phase of nutrition transition. The country will have to work towards shortening the duration of the transition and minimizing the prevalence of both under and over-nutrition and their adverse consequences. Taking these into consideration the Tenth Five Year Plan envisaged a paradigm shift from

- household food security and freedom from hunger to nutrition security for the family and the individual;
- untargeted food supplementation to screening of all the persons from vulnerable groups, identification of those with various grades of under nutrition and appropriate management;
- lack of focused interventions on the prevention of over-nutrition to the promotion of appropriate lifestyles and dietary intakes for the prevention and management of over-nutrition and obesity and
- vertical programmes to convergence of related sectors to provide integrated
- comprehensive services to improve nutrition and health status (<https://www.aiimsjodhpur.edu.in>)

#### **B. Prevalence of Dual Nutrition Burden**

##### **a. Prevalence of dual Nutrition Burden at Global Level**

In 2014, approximately 462 million adults worldwide were underweight, In 2016, an estimated 155 million children under the age of 5 years were suffering from stunting. These mostly occur in low- and middle-income countries.

Some recent WHO global estimates follow.

In 2016, more than 1.9 billion adults aged 18 years and older were overweight. Of these over 650 million adults were obese. In 2016, 39% of adults aged 18 years and over

(39% of men and 40% of women) were overweight. Overall, about 13% of the world's adult populations (11% of men and 15% of women) were obese in 2016.

The worldwide prevalence of obesity nearly tripled between 1975 and 2016.

Overweight or obese are considered a high-income country problems, overweight and obesity are now on the rise in low- and middle-income countries, particularly in urban settings. In Africa, the number of overweight young adults has increased by nearly 24% percent since 2000. Almost half of the young adults who were overweight or obese in 2019 lived in Asia (Bhardwaj *et al.*, 2011)

Over 340 million children and adolescents aged 5-19 were overweight or obese in 2016. The prevalence of overweight and obesity among children and adolescents aged 5-19 has risen dramatically from just 4% in 1975 to just over 18% in 2016. The rise has occurred similarly among both boys and girls. In 2016, 18% of girls and 19% of boys were overweight. While just under 1% of children and adolescents aged 5-19 were obese in 1975, more than 124 million children and adolescents (6% of girls and 8% of boys) were obese in 2016. Overweight and obesity are linked to more deaths worldwide than underweight. Globally there are more people who are obese than underweight – this occurs in every region except parts of sub-Saharan Africa and Asia. (<https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight>)

A study was done to examine the role of the workplace in the problem by studying the association between occupational sitting time and overweight and obesity (body mass index [BMI]  $\geq$  25) in a sample of adult Australians in full-time employment. Data on age, gender, occupation, physical activity, occupational sitting time, and BMI were collected in September 2003 from a sample of 1579 adult men and women in full-time employment at the time of the survey. Occupational sitting time was independently associated with overweight and obesity in men who were in full-time paid work. These results suggest that the workplace may play an important role in the growing problem of overweight and obesity (Mummery *et al.*, 2005).

This study was aimed to determine the prevalence rate of obesity, overweight, central obesity and their associated factors in the north of Iran. A population-based cross-

sectional study was conducted with a sample of 1800 women and 1800 men of urban population aged 20-70 years living in the north of Iran. The majority of subjects in particular women had none or low levels of physical activity. The overall prevalence rates of obesity and overweight were 18.8% and 34.8% respectively. The overall prevalence rate of central obesity was 28.3%. In both genders, particularly in the women, the rate of obesity was raised by increasing age. With respect to these findings, low level of activity and education, parity, family history of obesity, marriage at earlier age and ageing are responsible for both obesity and central obesity in the north of Iran (Hajian&Heidari, 2007).

A study was done to assess the association of energy intake from fried food with general and central obesity in Spain, a Mediterranean country where frying with oil is a traditional cooking procedure. This was a cross-sectional study of 33 542 Spanish persons aged 29-69 y who were participating in the European Prospective Investigation into Cancer and Nutrition between 1992 and 1996. Dietary intake was assessed by a diet history questionnaire. Height, weight, and waist circumference were measured by trained interviewers. The results of the study found that Fried food was positively associated with general and central obesity only among subjects in the highest quintile of energy intake from fried food (Guallaret *al.*,2007)

A cross-sectional survey of US adults (n = 7356) from the 1994-1996 Continuing Survey of Food Intakes by Individuals and two 24-h dietary recalls were used. There is a relationship exists between the consumption of an energy-dense diet and obesity and provide evidence of the importance of fruit and vegetable consumption for weight management (Ledikweet *al.*,2006).

A study was done to investigate the effect of physical activity on the association between television viewing and overweight (body mass index (BMI) > or =25 kg/m<sup>2</sup>). 3392 adults (64% response rate) from a representative population sample in the State of New South Wales, Australia were selected. BMI and physical activity patterns were both associated with hours of television watched. With approximately half the Australian adult population overweight or obese, these findings indicate that public health strategies to reduce overweight and prevent weight gain may need to focus on reducing sedentary

behaviours such as television viewing in addition to increasing physical activity (Salmonet *al.*,2000).

The following figure depicts the prevalence of over-weight, obesity and abdominal adiposity in South Asian Countries

Country [reference]	Setting	Year	Sample size	Age group	Overweight (%)	Obesity (%)	Abdominal obesity (%)	Diagnosis criteria	
Afghanistan [31]	Urban	2013	1200	25–65	A, 32.5 M, 33.8 F, 31.0	A, 24.9 M, 15.9 F, 35.8	A, 56.6 M, 49.3 F, 65.5	OW25–30, Ob ≥ 30, WC > 80 (F); WC > 94 (M)	
Bangladesh [32]	National	2011	5495	≥ 35	A, 18.9 M, 17.4 F, 18.4	A, 4.6 M, 3.0 F, 6.0	NR	OW 23.0–27.5, Ob ≥ 27.5	
India [10]	Chandigarh Jharkhand Maharashtra Tamil Nadu	Urban and rural	2008–2010	3216 3207 3809 3568	≥ 20	A, 15.9 A, 7.8 A, 11.3 A, 15.2	A, 31.3 A, 11.8 A, 16.6 A, 24.6	A, 36.1 A, 16.9 A, 18.7 A, 26.6	OW ≥ 23, Ob ≥ 25 WC ≥ 80 (F); WC ≥ 90 (M)
India [33]	Urban	2015–2016	171,155	15–49	M, 26.0 F, 36.0	NR	NR	OW > 22.99	
	Rural	2015–2016	425,289	15–54	M, 14.0 F, 17.0	NR	NR	OW > 22.99	
Maldives [34]	Urban	2004	2028	25–64	A, 63.3 M, 60.8 F, 65.5	A, 43.5 M, 38.1 F, 48.1	A, 40.0 M, 24.2 F, 54.1	OW ≥ 23, Ob ≥ 25, WC > 80 (F); WC > 90 (M)	
Nepal [35]	National	2016	13,542	≥ 18	M, 28.8 F, 32.8	NR	NR	OW/Ob ≥ 23.0	
Pakistan [36]	Urban and rural	2013–2014	7366	≥ 18	A, 26.3 M, 26.5 F, 26.2	A, 14.9 M, 12.1 F, 17.1	NR	OW 25–29, Ob ≥ 30,	
Sri Lanka [6]	National	2005–2006	4532	≥ 18	A, 25.2 M, 22.6 F, 28.0	A, 9.2 M, 7.2 F, 11.3	A, 26.2 M, 16.5 F, 36.3	OW ≥ 23, Ob ≥ 27.5, WC ≥ 80 (F); WC ≥ 90 (M)	

NR, not reported; OW, overweight ( $\text{kg m}^{-2}$ ); Ob, obesity ( $\text{kg m}^{-2}$ ); WC, waist circumference (cm); A, all; M, males; F, females

(Source: Misra *et al.*,2019)

**Figure 5: Prevalence of Overweight, Obesity, and Abdominal (central) Obesity in South Asian Countries**

### b. Prevalence of Dual Nutrition Burden at National Level

According to National Family Health Survey (NFHS) i.e NFHS-4 (2015-16), NFHS-3 (2005-06) and NFHS-2 (1998-99) the prevalence of overweight and obesity in India increased swiftly in last two decades. An alarming trend is that overweight/obese women as well as men population has been more than doubled in 2015-16 since last one and a half decade. There was a significant rise in the prevalence of overweight and obesity from 1998-99 to 2015-16 in both urban and rural areas in all the states of India. An emerging concern is that there was rise in overweight/obesity prevalence up to critical level among the states, where it was not severe earlier.

Overweight and obesity have become substantial problem among different socio-economic spectrum of women and men in India, particularly in older ages, people living in urban areas, well-educated and among households of highest wealth quintile and simultaneously among people living in poorer wealth quintile, uneducated and people belonging to socioeconomically less developed states. It was also found that food habits did not conclude any definite effect on the prevalence of overweight and obesity. One reason may be the complex and non-uniform dietary habits across the states, and other may be the availability of nutritious and balanced food (Shannawaz&Arokiasamy,2018)

There was also a strong positive relation between SES and body mass index at both time points and across urban and rural areas. A positive relation between SES and body mass index was also observed for men in 2005-2006. The distribution of underweight and overweight in India remains socially segregated. Despite rapid economic growth, India has yet to experience a situation in which underweight and overweight coexist in the low-SES groups. (Visscher&Seidell,2004).

In India, prevalence of obesity in urban slums is higher than in rural areas. The distribution of underweight and overweight in India remains socially segregated. In a study it was investigated that the evolution over time of overweight and obesity among ever-married Indian women (15-49 years) from selected 'underweight states' (Bihar, Orissa and Madhya Pradesh, where underweight proportion is predominant) and 'overweight states' (Kerala, Delhi and Punjab, where overweight is the prime concern), in relation to a few selected socio-economic and demographic indicators. National Family Health Surveys- NFHS-2 (1998-99) and NFHS-3 (2005-06) data were analyzed following Asian population specific BMI cut-offs for overweight and obesity. Results from 'overweight states' showed that the overweight problem has started expanding from urban and well-off women to the poor and rural people, while the rural-urban and rich-poor difference has disappeared. On the other hand in 'underweight states' overweight and obesity have remained socially segregated and increasing strongly among urban and richer section of the population. The rate of rise of overweight and obesity has been higher in rural areas of 'OW states' and in urban areas of 'UW states'. Indian policymakers thus need to design state-specific approaches to arrest the rapid growth of overweight and its penetration especially towards under-privileged section of the society. (Sengupta *et al.*,2015)

Similarly a study done by Dutta *et al* (2019) compared the data of NFHS 3 and 4 and it showed that the rate of under-nutrition has been decreased from NFHS 3 to NFHS 4 while the prevalence of over-nutrition has been increased between these two surveys. Among females the under-nutrition rate was 36% in NFHS 3 and it became 22.4% in NFHS 4 on the other hand, the prevalence of over-nutrition has been increased among females from 13.6% to 18.6%. Among State wise southern states displayed a major prevalence of over-nutrition.

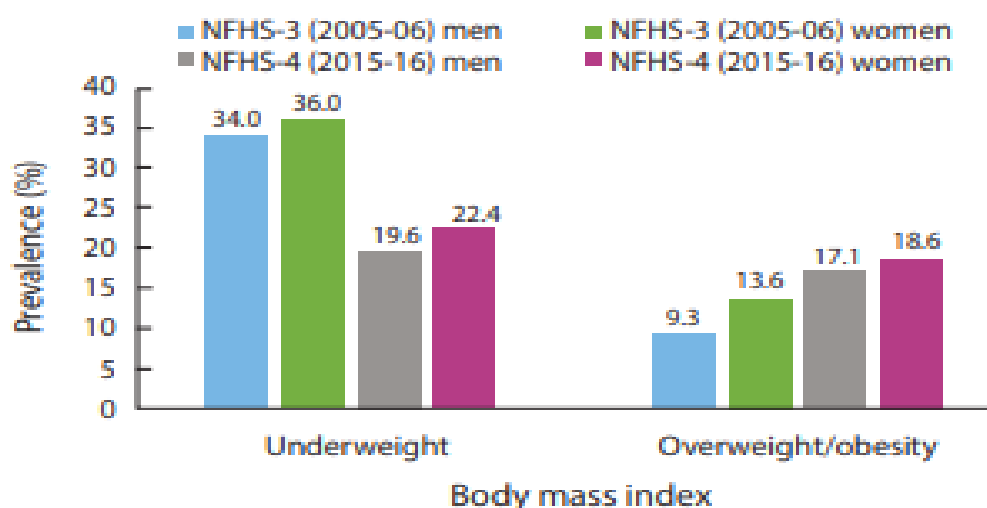


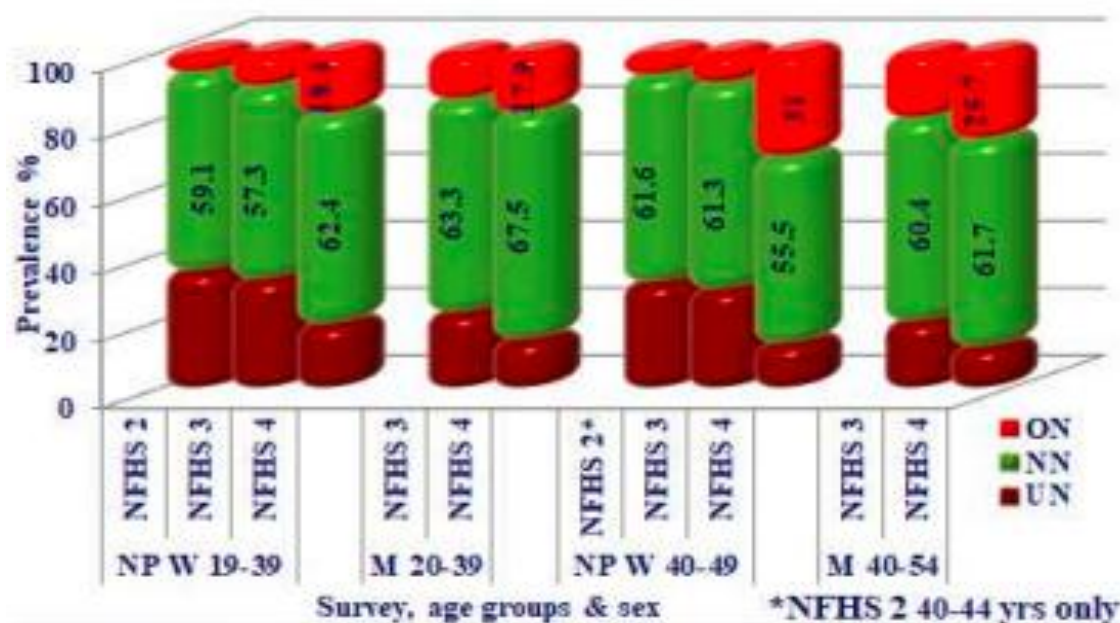
Figure 6: Comparison of Nutritional Status Data-NFHS 3 & NFHS 4

NNMB Report also pointed out that with years increasing; the prevalence of under-nutrition was decreasing in both males and females. Prevalence of normal nutrition and over-nutrition were also increasing with increasing years in both genders. This data also indicated that females are more obese than males (<http://nin.res.in>)

BMI	Periods	Males	Females
<18.5	1975-79	55.6	51.8
	1988-90	49.0	49.3
	1996-97	45.5	47.7
18.5-25.0	1975-79	42.1	44.8
	1988-90	48.4	46.6
	1996-97	50.4	46.3
≥25.0	1975-79	2.3	3.4
	1988-90	2.6	4.1
	1996-97	4.1	6.0

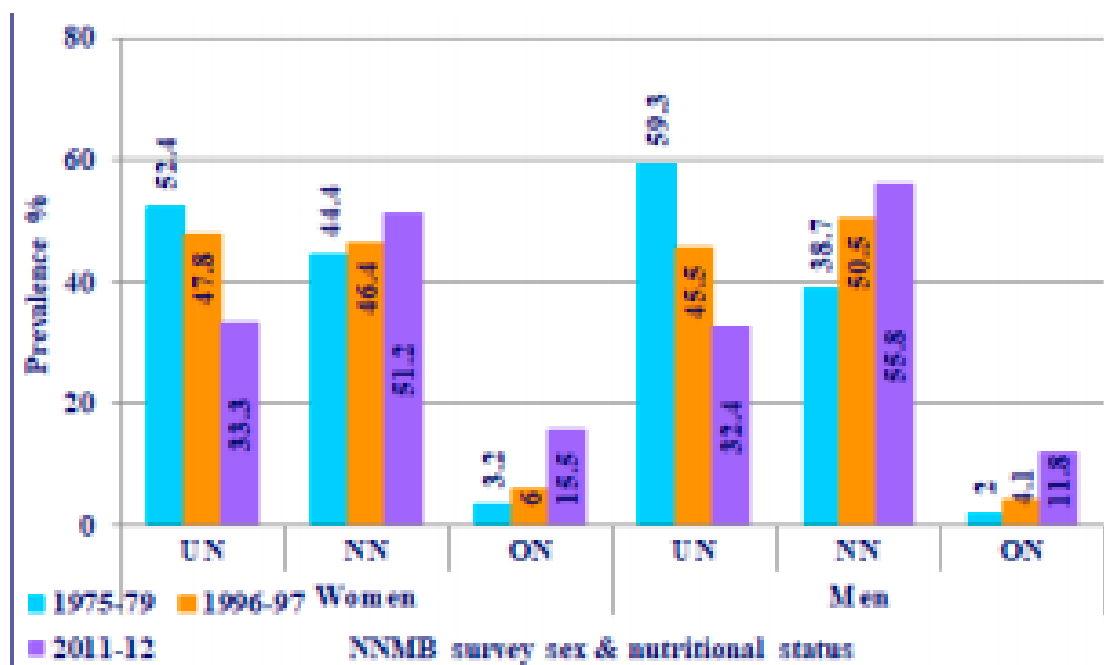
Figure 7: Nutritional Status by Gender, 1975-1997 (NNMB Urban Nutrition Report)

In a review article published by Ramachandran&Kalaivani (2018) stated that NNMB repeat rural surveys showed that, between 1975 and 2012, there was a reduction in under-nutrition from 59% to 32% in men and from 52% to 33% in women. Over the same period, prevalence of over-nutrition increased from 2% to 12 % in men and 3 to 16% in women. It is a matter of concern that the reduction in under-nutrition is matched by the rise in over-nutrition, and so the proportion of normally nourished (NN) persons remained unchanged at around 60%.



**Figure 8: Dual Nutrition Burden in Men and Women 1998- 2015 NFHS Surveys. Under-nutrition (UN), Normal nutrition (NN), Over-nutrition (ON)**

Source: (Ramachandran&Kalaivani, 2018).



Source: (Ramachandran&Kalaivani, 2018).

**Figure 9: Dual Nutrition Burden in Men and Women,1975- 2012 by NNMB reports.**

In India, women in the age group of 15-19 and 20-34 are 3.1 and 1.7 times respectively more likely to suffer from under-nutrition compared to women in the age group 35-49 and the difference are severe in the state of Delhi, Punjab followed by Himachal Pradesh, Andhra Pradesh and Maharashtra. In rural India, in 15-19 and 20-34 age groups, it is 2 times and 1.4 times more likely to be undernourished and in urban India, under-nutrition is 5.5 times and 2.3 times more than 35-49 age group respectively. But in a study it was revealed that in India, age groups 15-19 and 20-34 are the most vulnerable group of under-nutrition. In India, women of low and medium standard of living are more probable to be affected by under nutrition as compared to high standard of living. In case of risk factor, “caste” SC, ST and OBC categories are more likely to be affected by chronic under nutrition than general and all other categories of women. Women with primary, secondary and higher education are less likely to be affected by under-nutrition than their no education counterparts (Hazarika *et al.*,2012)

**c. Prevalence of Abdominal Adiposity**

When studies in Asian populations are taken together, Asians appear to have an increased metabolic risk at lower waist circumference and waist–hip ratio than Europeans. This is probably due to higher levels of body fat and abdominal adipose tissue<sup>i</sup> (<https://www.who.int/publications/i/item/9789241501491>). Larger waist circumference identifies people at increased cardiovascular risks (Hanet *al.*,1995).

Among women, the time trend in abdominal obesity was stronger than that in obesity. Further, levels of BMI and waist circumference were higher in winter than in summer seasons. The seasonal variation was larger for abdominal obesity than for obesity, among both men and women. The time trend for both men and women were stronger for abdominal obesity than for obesity. Furthermore, the waist circumference is a more sensitive indicator of variations in lifestyle and body composition than is body mass index. (Visscher&Seidell,2004).

The International Diabetes Federation (IDF) criteria for metabolic syndrome recommend use of ethnic specific threshold for waist circumference which is a surrogate marker of abdominal obesity. For Asian men and women, the respective cutoff of normal values are >90 and >80cms. The cutoff values for WC and WHR were lower in women than in men. The values were significantly lower compared with the corresponding values in white populations. There are some indications that WC may predict prevalent cardiovascular risk better than BMI or WHR, even though the differences are small. A higher body fat percentage with lower body weight and tendency for abdominal obesity are seen even among Asian children. (Ramachandranet *al.*,2012).

**d. Prevalence of Over-Nutrition/Obesity and Abdominal Adiposity in India**

A study was done to find the prevalence and risk factors for obesity in women aged 20-60 years in Ludhiana city. This study is a community based cross sectional study carried out in an urban area of Ludhiana among women aged 20-60 years. 324 women were enrolled for this study. It was found that the prevalence of overweight and obesity was 12.7% and 29.6% respectively. Obesity was found to be more common among

middle-aged Punjabi housewives belonging to upper socio-economic strata. There was strong association between overweight/obesity and hypertension. (Girdharet al.,2016)

ICMR-INDIAB study was conducted in a representative population of three States [Tamil Nadu (TN), Maharashtra (MH) and Jharkhand (JH)] and one Union Territory (UT) [Chandigarh (CH)] of India. A stratified multi-stage sampling design was adopted and individual's  $\geq 20$  yr of age were included. WHO Asia Pacific guidelines were used to define overweight [body mass index (BMI)  $\geq 23$  kg/m<sup>2</sup> but  $< 25$  kg/m<sup>2</sup>, generalized obesity (GO, BMI  $\geq 25$  kg/m<sup>2</sup>, abdominal obesity (AO, waist circumference  $\geq 90$  cm for men and  $\geq 80$  cm for women) and combined obesity (CO, GO plus AO). Of the 14,277 participants, 13,800 subjects (response rate, 96.7%) were included for the analysis (urban: n = 4,063; rural: n = 9737). It was revealed that Prevalence of AO as well as of GO were high in India. (Pradeepaet al.,2015)

A study was doneto assess the prevalence of abdominal obesity including intra-abdominal and subcutaneous adiposity along with other cardio metabolic risk factors in urban Asian Indians living in New Delhi. A cross-sectional epidemiological descriptive study was conducted with 459 subjects (217 males and 242 females), representing all socio-economic strata in New Delhi. The overall prevalence of obesity was high [by BMI ( $>25$  kg/m(2)), 50.1%]. The prevalence of abdominal obesity (as assessed by WC) was 68.9%. By this study it was found that high prevalence of generalized obesity, abdominal obesity and dysmetabolic state in urban Asian Indians in north India need immediate public health intervention (Bhardwajet al.,2011)

In this study, 5083 Kashmiri adults females of  $>$  or  $= 40$  years age were examined to determine the prevalence of obesity by using body mass index (BMI) and waist to hip ratio (WHR). BMI and WHR in females were comparatively more than that in males. According to BMI, the overall prevalence of obesity in the study population was 15.01%; the prevalence of obesity in males was 7.01% and in females 23.69%. This study concludes that obesity is a growing problem even in developing regions. It is more common in females and in urban population (Zargaret al.,2000)

The objective of this study was to assess the prevalence of obesity in urban population of Shivamogga. Cross sectional study was conducted in Urban Shivamogga Study during February 1st to July 30th 2016 for 6 months in aged 15-64 years. The calculated sample size was 2000. The prevalence of high BMI among study subjects was nearly fifty percent (45.6%). The prevalence of obesity in the study subjects was 31.6%, the prevalence was more in females (34.9%) compared to males (28.4%). The prevalence of central/ abdominal type of obesity was 41.2%. This community based study demonstrated high prevalence of obesity and overweight among the productive population of urban Shivamogga. (Nagendra *et al.*,2016)

The present study had been undertaken in literate high income group colonies of Gwalior city in which persons aged 30 years and above, in a family, were interviewed. Anthropometric data regarding height, weight and blood pressure was also taken. The study showed that 34.4% of males and 31.3 % of females, both aged 30years and above were either obese or over weight. There was a statistically significant difference noted in the likening of fried food and fast food between obese and overweight persons and persons with normal body mass index. BMI plays a crucial role in its early detection as it is simple to calculate and can even detect the pre-obesity stage in time (Tiwari *et al.*,2009)

A community based cross-sectional study from April 2008 to May 2009 (1 year) conducted at urban health center, Harazpenta and rural health center, Patancheruvu. Total of 1409 persons in the age group of above 15 years were involved in this study. Among urban population prevalence of obesity was 12.7% compared to 5.4% in rural area. All over weight and obese subjects should be educated to know about the occurrence of various health problems due to overweight (Rao&Sundar,2019).

Using data of the third round of the National Family Health Survey (NFHS) 2005-2006, this study examined the prevalence of overweight and obesity among women from different economic strata in urban India. The result shows that prevalence of overweight and obesity is very high in urban areas, more noticeably among the non-poor households. Furthermore, overweight and obesity increase with age, education, and parity of women. Marital status and media exposure are the other covariates associated positively with overweight and obesity. Thus, the growing demand which now appears before the

Government or urban health planners is to address this rising urban epidemic with equal importance as given to other issues in the past (Gouda & Prusty, 2014).

This study was undertaken in an urban slum in Chennai city, among women aged 20 years and above. Anthropometric data regarding height and weight was also taken. WHO Asian Classification of the body mass index (BMI) was used to classify the study population. In the study population, the prevalence of overweight (BMI  $\geq 23$ ) was 27.7% and the prevalence of obesity (BMI  $\geq 25$ ) was 19.8%. The prevalence of overweight and obesity was found to be significantly higher among the slum women with inadequate fruit intake, increased duration of television viewing and sleep duration of 9 hours per night. The prevention is economical and easy at an early stage, with the change occurring in the form of lifestyle modifications at an individual level with increasing awareness (Anuradha *et al.*, 2011).

It was a cross-sectional study conducted during February 2015 in Tamil Nadu. All consenting individuals above 18 years of age were included. Pregnant women, bed-ridden patients, and those who had an acute illness in the last 2 weeks were excluded. Number of families included was 170 comprising 315 individuals. Prevalence of overweight was 36.5% and prevalence of obesity was 12.4%. Although majority of population belonged to daily wage laborer workforce, prevalence of overweight is high. Distorted ideal and current body image perception is also significantly high and is a definite risk factor for obesity (Raj & Ploriya, 2018)

According to National Family Health Survey-3, Kerala ranks second among Indian states next to Punjab for overweight or obese. This research was conducted to study the prevalence of obesity among reproductive age women and its association with socio-demographic variables. It was a cross sectional study with a sample of 650 re-productive age women (15-49 yrs). The prevalence of obesity based on BMI WHO classification for adult Asians was 47.5. Higher prevalence of obesity was seen among higher age group, low socio-economic group, housewives. Menstrual irregularities and higher parity were significantly associated with obesity (Prahlaad & Ramesh, 2017)

This study was conducted to assess the prevalence of general and abdominal obesity among adult outdoor patient in Urban and Rural Health Training Centre,

Department of Community Medicine, Veer Chandra Singh Garhwali Government Medical Sciences and Research Institute, Srinagar, Uttarakhand. A total of 200 patients aged  $\geq 20$  years were randomly selected were studied. The prevalence of abdominal, as well as of general obesity, was high using WHO Asia Pacific Guidelines. Gender and occupation were risk factors associated with obesity. Suitable healthcare strategies are needed for combating obesity (Gupta *et al.*,2017)

A study was done to assess socio demographic predictors of prevalence, incidence and remission of overweight including obesity among adults (aged  $\geq 18$  years) in rural Eastern India , West Bengal, India. A sample of 24,115 adults (men: 10,915, women: 13,200) enrolled in 2008 were followed up for body mass index (BMI) reassessment in 2017. Women were more likely to be overweight in 2008 and to experience incident overweight than men. For men and women, education level and wealth were positively associated with prevalence and incidence of overweight. A nutrition transition to higher risk of overweight is evident in this rural setting in India, especially among women and individuals with high socioeconomic status. At the same time, a high prevalence of underweight persists, resulting in a significant double burden. Culturally sensitive interventions that address both ends of the malnutrition spectrum should be prioritized (Raies *et al.*,2018).

This study's Objective was to determine the prevalence of obesity among the government employees of G.R. Medical College, Gwalior. This has been undertaken among government employees of G.R. Medical College, Gwalior. Anthropometric data regarding weight and height was taken. The study shows that among total 215 employees. 35 (21.21%) males and 21 (42%) females were found overweight and obese with the criteria of BMI more than  $25 \text{ kg/m}^2$ . It was concluded from this study that obesity is a chronic illness. Early detection and appropriate intervention could prevent various complications associated with it. BMI plays a crucial role (Mahoreet *et al.*,2018).

An ex post facto study using a cross-sectional survey design was employed to find out the prevalence of overweight and obesity among young female college students in Chennai. A total of 2765 female college students aged 17-21 from 10 women's colleges in Chennai city were included in the study. Anthropometric assessments included body mass

index (BMI) and body fat percent. Dietary intake was assessed using a three 24 h dietary recall. The findings of this study reflect both a dual burden situation and an improper dietary pattern prevailing among the population of young female college students, necessitating the need for appropriate nutrition intervention (Ashok&Karunanidhi, 2016)

The study was done in rural areas of Haryana involved a survey of 1359 male and 1469 female respondents, aged 15-64 years. WHO STEP-wise tool was used as the study instruments which included behavioural risk factor questionnaire and physical measurements of height, weight, waist circumference and blood pressure. The results of this study showed a high burden of tobacco use and alcohol use among men, inactivity and overweight among women and low fruit and vegetable consumption among both sexes in rural areas (Krishnan *et al.*, 2008).

A study was done to estimate the nutritional status of women in the reproductive age group in rural Kolar. Community based Cross-sectional study was conducted in rural field practice areas of Medical College for 6 months. 180 women in the reproductive age group of 15-49 years residing at Devarayasamudra village were included. It was observed that out of 180 women, 49 (27.2%) of the women were overweight and 26 (14.4%) women were underweight. 36.67% women had a waist hip ratio of more than 0.85. Higher prevalence of overweight and abdominal obesity was observed among women of reproductive age group in rural area. Hence measures to improve the nutritional status of women in rural areas need to be addressed (Zachariah *et al.*, 2017).

In a similar way, Objective of an another study was to determine the prevalence of generalized and abdominal obesity in urban Asian Indians and compare the association of body mass index (BMI) and waist circumference (WC) with metabolic risk variables. Subjects were recruited from the Chennai Urban Rural Epidemiology Study (CURES) carried out between 2001 and 2004 and involved 2350/2600 eligible subjects. Anthropometric measurements, lipids and oral glucose tolerance tests were carried out. Generalized obesity ( $BMI \geq 23 \text{ kg m}^{-2}$ ) and abdominal obesity ( $WC \geq 90 \text{ cm}$  in men and  $\geq 80 \text{ cm}$  in women) were defined using WHO Asia Pacific guidelines. In Asian Indians, the prevalence of combined obesity is high among both sexes, while isolated generalized obesity is more common in men and isolated abdominal obesity more

common in women. However, these prevalence rates vary markedly depending on cut points used. WC is a better marker of obesity-related metabolic risk than BMI in women compared to men in this population (Deepa *et al.*, 2009)

A randomized cross-sectional community based study was conducted, which was carried out in 13 schools of Chandigarh, a North Indian city. 10,037 school going adolescents of age 10-18 years were evaluated. This study was concluded that abdominal obesity is more prevalent than generalized obesity and shows increasing trend with age. It was found that over one third of centrally obese adolescents are not obese by BMI criteria. This underlines the importance of waist circumference measurement in addition to BMI while assessing obesity (Solanki *et al.*, 2020).

This study demonstrated the prevalence of generalized, abdominal obesity including intra-abdominal and subcutaneous adiposity along with other associated factors in young adults. A cross-sectional study was conducted with 200 subjects. The anthropometric parameters (body mass index [BMI], waist circumference [WC], and skinfold thickness), fasting blood glucose (FBG), and blood pressure were recorded. Percentage of body fat (BF), total abdominal fat (TAF), intra-abdominal adipose tissue (IAAT), subcutaneous adipose tissue (SCAT), and basal metabolic rate (BMR) were measured by predictive equations. The prevalence of GO, abdominal obesity, regional adiposity among young adults necessitates public health intervention (Keshet *et al.*, 2018).

The objectives of this study are to estimate the prevalence of overweight, general obesity, and abdominal obesity and to examine their associations with socioeconomic status among young men residing in a rural field practice area of SRM Medical College Hospital, Kancheepuram. This cross-sectional study was done in the rural area of SRM Medical College Hospital involving 150 young adults (men) selected by simple random sampling method. Anthropometric measurements including participant's weight, height, and WC were assessed. About 39% of the study participants were found to be overweight and obese. Around 40% of study participants had WC more than 90 cm and about 60% of the study participants with a WC <90 cm. These results suggest a high prevalence of abdominal obesity which may be the key factor for metabolic disorders (Selvaraj *et al.*, 2017).

A study was conducted to assess the influence of socioeconomic status on the prevalence of the metabolic syndrome in an urban south Indian population in Chennai. The Chennai Urban Population Study is an epidemiological study involving two residential colonies in Chennai (formerly Madras) in south India representing the middle and lower income groups. All individuals  $>$  or  $=$  20 years of age living in the colonies were invited to participate in the study. Of the total 1399 eligible subjects participated in the study. The results of this study shows a significant difference exist in the prevalence of various components of the metabolic syndrome even within an urban environment and this appears to be influenced by socioeconomic status (Mohanet *al.*, 2001).

The objectives of this study were to find the prevalence of overweight and obesity in the urban population of Jamnagar and to explore the effect of dietary factors on the weight status of the people. A cross-sectional study was conducted among the adult population of Jamnagar city. The prevalence of overweight and obesity was found to be 22.04% and 5.20%, respectively. Overweight was more prevalent in females than males. The prevalence rose with an increase in age up to 60 years. Among dietary factors, the total calorie intake and habit of snacking had a positive association with weight gain. The prevalence of overweight and obesity in the urban population in Jamnagar was found to be 22.04% and 5.20%, respectively. Total calorie intake as well as composition of diet was the important dietary factor affecting weight gain (Vaderaet *al.*, 2010).

In this study the prevalence of overweight in north Indian urban and rural population samples was studied. The urban sample population (n = 3050) and the rural sample (n=2487) were selected. All participating individuals were 35-64 years of age. The study reveals that overweight is widely prevalent in the adult urban Delhi population, whereas underweight is a significant problem in the rural population. This was noted across all the age groups in both men and women (Reddyet *al.*, 2002).

A cross-sectional epidemiological descriptive study was done of a total of 532 subjects (170 males and 362 females). Based on body mass index (BMI), obesity was more prevalent in females (15.6%) than in males (13.3%). On the other hand, classifying obesity based on percentage body fat (%BF), 10.6% of males and 40.2% of females were obese. High waist-hip ratio (WHR) was observed in 9.4% of males and 51.1% of the

females. Appreciable prevalence of obesity, dyslipidaemia, diabetes mellitus, substantial increase in body fat, generalised and regional obesity in middle age, particularly in females, need immediate attention in terms of prevention and health education in such economically deprived populations (Misra *et al.*, 2001).

In a study it was showed that Visceral and central abdominal fat showed a strong association with type 2 diabetes. Both measures correlated well with each other and with waist circumference in urban Asian Indians (Anjana *et al.*, 2004)

The prevalence of obesity and its associations were assessed during a community based epidemiological survey of coronary heart disease on a randomised sample of 13,414 adults in the age group 25-64 years living in urban Delhi. Body Mass Index (BMI) > 25 was considered to be the cut off point for defining obesity. By this criterion, the overall prevalence rate of obesity was 27.8%. Obesity was found to be more common in female subjects (Male--21.3%, Female--33.4%,  $p < 0.001$ ) (Gopinath *et al.*, 1994).

A population- based multilevel study of 77 220 ever married women, aged 15–49 years, from 26 Indian states, derived from the 1998–99 Indian National Family Health Survey data. Rapidly developing economies, besides experiencing paradoxical health patterns, are typically characterized by increased levels of income inequality. This study suggests that the twin burden of under-nutrition and over-nutrition in India is more likely to occur in high- inequality states. Focusing on economic equity via redistribution policies may have a substantial impact in reducing the prevalence of both under-nutrition and over-nutrition (Subramanian *et al.*, 2007).

The relationship of body mass index (BMI), conicity index (CI) and waist circumference to four coronary heart disease (CHD) risk factors (systolic and diastolic blood pressures, total cholesterol and high-density lipoprotein (HDL) cholesterol levels) was examined in urban ( $n = 110$ ) and rural ( $n = 102$ ) men aged  $> \text{ or } = 20$  years, drawn from the 'Reddy' population of Southern Andhra Pradesh, India. The results of the present study revealed that BMI and waist circumference had a greater influence on the CHD risk factors. Hence this study suggests that BMI and waist circumference are better indicators of CHD risk factors (Venkatramana & Reddy, 2002)

To study the prevalence of central obesity and age-specific waist: Hip ratio of urban women from five Indian cities. Cross-sectional surveys were conducted in 6-12 urban streets in different parts of India using similar methods of sample selection and criteria of diagnosis. Randomly selection were taken of 3212 women, aged 25-64 years, from Moradabad (n = 902), Trivandrum (n = 760), Calcutta (n = 365), Nagpur (n = 405), and Bombay (n = 780). The overall prevalence of central obesity among the total number of women was 55.0%, with the highest prevalence in Calcutta (62.2%) and the lowest in Bombay (47.4%). Waist: Hip ratio was  $0.85 \pm 0.13$  (mean  $\pm$  SD) with the highest ratio for women in Calcutta ( $0.87 \pm 0.12$ ) and the lowest for women in Moradabad ( $0.84 \pm 0.16$ ). The overall prevalence of central obesity among the urban women of India has increased, more so in Calcutta and Trivandrum. Body mass index, sedentary lifestyle, and family history of excess intake of fat were significant risk factors for central obesity (Singh *et al.*, 1998).

A study reveals that in urban areas, the unhealthy weight burden was largely underweight in childhood and overweight in adulthood. In rural areas, the unhealthy weight burden was largely underweight at all ages. Urban residents compared with rural residents were more likely to be overweight and less likely to be underweight at nearly all ages. Combined unhealthy weight was comparable in urban and rural India. Although underweight continues to be the predominant nutritional problem, there is early evidence of an epidemiologic crossover from underweight to overweight. As India experiences urbanization and population aging, low overweight and obesity may be short lived. (Patel *et al.*, 2015)

This study was conducted to determine the prevalence of obesity among adult, its associated factors, and its relationship with retail food outlet density in Srikot, Uttarakhand. This study was a community-based cross-sectional study, carried out in Srikot, Uttarakhand, in 2016 among 155 adults systematically sampled, aged above 20 years. This study concludes that Srikot in Uttarakhand is in an early stage of urbanization as evident from the burden of obesity, and this might worsen by prevalent outlet density of food in the environment (Rautela *et al.*, 2018)

### **C. Reasons for Increasing Dual Nutrition Burden**

During the last three decades, a socio-economic transition has occurred in Asia resulting in increased availability of food, better transport facilities and better health care facilities. Epidemiological data from China and India shows that change in dietary habits, reduced physical activity due to mechanization, preference of viewing TV and videos, outdoor games and increase use of automobiles are associated with the change in rates of obesity. The changing trend was initially noted in urban populations and similar scenario had occurred in rural areas in the recent years. (Ramachandran *et al.*, 2012)

There are various other parameters which are also associated with the prevalence of over-nutrition. Higher Socio-economic status, Low physical activity, upper education, are directly associated with increasing prevalence of obesity. Results from NFHS 2,3,4 showed that the likelihood of obesity was three times higher among men and women of age more than 35 years compared to those in age group of 15-24 years (Rautela *et al.*, 2016)

Age is found to be an important factor. Higher is the age, greater is the chance to become obese or overweight. The likelihood of overweight or obesity among women with high school and above education is about 1.8 times more than illiterate women. Standard of living also has significant impact on overweight or obesity status of women. Occupational differences also persist in the prevalence of obesity/overweight among women. The likelihood of overweight and obesity decreases among women working as labourer with reference to not working women. Further, religious and ethnic backgrounds of women are also found to be an important factor. Women belonging to Sikh religion are almost two times more likely to be overweight or obese with reference to Hindu women. In addition, women from other caste are more likely and scheduled tribes are less likely to be overweight or obese with reference to scheduled cast women (Agrawal & Agrawal, 2012).

Apart from all other factors, having low physical activity is the main reason for increasing the prevalence of overweight and obesity in all age groups. So in this Review of Literature, impact of low physical activity, benefits of physical activity on health was elaborated. There are some studies done which are concluding the prevalence of low Physical activity among Indians.

Impact of Low Physical Activity in Increasing the Prevalence of Over Nutrition and Adiposity in a study revealed that Obesity and higher body weight are strongly associated with a sedentary lifestyle and lack of physical activity in the adult population of the European Union. According to NNMB Nutrition urban report, in India, about two third of men and three fourth of women work more than 8 hours per day mostly in a sitting posture. Only 15% of women were involved in physical activity. (NNMB, Nutrition Urban Report, 2016).

On August 29, 2019, India has launched “Fit India Movement” with an aim “to encourage the people to include physical activity and sports in their daily lives.” The promotion of physical activity should start from school going period itself with the help of education departments. Important barriers identified in the recent times are poor infrastructure at the school levels to promote physical activity. (Newtonraj *et al.*, 2019).

Singh & Singh, 2017 pointed out the health benefits of physical activity for an adult population; Overall, strong evidence demonstrated that compared to less active adult men and women, individuals who are more active:

- have lower rates of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, metabolic syndrome, colon and breast cancer, and depression;
- are likely to have less risk of a hip or vertebral fracture;
- exhibit a higher level of cardio respiratory and muscular fitness; and

Are more likely to achieve weight maintenance, have a healthier body mass and composition. (<https://www.who.int/teams/health-promotion/physical-activity/physical-activity-and-adults>)

People should engage in adequate levels of physical activity (60 minutes a day for children and 150 minutes spread through the week for adults. At least 30 minutes of regular, moderate-intensity physical activity on most days reduces the risk of obesity and co-morbidities.

Regular physical activity clearly attenuates many of the health risks associated with overweight or obesity; physical activity appears to not only attenuate the health risks of overweight and obesity, but active obese individuals actually have lower morbidity and

mortality than normal weight individuals who are sedentary, and inactivity and low cardiorespiratory fitness are as important as overweight and obesity as mortality predictors (Blair&Brodney1999)

Studies done on Physical activity for Assessing the Prevalence of Low and High Physical Activity among Indians and reported that there is an urgent need to improve the physical activity levels in rural as well as in urban area and in among all the age group for avoiding further health complications. From the beginning of life, involving physical activity in day to day life should be imparted. Measures to increase physical exercises both at home and at workplace could be undertaken using the behavior change communication strategy. People should also be promoted to do physical activity so that they can enjoy the health. In a study it was found that People reporting day-to-day habits such as walking and usage of bicycles seem to have lower prevalence of obesity levels. These may be considered as good practices and such simple and replicable behavioural modifications need to be brought about at a societal level to bring down the risk of future complications. For preventing obesity author suggested that low cost ideas should be utilized for preventing obesity. Our Indian traditions also can be used like dance, yoga, walking, and meditation (kamath, 2017)

In a study the author assessed the prevalence and factors associated with insufficient physical activity (PA) in urban and rural Vellore, Tamil Nadu, India, among adults aged 30–64 years. A cross-sectional World Health Organization STEPS survey was carried out in 48 wards of Vellore Municipality and nine rural villages of Tamil Nadu in 2010–2012. Adults ( $n = 6164$ , men 43.9%) aged 30–64 years were interviewed using the Global PA Questionnaire (2390 urban and 3774 rural). Women had a higher prevalence of insufficient PA compared to men, in both urban (70.8% vs. 53.8%) and rural (44.5% vs. 35.6%) areas. While urban participants had higher leisure time PA, rural participants had higher work- and travel-related PA. The high prevalence of insufficient PA found in this study shows that targeted interventions are needed to reduce insufficient PA, especially for women and urban populations.(Devamani *et al.*, 2019)

This study was aimed to explore the prevalence, patterns and associated factors of physical activity in university students. A total of 255 students were interviewed using IPAQ long form. In the overall sample, Walking was identified as a major contributor in females while vigorous activity contributed maximally in males. The Leisure-time domain

was observed as major contributor and work domain was the least contributor to the total PA levels. (Singh& Singh2017)

A cross-sectional study was conducted to assess the level of physical activity among 240 residents aged between 15 and 65 years in Kulappuram, a village in north Kerala. Low level of physical activity was seen in 65.8% of the study participants. The average duration of moderate to vigorous intensity physical activity per day in different domains such as work, travel, and recreation were 40.5, 10.1, and 12.7 minutes, respectively. The study concludes that the physical activity level was low in the study population.(Asleshet *al.*, 2016)

A household survey was done in the state of Punjab, India in a multistage stratified sample of 5127 individuals using the WHO STEPS questionnaire. The results showed that there was no significant urban rural difference noted in both sexes in all three domains of physical activity such as work, transport and recreation. However, rural females (19.1 %) were found to be engaged in vigorous activity more than the urban females (6.3 %). Males reported high levels of physical activity in both the settings. Higher prevalence of obesity (asian cut offs used) was seen among urban females (34.3 %) as compared to their rural counterparts (23.2 %). Abdominal obesity was found to be significantly higher among females in both the settings compared to males. Rapid urbanization of rural India might be responsible for the absence of a significant urban rural difference. (Tripathy *et al.*, 2016)

This is a cross-sectional study conducted among 267 adults from a rural area of Kancheepuram District in Tamil Nadu, South India. Overall prevalence of insufficient physical activity among adults in a rural area of South India was 22.5% and the prevalence of sufficient physical activity was 77.5%. Among overall physical activity, major contribution was from work (75%) followed by transport time activity (18%) and the least by leisure-time physical activity, which was only 7%. With increase in age, level of adequate physical activity was decreasing. In a rural area of South India, the physical activity was contributed majorly by work domain and least by other domains. Leisure-time physical activity in rural community was poor and to be encouraged in future by community interventions. (Newtonraj *et al.*, 2019)

A cross sectional study was conducted among adults 20-60 years age-group in rural and urban field practice areas of a medical college in Puducherry by simple random sampling method to select 237 individuals from each area. The level of physical activity was analysed using the global physical activity questionnaire. Among the study population, 61.39% belong to low physical activity level. The prevalence of obesity seems to be lower among the people who practice simple day-to-day habits such as walking and usage of bicycles as evidenced from this study. (Kamath, 2017).

A study was done to estimate the prevalence and levels of common risk factors for non-communicable disease in a rural population of Haryana. This study involved a survey of 1359 male and 1469 female respondents, aged 15-64 years. WHO STEP-wise tools were used as the study instrument which included behavioural risk factor questionnaire and physical measurements of height, weight, waist circumference and blood pressure. The study showed a high burden of tobacco use and alcohol use among men, inactivity and overweight among women and low fruit and vegetable consumption among both sexes in rural areas. (Krishnan *et al.*, 2008)

The present study was conducted on a total of 520 subjects randomly selected from general population of district Amritsar in Punjab in the age group of 20-50 years, divided into urban (130 men and 130 women) and rural (130 men and 130 women) population. Physical activity levels were assessed by general physical activity questionnaire. Results of this study showed that significant decline in waist circumference (WC), body mass index (BMI) and mean arterial pressure was observed in physically active population as compared to the sedentary life style population. (Mittal *et al.*, 2011)

A survey was done in urban, urban slum and rural population of Haryana, India, in a sample of 4129 men and 3852 women using WHO STEPS questionnaire. Rural men reported five times physical activity as compared with urban and urban slum men and rural women reported seven times physical activity as compared with women in the other two settings. Urbanization increases the prevalence of the studied non-communicable disease risk factors, with women showing a greater increase as compared with men. (Yadav & Krishnan, 2008)

The aim of this study was to assess physical activity patterns across India - as part of the Indian Council of Medical Research-India Diabetes (ICMR-INDIAB) study. Phase 1 of the ICMR-INDIAB study was conducted in four regions of India (Tamilnadu, Maharashtra, Jharkhand and Chandigarh representing the south, west, east and north of India respectively) with a combined population of 213 million people. Physical activity was assessed using the Global Physical Activity Questionnaire (GPAQ) in 14227 individuals aged  $\geq 20$  years [urban- 4,173; rural- 10,054], selected from the above regions using a stratified multistage design. Males were significantly more active than females. Subjects in all four regions spent more active minutes at work than in the commuting and recreation domains. The study shows that a large percentage of people in India are inactive with fewer than 10% engaging in recreational physical activity (Anjana *et al.*, 2014)

#### **D. Measures for Prevention of Dual Nutrition Burden**

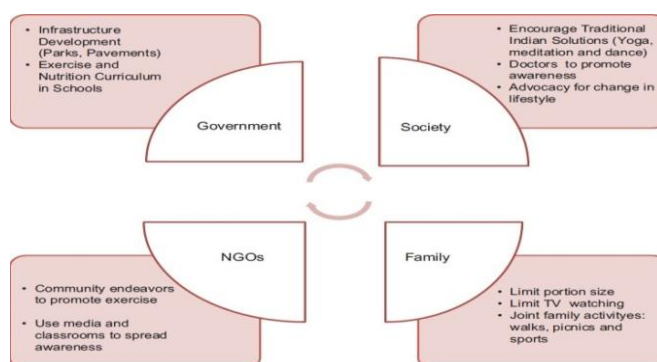
Appreciable prevalence of obesity, dyslipidaemia, diabetes mellitus, substantial increase in body fat, generalised and regional obesity in middle age, particularly in females, need immediate attention in terms of prevention and health education. A timely prevention will reduce the burden of many chronic co morbidities, like diabetes, cardiovascular diseases, hypertension, and infertility on the health system in India.

The epidemic of obesity needs to be tackled at several levels: the individual level, the community level, and the government level (Unnikrishnan *et al.*, 2012). To prevent increasing morbidity and mortality due to obesity-related T2DM and cardiovascular disease in developing countries, there is an urgent need to initiate large-scale community intervention programs focusing on increased physical activity and healthier food options, particularly for children. International health agencies and respective government should intensively focus on primordial and primary prevention programs for obesity and the metabolic syndrome in developing countries (Misra & Khurana, 2008).

Prevention of obesity is likely to be most effective when implemented in the childhood itself. Guidelines have been laid down by the WHO (2006) for formulating national policies to meet these challenges. For prevention of obesity, overweight and its related health risks, population-based strategies to improve social and physical

environmental contexts of healthy eating and physical activity are essential. Both physical activity and nutrition must be addressed to reduce the prevalence of obesity and improve health. People need to be educated for improving their life style and should be motivated to develop healthy life style as well as healthy diet for improving their nutritional as well as health status (NNMB Urban Nutrition Report). Awareness regarding the impact of fried and fast food on health could be spread among general populations (Nagendra&Belur, 2016)

Data from national surveys shows that affecting energy balance by 100 kilocalories per day (by a combination of reductions in energy intake and increases in physical activity) could prevent weight gain in most of the population. This can be achieved by small changes in behavior, such as 15 minutes per day of walking or eating a few less bites at each meal. Having a specific behavioral target for the prevention of weight gain may be key to arresting the obesity epidemic. (Hill *et al.*, 2003)



**Figure 10: Prevention of Weight Gain at Different Stake-Holder Level**Source: (Unnikrishnan *et al.*, 2012)

Anjana *et al.*, 2014 mentioned that eating a healthy diet can help in preventing obesity-

- Limit total fat intake and shift fat consumption away from saturated fats to unsaturated fats and elimination of trans fats.
- Increase consumption of fruits, vegetables, pulses, whole grains, legumes and nuts
- Limit intake of sugar and salt

WHO 2006 has recommended that food industry can play a significant role in promoting healthy diets by:

- reducing the fat, sugar and salt content of processed foods;
- ensuring that healthy and nutritious choices are available and affordable to all consumers;
- Restricting marketing of foods high in sugars, salt and fats, especially those foods aimed at children and teenagers; and ensuring the availability of healthy food choices and supporting regular physical activity practice in the workplace. <https://www.nhp.gov.in/disease/non-communicable-disease/obesity>

#### Policy War against Over-Nutrition and Obesity

- Physical activity should be promoted, providing basic structures for physical exercise, physical activity in the school curriculum, promoting activities like yoga in the context of body and mind care, and in managing overweight and obesity in particular
- Nutrition education should be strengthened at all levels and for adults as well as children
- The sale and supply of fresh products should be promoted
- Regulations on the content of processed food, in particular regarding additives, should be strengthened
- Trade policy formulation should be more inclusive of health considerations
- Taxes should be imposed on processed food,
- Advertising of unhealthy food items to children should be restricted
- Marketing should take better into account health considerations, which could be done by providing smaller food portions and using clear food labelling.
- Public awareness campaigns and the promotion of healthy diets should be reinforced. (<http://www.fao.org/3/a-bl634e.pdf>)

Vaderaet *al.*, 2010 concluded that preventive measures should be specifically targeted to Indian women. Independent risk factors for metabolic syndrome included increasing age, female gender, sedentary lifestyle and diabetes mellitus in parents. Apart from that, Sleep debt has a harmful impact on carbohydrate metabolism and endocrine function. Sleep debt may increase the severity of age-related chronic disorders.

Figure 11 depicts the association of Dual Nutrition Burden and Risk of Non Communicable Diseases

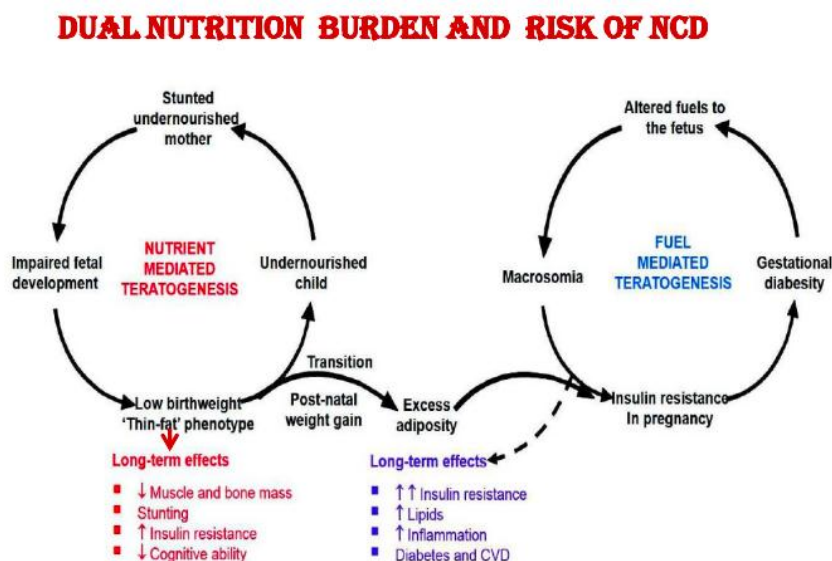


Figure 11: Dual Nutrition Burden and Risk of NCDs

Source: <https://nams-india.in/downloads/CME->

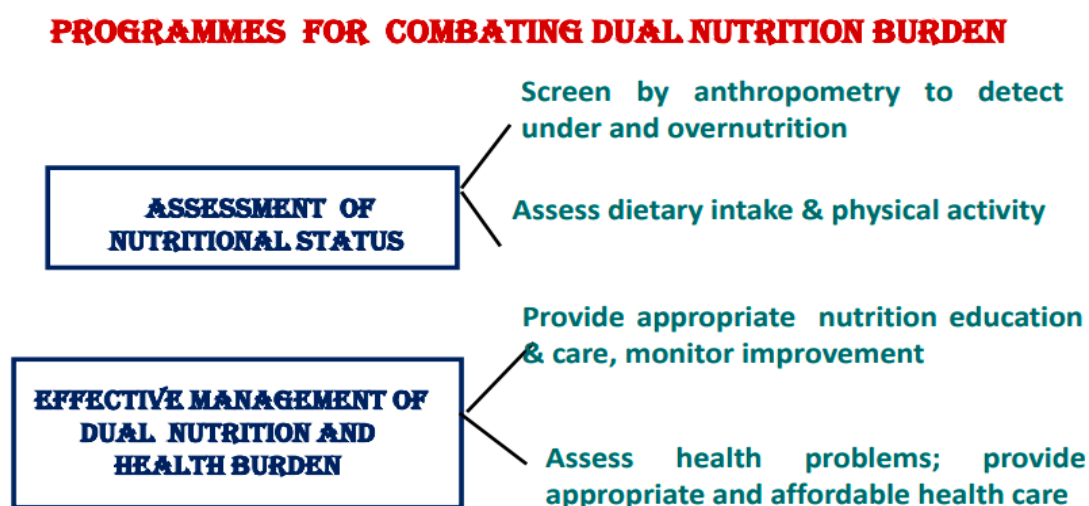
Approximate relative risk of physical health problems associated with obesity.

Relative risk >3	Relative risk 2-3	Relative risk 1-2
Type II diabetes	Coronary heart disease	Cancer
Gallbladder disease	Hypertension	Reproductive hormone abnormalities
Dyslipidemia	Osteoarthritis	Polycystic ovary syndrome
Insulin resistance	Hyperuricemia and gout	Impaired fertility
Breathlessness		Low back pain
Sleep apnea		Increased risk of anesthesia complications
		Fetal defects (associated with maternal obesity)

(Source: World Cancer Research Fund/American Institute for Cancer Research, 2007)

Figure 12: Low Physical Activity and Obesity as Contributing Factor to NCDs

Asian populations are lean when compared with western population. However, the association between BMI and glucose intolerance is as strong as in any other population. Studies in India and other Asian populations have shown that a BMI of  $\geq 23$  kg/m<sup>2</sup> is associated with risk of diabetes. The World Health Organization (WHO) has recommended that BMI of 18.5–<23 kg/m<sup>2</sup> is healthy for Asians. The major NCDs include cardiovascular diseases (including stroke), diabetes, cancer, chronic obstructive pulmonary diseases, mental health, and injuries are the leading cause of morbidity and mortality around the world. Lack of physical activity is recognized as a major modifiable risk factor of these diseases. Demographic changes, changes in the lifestyle along with increased rates of urbanization, Tobacco, alcohol, diet, physical inactivity, high blood pressure, and obesity are the major reasons responsible for the tilt towards the non-communicable diseases. A higher prevalence of diabetes and CVD specially in women could be attributed to these features. Visceral fat is also a risk factor for dyslipidaemia and is also associated with insulin resistance. A study by the authors in Asian Indians showed that subcutaneous fat also was associated with insulin resistance. While considering the global burden of non-communicable diseases, India contributes a major share (Gupta *et al.*, 2017)



(Source: <https://nams-india.in/downloads/CME->)

**Figure 13: Programmes for Combating Dual Nutrition Burden**

Strategies to Combat Under Nutrition are highlighted in the aspect of Improved Health Care System. Infections like malaria, measles and diarrhea are prevalent in our society and they precipitate acute malnutrition among children and infants. A good health care system that provides immunization, oral rehydration, periodic deworming, early diagnosis and proper treatment of common illnesses can go a long way in preventing malnutrition in the society. Providing Suitable Personalized Nutrition Education and Nutrition supplementation (Source: <https://vikaspedia.in>)

Strategies to Combat Over-Nutrition are mentioned that the steep emergence of overweight/obesity poses great challenge to healthcare providers and policymakers. Effective implementation of programmes is required before overweight/obesity becomes a more widespread epidemic (Shannawaz & Arokiasamy, 2018)

There is an urgent need to recognize the gravity of this emerging health problem and incorporate obesity in the general health system. Obese women should be given special attention by health providers and policy makers. In the era of growing urbanisation and migration, the traditional focus on under nutrition among women in India should be expanded to encompass all aspects of malnutrition which includes over nutrition, i.e., overweight and obesity. A healthy lifestyle should be promoted to tackle this emerging health threat. Immediate efforts are needed at a national level to control this problem among women in India (Agrawal & Agrawal, 2012)

In a paper it was highlighted that an utmost need for the use of disaggregated urban data and addressing nutrition inequities among women in urban India, which go unnoticed owing to the use of urban aggregate data at all levels. Given the high levels of undernutrition in women in the poorest urban quartile, it is suggested that the following may be done: (i) routine screening of women who are undernourished or suffer from three key micronutrient deficiencies, using field-based methods and instituting corrective measures; (ii) improving access to food subsidy through Public Distribution System (PDS) via better access to card-holders living below poverty line (BPL) or alternative approaches that are being currently debated or piloted; (iii) free distribution of iodized salt to pregnant women during health and nutrition days and/or universalizing its subsidy through PDS; (iv) institutionalizing nutrition and health counselling for mothers, using approaches

involving fixed day, time, and venue and monitoring their coverage and quality for promotion of services and consumption of micronutrient-rich foods; and (v) resetting strategies for improving compliance to iron folic acid tablets and testing efficacy of strategies for alternative micronutrient food-based supplementation, including the strengthening of measures to prevent intestinal infections. (Agarwal&Sethi, 2013)

### **Recommendation**

Dual Nutrition Burden both Over and under Nutrition is the major global health challenge of the 21<sup>st</sup> Century. Adult women are the most vulnerable population. People need to be educated on the benefits of healthy lifestyle and healthy dietary habits as it enables the prevention of non communicable diseases and promotion of over all health. (<http://nin.res.in>)