Diversity of Overweight and Obesity across Indian states – How should policy makers approach this growing disparity

Contents

Introduction

Background

The challenges of addressing the growing dual burden of malnutrition has concerned the Indian health administration in the recent decades. Post-independence, India's challenges about malnutrition was primarily "undernutrition" (which appears to have a gradual yet substantial progress) but the recent decades of rapid economic growth and globalisation has resulted in new challenges due to the rising trends of Overweight and Obesity (O-O), both in urban and rural India (NFHS-3, 2006; NFHS-4, 2016). The proportion of Indian obese population has nearly doubled in 10 years (NFHS-4, 2016). Similar prevalence of O-O has also been noticed for childhood and adolescent population at 19.3% based on the pooled data after 2010 to 2015, which is a significant increase from the earlier O-O prevalence of 16.3% reported in 2005 (Mohan et. al, 2016). This recent shift towards the other end of malnutrition spectrum, both among the young children and adult population has emerged into a major public health crisis with tsunami of diet related NCDs across many Indian states.

Obesity pandemic displays multi-dimensional aetiologies (a mixed bag of biological, social, technological, economic and behavioural factors). As we can't just reverse all the causes of obesity to slow down the alarming growth rate, understanding these causes and going upstream before it evolves is crucial to implement effective interventions (John Crawly, JHE, 2015). Increase in disposable household income and socio-economic conditions of Indian states coupled with disruptive changes in perception and behaviours in lifestyle and food consumption patterns in general is having a significant impact on the overall health and well-being (Tanumihardjo et. al, 2007; WHO, 2006).

Robust a high quality social science datasets is fundamental in understanding the undercurrents of this crisis. In India, the demographic and health surveys are carried out almost every 10 years over the last 3 decades. The National Family Health Survey (NFHS) is a multi-round, large-scale survey performed throughout India on a representative sample of households. There have been four rounds of surveys with the recent one being concluded for the 2015-2016 period. These surveys provide information at state and national levels on family planning practices, infant and child mortality, fertility, maternal and child health, nutrition, reproductive health, anaemia, and quality of health. The International Institute for Population Sciences, Mumbai (IIPS) has been designated

as the nodal agency by the Ministry of Health and Family Welfare (MOHFW) to provide coordination and technical guidance for the surveys. Technical assistances required for the surveys is mainly provided by ORC Macro (USA). The funding for conducting these surveys are provided by DFID, USAID, the Bill and Melinda Gate Foundation, UNFPA, UNICEF and MOHFW, Govt. of India (adapted from http://rchiips.org/nfhs/). Researchers have used this survey data to analyse and understand the potential causes that have a significant impact on an individual's overall health, including the effects on overweight and obesity. However, in the Indian context, there seems to be a lack of research on how these findings can be used to address the health issues associated with obesity and overweight and in guiding the policy makers to design tools that can reduce the growing regional as well as gender disparities to efficiently contain the O-O related health adversities and improve the health outcomes at an aggregate national level.

Objective of the Study

The current research study quantifies and assesses the disparities among the Indian states with respect to O-O prevalence. It also gives insights into the significant disparities between the O-O prevalence between male and female populace, and across the different regions within the Indian sub-continent. This study attempts to describe an application based approach to the decision makers to target the essential levers influencing O-O for policy formulation. While it is important to understand the strength of associations of the drivers for overweight and obesity among the rural and urban individuals, identifying the magnitude and potential reasons for variations in the O-O prevalence rate across the states seems essential in Indian context.

This research work intends to conduct an analysis of the O-O measure of the Indian population and the rising trend over the last decade and to analyze the significance of the risk factors influencing the O-O prevalence separately for male, female, urban and rural populations. Using the latest information of the survey data which is a representative database of the Indian population, this analysis will help to understand the significance of some of the risk factors influencing the O-O prevalence.

The strategies to minimize the geographical disparities in prevalence of O-O and to reduce the burden of weight related NCDs is vital to improve the overall health outcomes across the nation. Given the dynamics of the multidimensional factors causing O-O and huge socio-cultural differences across regions a “one size fits all” national policy approach may not be the most effective method in tackling the O-O related burden across Indian states. Intuitively, having better understanding of regional variations and the residents access to information about the problems of O-O at state level, a targeted ‘factors’ specific approach by government at state levels appears logical to slow down the rapid growth rate of O-O. Therefore, an innovative tool to engage the states in a competitive yet participatory way to reduce the disparities in O-O prevalence is proposed in the way of an “obesity scorecard” to the national health policy makers. Such a tool in the form of obesity scorecard will therefore help to visualize the relative magnitudes in the regional variations in O-O prevalence and monitor the response to the targeted policies. By measuring and sharing the impact and potential incremental progress because of targeted social, health and economic policy interventions incentivizes the states for an improved engagement with the federal government and provides a good understanding of what works in individual states. This is vital

particularly in context to the O-O associations with rapid increase in morbidity and higher rates of mortality from weight related chronic conditions such as diabetes, liver diseases, hypertension and other cardiovascular diseases (Flegal, 2013).

Literature Review

The health issues surrounding O-O have become “a major global crisis affecting at every level; individuals, families, societies, economies, health care systems and nation as whole” (Sunyer, 2016). Worldwide, around 1.9 billion adults are overweight and more than 600 million adults are obese in 2015(WHO; Policy brief 2016). O-O is responsible for significant suffering and deaths as it predisposes individuals to diabetes, stroke, hypertension, musculoskeletal disorders and other weight related heart, liver diseases and malignancies (Antwi, 2012; WHO, 2017). Although the causes and drivers of this obesity pandemic is multifarious, there are some common triggers affecting different populations across and within countries. Studies from the EU region show that there is considerable country to country variation of over 10% for the O-O prevalence, and such variation suggests a pattern of differential distribution of risk factors as well as separate factors in different countries (Blundell et al., 2017). From a gender perspective; in 138 out of 194 countries, women are 50% more likely to be O-O compared to men (WHO Global InfoBase: Obesity and Overweight, available at http://www.who.int/topics/obesity/en/).

The O-O prevalence among women in Sub-Saharan African countries is particularly high (Martorell et al., 2000). Though it is difficult to ascertain the absolute reason for rising O-O, some of the known attributable environmental factors are commercialization of food industries, easy access to cheaper unhealthy foods, excess intake of energy-dense foods and lack of adequate physical activity largely due to advancing technology and changing lifestyles (Prentice, 2006; Sinha and Kapoor, 2010).

Until last couple of decades, O-O problems were regarded as problems of the rich and developed nations. However, this is now growing at much faster rate in developing countries due to rapid globalization, urbanization and economic freedom with increase in disposable incomes. Thus, a much complex dual burden of malnutrition has now evolved into a major public health crisis in these developing economies and calls for desperate and effective actions (Kennedy, Nantel and Shetty, 2006). Many researchers and academicians have attributed this growing crisis in both developed and developing countries to nutritional transition. (Popkin, 2006; Ramachandran et al, 2008). There is a significant positive relationship between the economic status of households to the composition of food consumed. Thus, families with higher household incomes are likely to adopt sedentary lifestyle and resort to energy-dense foods (International Union of Nutritional

Sciences, 2013; Lawlor and Chaturvedi, 2006). This is shown in the case of China, where increasing GDP per capita is linked to rapid rise in intake of energy dense foods and manifestation of other food consumption related behaviors over the past few decades (Parizkova et al, 2007). In addition to changing food consumption patterns, lifestyle changes from reduced physical activity due to improved motorized transport, mechanization and automation at work, and habituated TV viewing for long hours have all resulted in positive energy accumulation in people thus causing weight gain even in the Indian context (Gopalan, 1996; Vijayalakshmi et al, 2002; Ramachandran et al, 2004). Also, the introduction of newer technology in many sectors have improved productivity and efficiency resulting in lowering the prices. However, like other developing nations, India is still trying to solve its ongoing challenges of undernutrition and anemia over last many decades.

This double burden of malnutrition is now a reality and ubiquitous particularly in rapidly developing low and mid-income countries. In India, while there are many international and national programs to address undernutrition and its related consequences among the vulnerable and deprived sections of the population, the alarming rise in O-O prevalence and its associated overall health consequences has become socially and economically disruptive (Bhadra, Mukhopadhyay and Bose, 2005; Ziraba, Fotso and Ochako, 2009). The numbers are even more alarming among the female population compared to the male. There was 18.6% obese adult male population in 2016 against 9.3% in 2006, and 20.7% of adult females were obese in 2016 against 12.6% in 2006 (NFHS-4, 2016). Given that global gender disparities in obesity exist (Popkin et al, 2012), gender specific or gender-tailored solutions may be necessary if the global obesity pandemic is to slow down. It is also noticed that there is a distinct difference in the obesity burden between the different strata of society and among the rural and urban regions (Montgomery, Gragnolati and Burke, 2000; United Nations, 2011). Consequent to the rapid increase in unplanned urbanization, intra-urban disparities in socio economic status is rising and so are the inequalities in health standards (Census of India, 2011).

Over the past few years, many initiatives have been adopted by the governments to mitigate obesity risks in their respective countries and this remains insufficient. In case of Mauritius, a national action plan was launched during 2011-2014 for encouraging physical activity (Nugent, 2008). Some countries from the EU region and the US have undertaken the practice of publishing a

nutrition and physical activity plans and follow through the impact realized from those initiatives (Levi et al, 2008). The United States Department of Agriculture concluded that despite the provision of food assistance programs for the low socio-economic status individuals, studies have shown that these programs were not successful in curbing obesity (Hammond and Levine, 2010). Although obesity is largely a personal responsibility, other exogenous factors of environmental and economic policy changes are also key influencers of obesity prevention (WHO Expert Consultation, 2004). The Indian Government has taken the first step to implement the Global Monitoring Framework on NCDs in line with WHO's "Global Action Plan for the prevention and control of NCDs 2013-2020" (WHO, 2015). Encouragingly, India is the first country in the world to develop national targets and indicators to reduce premature deaths from NCDs by 25% by 2025 (WHO, 2015). The new Indian Government has decided to address the surge in NCDs by acting swiftly and by targeting the greatest risk factors leading to NCDs such as physical inactivity, tobacco and alcohol use, air pollution, and unhealthy diets (Bachani, 2017).

Research Methodology

Data Sources

This research study uses a representative dataset for India from the National Family Health Surveys; NFHS-3 and NFHS-4, conducted during the periods of 2005 to 2006 and 2015 to 2016 respectively. NFHS-4 comprises a representative sample of 699,686 women in the age group of 15-49 years and 103,525 men aged 15-54 years across the 36 states and union territories in India. Whereas, the NFHS-3 dataset covers a representative sample of 74,369 males and 124,384 females for 29 states. The complete survey data of NFHS-3 for 2005-2006 and the facts sheets of all the data points giving a snap shot information of NFHS-4 survey are available on NFHS website. A detailed report for NFHS-4 survey is due to be published by the year end.

Information on some of the economic indicators such as Gross State Domestic Product per capita (GSDP) and Gini Coefficients are also included in our analysis. GSDP and Gini coefficient data were obtained from www.Knoema.com, an online metadata platform. They liberate data from various databases and other data silos that are in possession of various agencies including WHO, World bank, IMF, Eurostat etc. This provides various data-driven tools to researchers to analyze or report. They have resourced some of the economic data used in this research from Govt of India's National Account Statistics database.

Research Methods

The state-level summaries of the 2015-2016 survey data gives a snapshot of the health, economic and social measures of the Indian households, with each measure depicted as a proportion of the population. For example, at a national level, for the survey parameter: Women who are overweight or obese that is BMI $\geq$ 25, the value is shown as 20.7%, which means that 20.7% of the respondents surveyed have been found either overweight or obese. With the available state-level data summary for NFHS-4, it was evaluated if there are significant disparities in O-O prevalence, between rural versus urban population, between male versus female population and between the states and their dispersion from the national average.

A multi-variate regression analysis using the O-O prevalence rate as the dependent variable against several independent variables; Literacy rate, Sex ratio, few lifestyle and socio-economic

parameters is carried out. Correlation analysis is also carried out to estimate the relationship of O-O prevalence and certain measured weight dependent NCDs like Diabetes and Hypertension. The technique of Cluster Analysis will be applied for the states to categorize them into three groups based on severity of O-O prevalence.

Finally, using each of these parameters, the states are ranked based on their performance in each category of the measured socio-economic and socio-cultural parameters. From this, a score card is designed with an intention to understand the relative position of a state vis-à-vis others and a dynamic representation of facts to identify the factors behind variations in the rates of O-O as well as encouraging aggressive policy interventions and understanding their impacts based on the states performances to reduce the burden.

Analysis and findings of the study

Comparison of survey results – NFHS4 vs. NFHS3

At first, the states' burden of obesity in 2015-2016 compared to the representative data from 2005-2006 is evaluated. 6 Union territories; Andaman and Nicobar Islands, Chandigarh, Daman and Diu, Dadra and Nagar Haveli, Lakshadweep, Pondicherry and 2 states; Andhra Pradesh and Telangana (recently split into two different states) are included in this analysis due to missing NFHS-3 data. Figure 1(a) gives a snapshot of how the states' O-O burden looked like a decade ago (2005) from now compared to the national average of 12.6% and 9.3% for the female and male population respectively. For majority of the states, the percentage of O-O female population is higher compared to male which is in line with global trend.

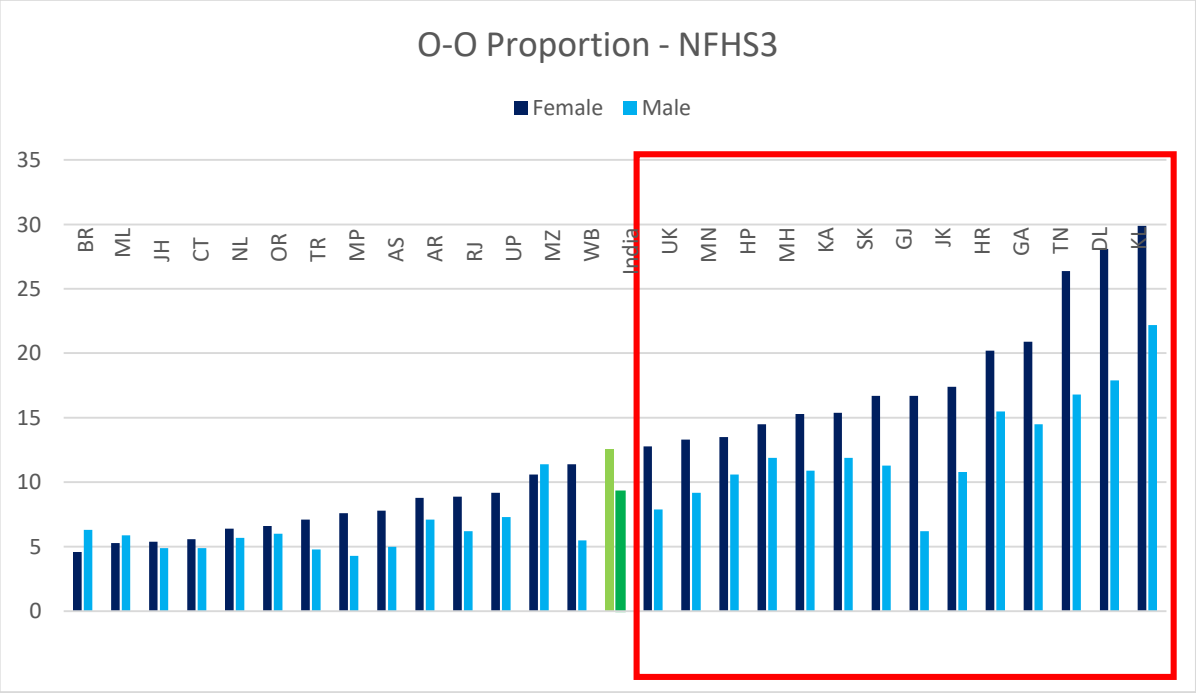


Fig. 1(a): O-O Burden for Indian states from NFHS3 dataset

belongs to Sikkim with a male O-O proportion of 34.8% and 11.9% in 2015 and 2005 respectively. We will look closer at these state level disparities in the coming section

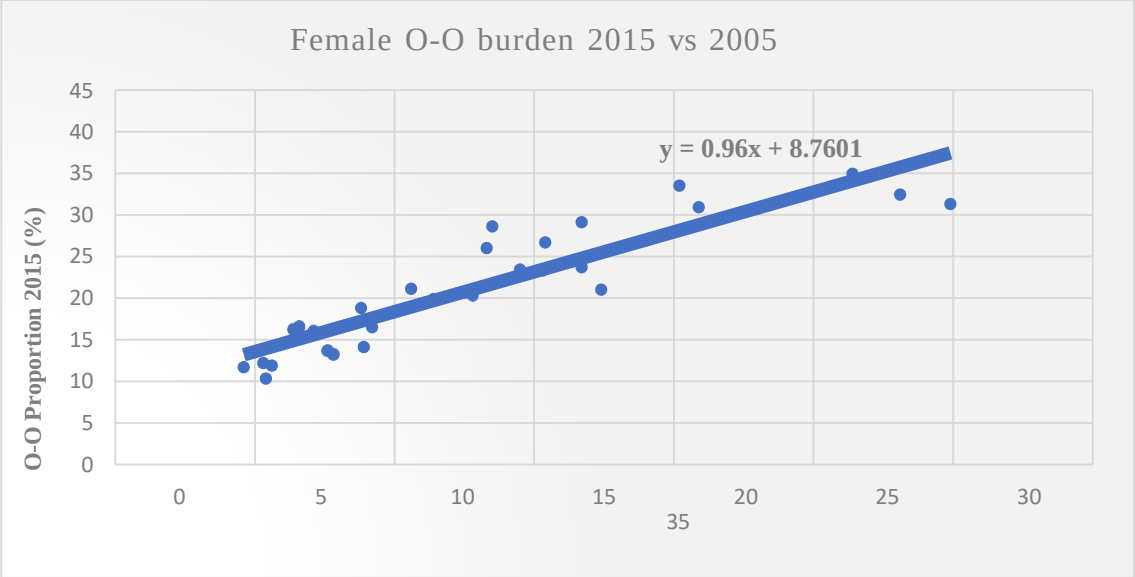


Fig. 1(b): Female O-O Burden of Indian States: 2015 against 2005

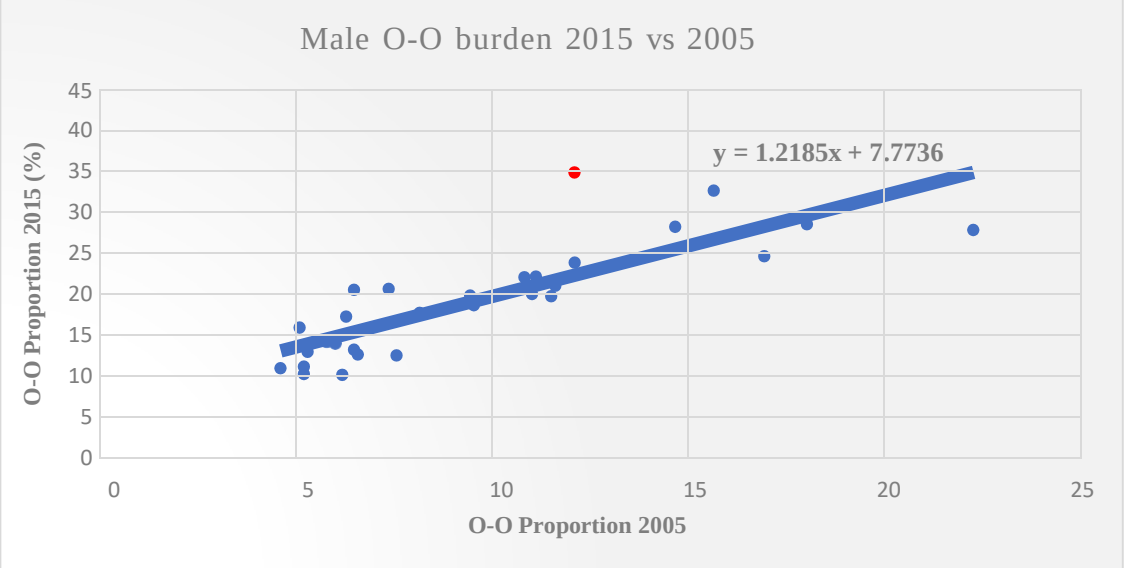
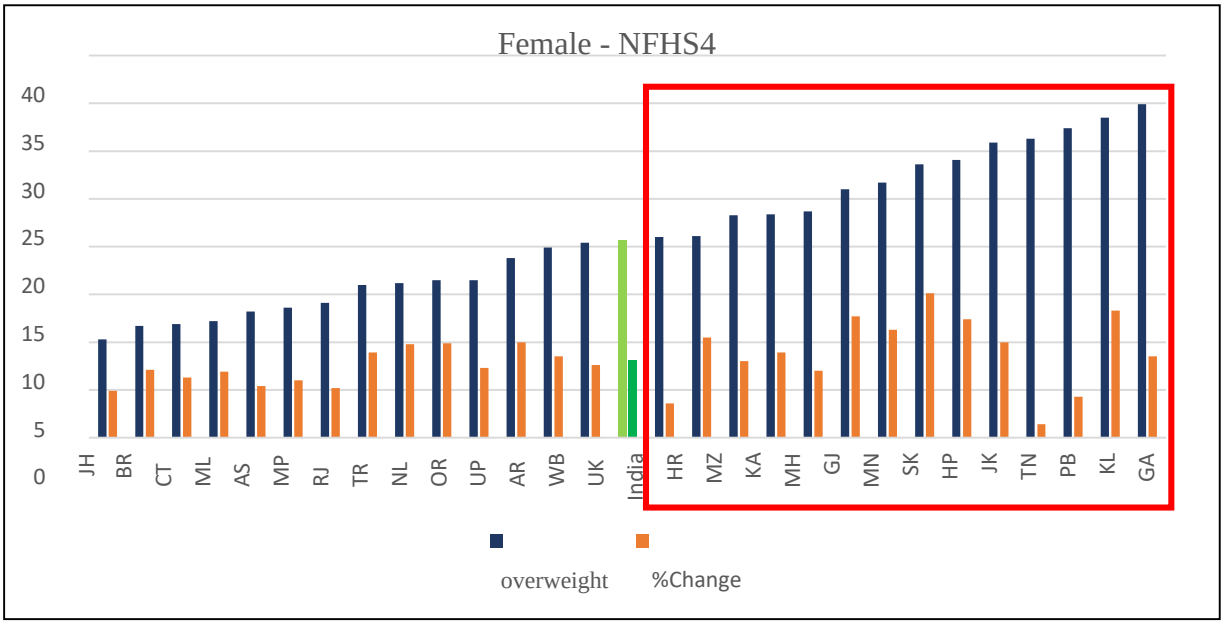


Fig. 1(c): Male O-O Burden of Indian states: 2015 against 2005 data

Disparities in the O-O prevalence among the Indian states

The subsequent figures 2(a) and 2(b) represent the current O-O burden in different Indian states based on the NFHS4 survey data and the % change in the O-O burden over last decade. A variable rate of % changes is seen across the states with some states with high prevalence showing a slowdown in the pace of rise in O-O compared to other states in the last 10 years.

Fig. 2(a): O-O Burden and %change from NFHS3 for female population



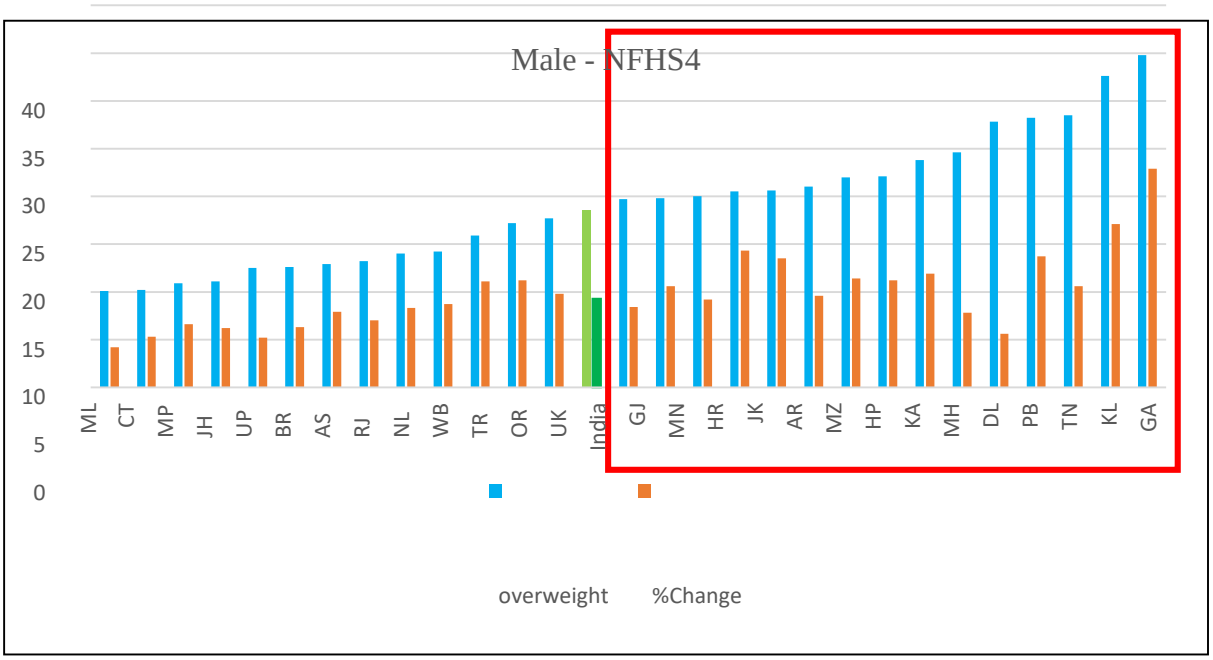


Fig. 2(b): O-O Burden and %change from NFHS3 for male population

The min and max for the Indian states' NFHS4 O-O prevalence and their standard deviation is shown in Table 2.

Table 2: Disparities in Indian States for O-O prevalence in 2015

	Min	**Max**	**Std. Dev**
Male	10.1	38.2	7.99
Female	10.3	41.5	8.69

Such a high spread value and standard deviation from the above table suggests that there are significant disparities among the Indian states in O-O prevalence. Distinct behavior was also noticed for male and female populations and hence they should be targeted separately. We have statistically tested this hypothesis using z-test which suggested in accordance to past results of significant disparity between male-female populations. Please refer Appendix I to consult with the results of z-test. We therefore approach the state-wise disparity separately for male and female population, for all our analysis and for building the scorecard.

Cluster Analysis

The next exercise is to categorize the Indian states based on their current O-O proportion and its change from NFHS-3 survey conducted 10 years back. The k-means clustering technique was used for this analysis to categorize the states into three clusters – High, Medium and Low, based on the degree of threat of O-O in these states, and separately for Female and Male population. For this, each state's measure is a 2-dimensional feature vector – O-O proportion and Change in O-O proportion from last survey. The states with bold letters in both genders remain in the same threat category.

Table 3(a) and 3(b) below show the outcome of the cluster analysis.

Table 3(a): Categorization of Indian states based on their level of O-O threat for Female Population

Cluster Name based on O-O Threat	**Name of States**
High	Delhi, Manipur, Himachal Pradesh, Jammu and Kashmir, **Goa**, **Kerala, Punjab, Sikkim, Tamil Nadu**
Medium	**Arunachal Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Mizoram, Uttarakhand, West Bengal**
Low	**Assam, Bihar, Chhattisgarh, Jharkhand, Meghalaya, Madhya Pradesh, Nagaland, Rajasthan, Tripura, Uttar Pradesh**, Orissa,

Table 3(b):

Categorization of Indian states based on their level of O-O threat for Male Population

Cluster Name based on O-O Threat	Name of States
High	**Goa, Kerala, Punjab, Sikkim, Tamil Nadu**
Medium	Delhi, Manipur, Himachal Pradesh, Jammu and Kashmir, **Uttarakhand, Arunachal Pradesh**, **Gujarat, Haryana, Karnataka, Maharashtra, Mizoram, Orissa.**
Low	**Assam, Bihar, Chhattisgarh, Jharkhand, Meghalaya, Madhya Pradesh, Nagaland, Rajasthan, Uttar Pradesh, Tripura,** West Bengal

Regression Analysis

To assess the impact of several parameters on the outcome variable of O-O proportion, a multi-variate regression analysis is carried out. The outcome variable is the O-O proportion. The independent variables are Gini Coefficient, Gross Sate Domestic Product (GSDP) per capita, Use of Iodized Salt, Literacy Rate, Tobacco and Alcohol consumption. The variables of Gini coefficient and GSDP per capita represent the socio-economic status for the states. Gini coefficients are available separately for Rural and Urban economic status for the states, and GSDP per capita are published at a state level only. Tobacco and Alcohol consumption are lifestyle patterns. The parameter of literacy rate represents the demographics of the Indian states.

We will first conduct an overall regression analysis on the entire sample dataset irrespective of gender and economic status i.e. rural or urban status of the sample data. Next step will be to look at the impact of parameters separately for male, female population and rural and urban samples. We can then deduce the relationships of the predictor variables on the outcome parameter. The outputs of the regressions are included in Appendix I. Table 4 summarizes the results of the regression analysis.

Table 4: Regression results summary

Parameters	Overall	Rural	Urban	Male	Female
Iodized Salt	-0.2502***	-0.3556*	-0.5847***	-0.1142***	-0.5490**
Literacy rate	0.6093*	0.4301*	0.3608***	0.5739*	0.6945*
Tobacco Use	-0.3432*	-0.3120*	-0.2618*	-0.3322*	-0.5977**
Alcohol Use	0.0440	0.0877	0.0735	0.0570	0.2849
Gini coefficient	-0.1197	-1.6757	-20.8988	--	--
GSDP per capita	-0.0114	--	--	--	--
Adj. R Square	**0.6534**	**0.3637**	**0.4605**	**0.5967**	**0.6497**

(Predictor variables are significant at *99% confidence level, **95% confidence level and ***90% confidence level)

The regression summary in the above table displays the impact of the predictor variables on the O-O burden. It shows the magnitude of impact on the outcome parameter as coefficients, their significance based on p-value and their nature of influence on the outcome based on the coefficient's positive or negative sign.

Correlation analysis for O-O and NCDs

We have earlier discussed that O-O is the cause for many weight related NCDs such as diabetes and hypertension. We therefore want to check their relationship with the help of correlation analysis. As there are multiple NCDs regarded to be a result of obesity hence regression analysis technique is not an appropriate method to be used when there are multiple dependent variables. We have available survey data for diabetes categorized as High and Very High levels of blood sugar, and Hypertension categorized into Above Normal, Moderately High and Very High. We therefore need to understand the correlation between these five parameters with that of O-O. The Pearson correlation coefficient, which takes a maximum and minimum value of 1 and -1 respectively suggest the degree of correlation between two parameters. A value of absolute 1 suggest perfect correlation, whereas a value of 0 suggest no correlation. The results of the correlation analysis is depicted in Table 5 below.

Table 5: Correlation results summary

	Blood Sugar		**Hypertension**		
	High	Very High	Above normal	Moderately High	Very High
Overweight	0.3313	0.4332	0.1572	0.1382	0.1042

Discussions and implications of the study

Findings of the study

The findings from this study depicts the significant levers of O-O among the adult Indian population. It also suggests that there is a significant gender disparity in O-O prevalence, as well as between the urban and rural population. The Indian states also shows significant variations in O-O prevalence with other states and with the estimated national average. Also, it's a widely-known fact that O-O has influence on increasing burden of weight related NCDs such as diabetes, hypertension and cardiovascular diseases etc.

Alcohol use is also a non-significant parameter. The other prominent parameters which have a significant influence are Use of iodized salt, literacy rate, and tobacco use. It also suggests that use of iodized salt and tobacco consumption negatively impact O-O. Use of iodized salt reduces various thyroid related health problems (Kennedy, Nantel and Shetty, 2006) and hence curb O-O but tobacco use has a negative impact on O-O as it causes certain NCDs such as respiratory problems, cardio vascular diseases etc. (Popkin, 2006; Ramachandran et al, 2008).Literacy rate is a significant factor of O-O and have a positive relationship with the O-O parameter. Such a correlation of literacy rate with O-O is due to urbanization and increase in income, thus encouraging the rural households with changing food consumption patterns. This relationship pattern is mainly noticed in case of low-income countries such as India (Cohen, Rai, Rehkopf and Abrams, 2013). However, in our NFHS data released by the authorities, the definition of literacy is not clearly mentioned. It does not say the years of schooling and education level for the literate population. In a study by Siddiqui and Donato (2016) on the NFHS3 dataset showed that there is an "inverted-U" curve relationship between the level of education and O-O proportion. This suggests that after a certain level of education, the O-O prevalence reduces with increase in academic level. The other socio-economic parameters of Gini coefficient and GSDP per capita at states level displays a negative relationship with the O-O prevalence. However, these two parameters are not very significantly influential. Household wealth quintile could be used as a better economic parameter to assess its impact on O-O (Siddiqui and Donato, 2015).

Score Card based on rankings of the Indian States

A visual representation of the O-O prevalence for the Indian states is drawn out from this work. Significant disparities in the O-O burden is seen among the states. These views were separately produced for male and female population. Both the samples showed disparities in O-O measure for the states as displayed in figures 2(a) and 2(b).

Understanding into how each of these states perform over time and the reasosn behind them is vital for the policy makers. States are separately ranked for the individual parameters of O-O proportion, Use of Iodized salt, Literacy Rate, Tobacco use, Alcohol consumption, Gini coefficient, and GSDP per capita. The logic for ranking the states is different based on the nature of the parameter. A state will receive a better rank compared to other states when individual parameters of O-O proportion, Sex Ratio Deviation, Tobacco and Alcohol consumption, and Gini coefficient is lower in value, as a lower value of these parameters displays a positive aspect. For the remaining parameters, such as Literacy rates, Use of Iodized salt and GSDP per capita, a higher value denotes a better situation for the states. The ranking for the states were done separately for the female and male population, as we noticed in Figure 1(a), there is a significant disparity of the O-O burden between the male and female population. It is therefore imperative for the states to take a different gender-specific stance. A derived parameter, O-O Threat, is also shown alongside the states' ranks to suggest which states pose an immediate threat of O-O increase in the future. As the O-O Threat combines both the impact of current O-O burden as well as O-O increase from last survey, hence it is suggestive which states need immediate intervention by the policy makers.

The below tables give a snapshot of the state rankings for each of the parameters and the associated O-O threat. The color coding depicts the relative position of a state vis-à-vis other states. A green color represents a good rank, amber is for the states around the 50^{th} percentile, whereas a red shade suggests the least performing states. Spaces where there is no data available is left blank.

Table 6: Ranks for each of the states based on individual parameters for female population

Female population	State Ranks for each of the parameter							
State Name	O-O	Iodized Salt Use	Literacy Rate	Tobacco Use	Alcohol Use	Gini	GSDP per capita	O-O Threat
Andaman & Nicobar	30	5	9	32	26	--	17	--
Andhra Pradesh	32	36	31	12	14	17	18	--
Arunachal Pradesh	12	6	29	30	37	--	16	Med
Assam	5	1	22	31	34	1	28	Low
Bihar	2	27	37	14	7	2	32	Low
Chandigarh	37	12	10	2	15	--	--	--
Chhattisgarh	3	9	28	13	31	--	21	Low
Daman & Diu	29	17	11	4	21	--	--	--
Delhi	34	15	13	8	17	3	2	High
Dadar & Nagar Haveli	13	37	32	10	1	--	--	--
Goa	33	21	4	9	29	--	1	High
Gujarat	21	23	21	24	12	6	7	Med
Himachal Pradesh	25	10	5	3	10	9	11	High
Haryana	17	32	20	7	4	19	6	Med
Jharkhand	1	16	35	19	28	4	30	Low
Jammu & Kashmir	26	22	25	16	5	5	19	High
Karnataka	19	34	23	18	19	7	8	Med
Kerala	31	13	1	5	22	20	9	High
Lakshadweep	36	19	2	28	2	--	--	--
Maharashtra	20	18	17	20	8	14	5	Med
Meghalaya	4	8	12	34	24	--	25	Low
Manipur	22	4	7	36	33	--	33	High
Madhya Pradesh	6	29	34	27	23	15	22	Low
Mizoram	18	11	3	37	32	--	14	Med
Nagaland	9	3	15	33	27	--	27	Low
Orissa	10	31	27	29	25	11	26	Low
Punjab	28	14	14	1	3	18	15	High
Puducherry	35	33	8	6	16	--	4	--
Rajasthan	7	28	36	21	6	16	23	Low
Sikkim	23	2	6	23	36	--	3	High
Tamil Nadu	27	35	18	11	13	8	10	High
Tripura	8	7	16	35	30	--	29	Low
Telangana	24	20	30	15	35	--	12	--
Uttarakhand	15	24	19	17	11	--	13	Med
Uttar Pradesh	11	26	33	25	9	12	31	Low
West Bengal	14	25	24	26	18	13	24	Med

Table 7: Ranks for each of the states based on individual parameters for male population

Male population	State Ranks for each of the parameter							
State Name	O-O	Iodized Salt Use	Literacy Rate	Tobacco Use	Alcohol Use	Gini	GSDP per capita	O-O Threat
Andaman & Nicobar	37	5	17	1	1	--	17	--
Andhra Pradesh	34	36	35	8	17	17	18	--
Arunachal Pradesh	19	6	26	31	37	--	16	Med
Assam	7	1	37	32	19	1	28	Low
Bihar	6	27	36	24	11	2	32	Low
Chandigarh	32	12	18	5	23	--	--	--
Chhattisgarh	2	9	21	27	34	--	21	Low
Daman & Diu	31	17	12	12	20	--	--	--
Delhi	27	15	15	10	9	3	2	Med
Dadar & Nagar Haveli	23	37	30	17	15	--	--	--
Goa	33	21	6	4	29	--	1	High
Gujarat	15	23	13	25	4	6	7	Med
Himachal Pradesh	21	10	4	19	26	9	11	Med
Haryana	17	32	11	14	8	19	6	Med
Jharkhand	4	16	34	23	24	4	30	Low
Jammu & Kashmir	18	22	20	16	3	5	19	Med
Karnataka	22	34	25	13	13	7	8	Med
Kerala	30	13	2	7	21	20	9	High
Lakshwadeep	26	19	1	6	2	--	--	--
Maharashtra	24	18	7	15	6	14	5	Med
Meghalaya	1	8	28	36	28	--	25	Low
Manipur	16	4	5	35	33	--	33	Med
Madhya Pradesh	3	29	32	30	14	15	22	Low
Mizoram	20	11	3	37	31	--	14	Med
Nagaland	9	3	23	34	22	--	27	Low
Orissa	12	31	27	28	25	11	26	Med
Punjab	28	14	19	3	16	18	15	High
Puducherry	36	33	8	2	27	--	4	--
Rajasthan	8	28	24	22	5	16	23	Low
Sikkim	35	2	9	18	32	--	3	High
Tamil Nadu	29	35	16	11	30	8	10	High
Tripura	11	7	14	33	36	--	29	Low
Telangana	25	20	29	9	35	--	12	--
Uttarakhand	13	24	10	20	18	--	13	Med
Uttar Pradesh	5	26	31	26	7	12	31	Low
West Bengal	10	25	33	29	10	13	24	Low

Conclusions

As per India's health statistics, NCDs in India have claimed more than 5.2 million deaths in 2008 (WHO, 2012). More than 80% of deaths from NCDs could be attributed to four diseases – cancer, respiratory problems, cardio vascular diseases and diabetes. The risk factors influencing these diseases are primarily tobacco and alcohol use, unhealthy food consumption, physical inactivity, hypertension, blood glucose level and overweight and obesity (Ramachandran, Snehalatha, Vijay, 2002; Ramachandran et al, 2008). India therefore in consultation with the stakeholders came up with its National NCD Monitoring Framework for the prevention and control of NCDs (NCD Monitoring Framework, 2013). This NCD Monitoring framework suggested ten primary parameters along with the assigned targets for 2020 and 2025 (Refer Appendix II). The Central Government of India has also realized the importance of engaging the different sectoral Governments for their intervention in preventing and controlling the risk factors influencing the occurrence of NCDs (Refer Appendix III).

Given the above observations, it's imperative for the Government to take measures to address the underlying risk factors influencing NCDs and devise policies to reduce these risk factors. Also, a "one size fits all" approach towards health policy making won't work, but more focused and newer policy instruments to overcome this hurdle is needed. This should be in alignment with the idea and understanding of the NITI Aayog's competitive co-operative federalism policy to allocate funds and create incentives for the states to share best practices and to improve performance (refer http://niti.gov.in/, for more details). Hence, the designed score card with the ranks of the states and separately for the male and female populations for the studied risk factors could serve as a useful tool for the Government to monitor the progress of its policy implementation and review the values against the set targets in 2020 and 2025. The O-O Threat rating in the score card can also aid the Government to take a focused approach for the more vulnerable states and hence can prioritize actions for states needing immediate attention. The results from the regression analysis could be used to weigh the significance of these risk factors influencing O-O burden and hence the weight related NCDs. These together can serve as a handy tool for the Indian Government to provide O-O targets to the States and use it for monitoring and performance rating purposes as India moves towards a more competent nation in the global atmosphere.

Thus, the usefulness of the score card could therefore be summarized as below:

- To serve as a handy tool to show the relative position of states against others for multiple number of parameters
- To easily educate the states on their current performance and to publicize among the state citizens about the current O-O prevalence. The O-O information is not very publicly available; hence the common citizens are not aware of the current statistics and its implications. Circulating such information with the help of this tool will empower not only the states but its citizens to take measure towards reducing the O-O threat.
- To be a transparent approach of incentivizing a state for performing well in certain measures, as well as encouraging to share best practices and improve on other parameters
- The new GST reforms also provide an upper hand to the Center to explore certain health policies – sugar tax, health education, effectiveness of primary prevention of O-O in general etc. Under this new structure, policies promoting physical activities both in women and children population, using tools like Pigouvian taxes on food industries promoting unhealthy foods, offering subsidies for healthier and unprocessed foods which would benefit the poorer, unaffordable section of the society who have but no choice to opt for cheaper unhealthier options and alter their food consuming behavior. This scorecard will be beneficial for the Government to prioritize those states needing immediate attention on certain parameters.

Limitations of the study

The primary objective of the study was to develop a scorecard to look at the O-O prevalence disparity among the Indian states. We could derive such a tool to make a comparison among the performance of the Indian states and to draw insights on the action to be taken at a state level. However, there are some genuine limitations of the study that should be mentioned:

- The health survey data for 2005 did not contain information on 8 Indian states and Union Territories (UTs) that were covered in the 2015 survey – Andaman & Nicobar, Andhra Pradesh, Chandigarh, Daman & Diu, Dadar & Nagar Haveli, Lakshadweep, Pondicherry and Telangana (newly formed state). Hence, these states and UTs could not put into any specific cluster of the O-O Threat

- Gini coefficient data was not available for any of the North-Eastern states – Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim and Tripura, and for the UTs, and some states – Chhattisgarh, Goa, Telangana and Uttarakhand. Hence, the relative ranking of the Indian states based on this variable may be skewed.
- GSDP per capita data was not available for four UTs – Chandigarh, Daman & Diu, Dadar & Nagar Haveli and Lakshadweep. Hence, the relative ranking of the Indian states based on this variable may be skewed
- Scope of including other important variables in the study. Past research in similar fields have shown the importance of variables for O-O prevalence like level of literacy, TV viewing, high-energy food consumption, physical activity level etc.

Future Scope of Work

The current prevalence rate of O-O is, if anything an underestimation of the real threat. There are studies supporting the use of lower thresholds for defining O-O for population from Indian sub–continent, who are inherently at a higher risk of developing weight related NCDs at a much lower level of BMIs than the WHO definitions (Tandon and Praveen, 2016). This is due to the potential risks associated with their genetic predisposition and impacts from rapid changes in their food habits that are significantly different from their cultural and social hereditary background that has influences on biological expressions of an individual. It would therefore be useful to take a relook at the basic measure of O-O from an Indian context and understand the nuisances of the risk factors associated with O-O. Other risk factors such as diet and physical activity would be interesting parameters to study and to derive ranks for the Indian states based on these. Another scope of future research in this subject could be carried out with more focus on NCDs and their risk factors. However, availability of quality data would be very crucial before conducting these studies.

This study was a humble approach towards building a first-of-its-kind scorecard regarding health related parameters and associated risk factors in an Indian context. It should be regarded as a stepping stone towards a much bigger objective of causing an impact and improvement of the general health of the Indian population. Hence, consistent research and study is required for all the stakeholders to evaluate the cost of implementation, improve the quality of surveys and capture of

more health information, and circulation of the scorecard through the Digital India (refer the Open Govt. Data Platform India, https://data.gov.in/, as an example) initiative to make the Indian citizens knowledgeable and hence encourage and empower them to prevent and control the surge in O-O prevalence. A research in building any scorecard will only be beneficial to the larger environment when it is taken out of a theoretical framework and implemented and accepted by all the individual states. Thus, the onus lies on the stakeholders, Government agencies, academicians, public and private enterprises to devise strategies on better implementation and acceptance of a scorecard tool, to jointly eradicate the menace of overweight and obesity and its weight related NCDs.

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Appendix I

OLS Regression Analysis

The regression equation will take the following form:

$$Y_i = \alpha + \beta_j X_{ij} + \varepsilon$$

Where, Y_i = Dependent variable, that is O-O prevalence

α is the intercept

β_j is the coefficient for the j^{th} independent variable

X_j is the j^{th} independent variable, which are Gini, GSDP per capita, Use of Iodized Salt, Literacy Rate, Tobacco Use and Alcohol Use.

ε is the error term.

```
. regress overweight sexperc iodizedsalt literacy tobacco alcohol gini gsdppercapita

      Source |       SS       df       MS              Number of obs =      79
-------------+------------------------------           F(  7,    71) =   22.01
       Model |  4463.89262     7  637.698946            Prob > F      =  0.0000
    Residual |  2057.55104    71  28.9795921            R-squared     =  0.6845
-------------+------------------------------           Adj R-squared =  0.6534
       Total |  6521.44366    78  83.6082521            Root MSE      =  5.3833

------------------------------------------------------------------------------
  overweight |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     sexperc |  -.2526505   .3868498    -0.65   0.516    -1.024007    .5187061
iodizedsalt |  -.2501772   .1334562    -1.87   0.065    -.5162813    .0159268
    literacy |   .6093593    .087092     7.00   0.000     .4357028    .7830158
     tobacco |  -.3432271   .0537184    -6.39   0.000    -.4503384   -.2361157
     alcohol |    .043982   .0701294     0.63   0.533    -.0958521    .1838161
        gini |   .1196925   9.891943     0.01   0.990    -19.60428    19.84367
gsdppercap~a |  -.0000114   .0000108    -1.06   0.292    -.0000329      .00001
       _cons |   19.23653   22.37331     0.86   0.393    -25.37458    63.84763
------------------------------------------------------------------------------
```

(Note: OLS Regression output from STATA for the entire sample set)

```
. by statecode, sort : regress overweight sexperc iodizedsalt literacy tobacco alcohol gini

-------------------------------------------------------------------------------
-> statecode = 1

      Source |       SS       df       MS              Number of obs =      40
-------------+------------------------------           F(  7,    32) =    4.18
       Model |  847.279242     7  121.039892            Prob > F      =  0.0023
    Residual |  925.716769    32   28.928649            R-squared     =  0.4779
-------------+------------------------------           Adj R-squared =  0.3637
       Total |  1772.99601    39  45.4614362            Root MSE      =  5.3785

------------------------------------------------------------------------------
  overweight |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     sexperc |  -.4818901   .5623085    -0.86   0.398    -1.627275    .6634949
 iodizedsalt |  -.5847056   .3381264    -1.73   0.093    -1.273446    .1040353
    literacy |   .3608725   .1877467     1.92   0.064     -.021555    .7432999
     tobacco |  -.2618481   .0912358    -2.87   0.007    -.4476893   -.0760068
     alcohol |   .0734761   .1177344     0.62   0.537    -.1663411    .3132932
        gini |   -20.8988   13.26604    -1.58   0.125    -47.92084    6.123234
gsdppercap~a |  -3.82e-06   .0000142    -0.27   0.790    -.0000328    .0000252
       _cons |   91.82649   43.62148     2.11   0.043     2.972437    180.6805
------------------------------------------------------------------------------

-------------------------------------------------------------------------------
-> statecode = 2

      Source |       SS       df       MS              Number of obs =      39
-------------+------------------------------           F(  7,    31) =   19.58
       Model |  1670.07891     7  238.582702            Prob > F      =  0.0000
    Residual |  377.711884    31  12.1842543            R-squared     =  0.8156
-------------+------------------------------           Adj R-squared =  0.7739
       Total |   2047.7908    38  53.8892315            Root MSE      =  3.4906

------------------------------------------------------------------------------
  overweight |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     sexperc |  -.1714045    .435944    -0.39   0.697    -1.060518     .717709
 iodizedsalt |   -.355581   .1073909    -3.31   0.002    -.5746061   -.1365558
    literacy |   .4300587   .0819007     5.25   0.000     .2630211    .5970963
     tobacco |  -.3120504   .0458468    -6.81   0.000    -.4055555   -.2185453
     alcohol |   .0876867   .0605094     1.45   0.157     -.035723    .2110964
        gini |  -1.675713   11.20352    -0.15   0.882    -24.52544    21.17401
gsdppercap~a |   5.81e-06   .0000124     0.47   0.641    -.0000194     .000031
       _cons |   32.70598   24.45629     1.34   0.191    -17.17295     82.5849
------------------------------------------------------------------------------
```

(Note: OLS Regression output from STATA by State Code. 1 is for Urban and 2 for

```
. by gendercode, sort : regress overweight sexperc iodizedsalt literacy tobacco alcohol gini gsdppercapita

-------------------------------------------------------------------------------
-> gendercode = 0

      Source |       SS       df       MS              Number of obs =      39
-------------+------------------------------           F(  7,    31) =    9.03
       Model |  1749.45694     7  249.922419            Prob > F      =  0.0000
    Residual |  857.669815    31  27.6667682            R-squared     =  0.6710
-------------+------------------------------           Adj R-squared =  0.5967
       Total |  2607.12675    38  68.6085987            Root MSE      =  5.2599

------------------------------------------------------------------------------
  overweight |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     sexperc |  -.0586527   .7275485    -0.08   0.936    -1.542498    1.425192
iodizedsalt |  -.1141563   .2099383    -0.54   0.590    -.5423282    .3140156
   literacy |   .5739198   .2103716     2.73   0.010     .1448641    1.002975
    tobacco |   -.332211   .0817604    -4.06   0.000    -.4989625   -.1654595
    alcohol |   .0570443   .0877472     0.65   0.520    -.1219173    .2360059
       gini |   5.955259   14.67271     0.41   0.688    -23.96994    35.88045
gsdppercap~a |   -.000014   .0000178    -0.79   0.438    -.0000502    .0000223
       _cons |  -2.917661   36.40429    -0.08   0.937     -77.1647    71.32937
------------------------------------------------------------------------------

-------------------------------------------------------------------------------
-> gendercode = 1

      Source |       SS       df       MS              Number of obs =      40
-------------+------------------------------           F(  7,    32) =   11.33
       Model |  2629.90663     7  375.700947            Prob > F      =  0.0000
    Residual |  1060.92315    32  33.1538483            R-squared     =  0.7126
-------------+------------------------------           Adj R-squared =  0.6497
       Total |  3690.82978    39  94.6366609            Root MSE      =  5.7579

------------------------------------------------------------------------------
  overweight |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
     sexperc |  -1.023845   .7654939    -1.34   0.190    -2.583105     .535415
iodizedsalt |  -.5490483   .2424365    -2.26   0.030    -1.042875   -.0552213
   literacy |   .6944698   .1292177     5.37   0.000     .4312619    .9576776
    tobacco |  -.5977244   .2550639    -2.34   0.025    -1.117273   -.0781762
    alcohol |   .2848606   .3644355     0.78   0.440    -.4574701    1.027191
       gini |  -14.02313   15.80221    -0.89   0.381    -46.21118    18.16492
gsdppercap~a |  -.0000287   .0000195    -1.47   0.151    -.0000685    .0000111
       _cons |   87.98918   51.81758     1.70   0.099    -17.55977    193.5381
------------------------------------------------------------------------------
```

(Note: OLS Regression output from STATA by Gender Code. 0 is for Male and 1 for Female)

z-test for sample proportions

Using the state level summaries of the latest NFHS-4 data, significance was tested to assess the difference between O-O measure between the male and female populations and between rural and urban regions. As the parameters of the survey results used in our study are represented as a proportion of the population, a z-test for sample proportions is used to test the hypothesis. The null hypothesis in our analysis was that there is no significant difference of the O-O proportions between 1) urban and rural population and, 2) between male and female population. The below table shows the P values suggesting that there is a significant difference between the O-O proportions of male and female population, and rural and urban regions, conducted at a 95% confidence level.

Table: Test results for population sub-groups

Sub-group	P value
Male vs. Female	0.044783435
Urban vs. Rural	6.66134E-16

Appendix II – Targets for NCD prevention and control in India

S.No.	Framework element	Targets		
		Outcome	2020	2025
1.	Premature mortality from NCDs	Relative reduction in overall mortality from cardiovascular disease, cancer, diabetes, or chronic respiratory disease	10%	25%
2.	Alcohol use	Relative reduction in alcohol use	5%	10%
3.	Obesity and diabetes	Halt the rise in obesity and diabetes prevalence	No mid-term target set	Halt the rise in obesity and diabetes prevalence
4.	Physical inactivity	Relative reduction in prevalence of insufficient physical activity	5%	10%
5.	Raised blood pressure	Relative reduction in prevalence of raised blood pressure	10%	25%
6.	Salt/sodium intake	Relative reduction in mean population intake of salt, with aim of achieving recommended level of less than 5gms per day	20%	30%
7.	Tobacco use	Relative reduction in prevalence of current tobacco use	15%	30%
8.	Drug therapy to prevent heart attacks and strokes	Eligible people receiving drug therapy and counselling (including glycemic control) to prevent heart attacks and strokes	30%	50%
9.	Essential NCD medicines and basic technologies to treat major NCDs	Availability and affordability of quality, safe and efficacious essential NCD medicines including generics, and basic technologies in both public and private facilities	60%	80%
10.	Household indoor air pollution	Relative reduction in household use of solid fuels as a primary source of energy for cooking	25%	50%

Appendix III – Cross-sectoral Government engagement

Sector	Tobacco	Physical inactivity	Harmful use of alcohol	Unhealthy diet
Health	✓	✓	✓	✓
Agriculture	✓		✓	✓
Food processing			✓	✓
Finance, tax and revenue	✓	✓	✓	✓
Law and justice	✓		✓	✓
Information and broadcasting	✓	✓	✓	✓
Consumer affairs	✓		✓	✓
Women and child development	✓	✓	✓	✓
Commerce and industry	✓		✓	✓
Human resource development	✓	✓	✓	✓
Youth affairs and sports	✓	✓	✓	✓
Road transport and highways			✓	
Labour	✓	✓	✓	✓
Urban and rural development	✓	✓	✓	✓
Social justice and empowerment	✓	✓	✓	✓
Environment	✓	✓	✓	✓

(Adapted from: http://www.who.int/nmh/events/2012/20121128.pdf)