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Burden and cost of overweight and obesity in south India public health system

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1. Introduction

The incidence of overweight and obesity are rising worldwide (Roberto et al., 2015). World Health Organization (WHO) estimated that 2.8 million people die each year because of being overweight or obese. Also, 35.8 million (2.3%) of global Disability Adjusted Life Year (DALY) are affected by overweight or obesity, and diet-related risk factors (World Health Organization, 2010). High Body Mass Index (BMI) is the sixth most important risk factor contributing to the global disease burden according to the 2010 Global Burden of Disease (GBD) study (Lim et al., 2012). However, in developed countries, the increase in adult overweight prevalence has reduced (Ng et al., 2014). In contrast, several studies have suggested that overweight is an increasing health problem in low and Middle-Income Countries (LMICs) which are also, in rapid economic transition, and urbanisation phase (Popkin, 2001, 2004). For instance, in 2013, China and India jointly accounted for 15% of the overweight population worldwide (Ng et al., 2014). This rapid increase in new cases of overweight and obesity, will continue to increase in the future; because of economic development and rises in per capita income level of these countries.

In India, two national surveys of the adult population in 2005 and 2015 showed that overweight and obesity prevalence rates have increased over the past ten years, from 10.95% to 19.8% (International Institute for Sciences, 2016).In accordance to National Family Health Survey (NFHS) 2015 conducted by Indian Institute of Population Science (IIPS), Andhra Pradesh ranked top in the prevalence of obesity with 36.04% followed by Kerala 30.6%, Tamil Nadu 29.45%, Telangana 26.95%, and Karnataka 23.5% among the states from south India. Overweight and obesity were risk factors for several chronic medical conditions, like cancer, diabetes, heart disease, that in turn are primary drivers of health care spending, disability, and death. The estimated numbers of obesity-attributed cancers are significant and include common cancer as pancreas, colorectal, breast, and endometrium (Polednak, 2008; Sturm and Wells, 2001). A review of the economic burden of overweight found that overweight accounts for 0.7–2.8% of a country's total healthcare expenditure (Withrow and Alter, 2011). As overweight and obesity are on the rise, the health and economic burden of CVD, type 2 diabetes, cancer and hypertension will grow as well – in addition to the existing high communicable disease burden (Ni Mhurchu et al., 2004; Parr et al., 2014). In recent years the economic costs of obesity have raised considerable attention. So, it is essential to know the price, of an illness. Also, these cost of illness can be measured by the financial impact of related diseases on the health system (direct costs) and by the loss of productivity and quality of life (indirect costs) to society and individuals. Obesity presents a significant health challenge, especially in developing country like India. Few studies have been published regarding the cost of illness due to overweight, and obesity in Andhra Pradesh. Also, the cost is substantial and unknown to Andhra Pradesh health system. So this study aims to calculate an estimate of the direct costs associated with inpatient care of overweight and obesity-related diseases in the perspective of the Andhra Pradesh Health System.

2. Methods

As for most countries, there are no key data sets that allow direct estimates of medical care costs and productivity for the obesity-related disease. To do the estimates of the impact of overweight and obesity on the (i) costs of the healthcare system i.e. costs of hospitaliz ation, outpatient visits, drugs, etc. we rely on a more indirect method that uses the best estimates of obesity effects on each disease and links those to disease-specific costs.

2.1. Source of relative risk estimates

The Relative Risk (RR) for each condition associated with physical activity or overweight/obesity was selected based on the epidemiological review. To estimate this accurately, we searched for meta-analysis presenting RR estimates associated with the presence of overweight and obesity. After identifying the most recent meta-analysis, we looked for large individual studies covered by the meta-analysis. We did a literature search in two databases, Scopus and Medline. The search always contained two blocks of concepts: one of the descriptors of exposure (overweight or obesity) and the other descriptors related to the selected outcomes.

Table 1 presents the relative risks and respective 95% confidence

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Table 1
Relative risks and respective 95% confidence intervals, by gender, for selected diseases Use of Population Attributable Risks (PAR).

Disease	Overweight	Obesity
Colon-rectum cancer	M: 1.48 (1.23–1.79)	M: 1.95 (1.51–2.51)
	W:1.55 (1.30–1.86)	W: 1.49 (1.21–1.82)
Ovary cancer	W: 1.29 (1.12–1.23)	W:1.47 (1.13–1.91)
Endometrium cancer	W: 1.90 (1.53–2.36)	W: 3.39 (2.51–4.58)
Diabetes Mellitus Type II	M: 2.29 (1.98–2.64)	M: 5.36 (4.32–6.65)
	W: 3.64 (2.93–4.52)	W: 10.47 (7.31–15.0)
Stroke	M: 1.23 (1.13–1.34)	M: 1.51 (1.33–1.72)
	W: 1.15 (1.00–1.32)	W: 1.49 (1.27–1.74)
Ischemic Heart Disease	M: 1.29 (1.18–1.41)	M: 1.72 (1.51–1.96)
	W: 1.14 (0.88–1.48)	W: 1.91 (1.45–2.50)
Congestive Heart Failure (men)	M: 1.36 (1.01–1.83)	M: 1.80 (1.27–2.56)
	W: 1.20 (0.97–1.60)	W: 1.78 (1.07–2.95)
Asthma	M: 1.20 (1.08–1.33)	M: 1.43 (1.14–1.79)
	W: 1.25 (1.05–1.49)	W: 1.78 (1.36–2.32)
Osteoarthritis (knee and hip)	M: 2.01 (1.92–2.09)	M: 2.47 (2.27–2.70)
	W: 1.80 (1.75–1.85)	W: 1.96 (1.88–2.04)
Gallbladder cancer	M: 1.15 (1.01–1.30)	M: 1.35 (1.09–1.68)
	W: 1.15 (1.01–1.30)	W: 1.88 (1.66–2.13)
Post-menopausal breast cancer	W: 1.11 (1.01–1.22	W: 1.17 (1.04–1.32)

intervals, by gender, for the selected diseases (for overweight and obesity). The quality evaluation of the meta-analysis was done by AMSTAR inventory tool, which scored the methodological aspects of the meta-analyses used in this study (Shea et al., 2009). Ni Mhurchu et al. and Parr CL et al. did the meta-analyses (Ni Mhurchu et al., 2004; Parr et al., 2014) in Asia, specific region was selected to provide RR for PAR calculation.

Direct costs refer to the costs to the healthcare system – such as costs of hospitalisation, outpatient visits, drugs, etc. were calculated for each disease condition using Population Attributable Risks (PAR). PAR is the proportion of the occurrence of a disease in the population that is due to exposure to a risk factor. In this cost study two groups of exposure were of interest for estimating the PAR: individuals with overweight (Body Mass Index- BMI 25–29.9 kg/m2) and obesity (BMI ≥ 30 kg/m2). The related diseases were selected for calculating PAR if their associations with overweight and obesity have the following parameter: Relative risk (RR) ≥ 1.10. The epidemiological formula used to estimate PAR is:

$$PAR = Pe(RR - 1)/Pe(RR - 1) + 1$$

Where Pe-Prevalence and RR refers to -Relative Risk.

2.2. Source of population estimates for the exposures

The prevalence of overweight and obesity in individuals with ≥18 years were obtained from a recent National Family Health Survey (NFHS-4), which was done by Ministry of Health and Family Welfare (MoHF) India in every ten years. The study presents the prevalence of overweight and obesity, stratified by gender and state.

2.3. Cost estimates

The State Government of Andhra Pradesh is implementing a health scheme known as Dr NTR Vaidya Seva where treatment is given free of cost for 1044 procedures and have all the database of health in the state of Andhra Pradesh. This database was used to estimate the annual cost of the Andhra Pradesh with diseases that are included in the analysis. This database provides the reimbursed values by the government for public health care organization that offer inpatient, outpatient and follow up needed for treatment and monitoring of these diseases. Type of service (inpatient and follow up) stratified by sex extracted from Dr NTRVST database from January 2017 to December 2017. PAR was calculated and stratified by 13 districts of Andhra Pradesh. The costs were converted into US dollar during the analysis assuming (US$ 1 = INR68.4).

3. Results

The effect of overweight and obesity on selected diseases varies a lot, from 1% to gallbladder cancer (obese/overweight) to 27% to stroke (obesity/overweight). The calculated PAR are enumerated in Table 2.

The estimated total costs in one year with all diseases related to overweight and obesity is US$ 55,200,030. Hospitalizations account to US$ 54,610,247, 98.93% of total expenses and follow up procedures consider to US$ 590,030and the same enumerate in Table 3.

The PAR is ranging between 5.5% and 13.7%. of total costs. Obesity/overweight attributable hospitalisations costs were higher among men (US$ 7.65 million vs US$ 6.37 million). Also, PAR was higher in men 13.76% than in women 13.22%.

The major costs due to obesity as a risk factor to cardiovascular disease (US$ 9.82 million) followed by overweight and obesity-related neoplasms (US$ 9.75 million, mainly in women 62.54%), elicit in Table 4.

The major part of costs with cardiovascular diseases was due to Ischemic heart disease (82.24%).

Table 2
Overweight/Obesity PAR by gender and Andhra Pradesh District in percentage, for the selected diseases.

District of AP	CC		EC	PBC	OC	GBC		Asthma		IHD		Osteoarthritis		Diabetes		Stroke		CHF
	M	W	W	W	W	M	W	M	W	M	W	M	W	M	W	M	W	M
Anantapur	9.34	9.40	12.55	2.63	5.96	3.76	3.5	4.8	5.3	6.47	3.3	14.47	11.78	16.22	19.2	5.39	3.46	7.62
Chittoor	9.99	10.11	13.5	2.82	6.41	4.02	3.7	5.13	5.7	6.92	3.5	15.48	12.67	17.35	20.7	5.76	3.72	8.15
East Godavari	9.08	12.92	17.24	3.61	8.18	3.65	4.7	4.67	7.3	6.29	4.5	14.07	16.18	15.77	26.4	5.24	4.75	7.41
Guntur	12.65	16.00	21.36	4.47	10.1	5.09	5.9	6.5	9	8.77	5.5	19.60	20.04	21.97	32.7	7.29	5.88	10.32
Krishna	15.11	16.15	21.55	4.51	10.2	6.08	5.9	7.77	9.1	10.5	5.6	23.42	20.22	26.25	33	8.71	5.93	12.34
Kurnool	10.28	8.84	11.79	2.47	5.6	4.13	3.2	5.28	5	7.13	3.1	15.93	11.07	17.86	18.1	5.93	3.25	8.39
Prakasam	10.90	11.53	15.39	3.22	7.31	4.38	4.2	5.6	6.5	7.55	4	16.88	14.44	18.93	23.6	6.28	4.24	8.89
Nellore	10.38	12.42	16.58	3.47	7.87	4.17	4.6	5.33	7	7.19	4.3	16.08	15.56	18.03	25.4	5.98	4.57	8.47
Srikakulam	6.13	8.66	11.56	2.42	5.49	2.47	3.2	3.15	4.9	4.25	3	9.50	10.84	10.65	17.7	3.53	3.18	5.00
Visakhapatnam	9.41	10.22	13.64	2.85	6.47	3.78	3.8	4.83	5.8	6.52	3.5	14.57	12.80	16.34	20.9	5.42	3.76	7.68
Vizianagaram	10.41	7.95	10.61	2.22	5.04	4.19	2.9	5.35	4.5	7.22	2.8	16.13	9.96	18.08	16.2	6.00	2.92	8.50
West Godavari	13.39	14.19	18.95	3.96	8.99	5.39	5.2	6.88	8	9.28	4.9	20.75	17.78	23.27	29	7.72	5.22	10.93
Y.S.R Kadapa	13.26	9.62	12.84	2.69	6.09	5.33	3.5	6.82	5.4	9.19	3.3	20.55	12.04	23.04	19.7	7.65	3.53	10.83

Note- Andhra Pradesh: AP; M: Men; W: Women; Colorectal Cancer: CC; Endometrial Cancer: EC; PBC: Postmenopausal Breast Cancer; OC: Ovarian cancer; GBC: Gallbladder Cancer; IHD: Ischemic Heart Disease; CHF: Congestive Heart Failure.

Table 3
Hospitalization, follow up, and total costs with estimated attributable costs of overweight and obesity-related diseases.

	Hospitalization costs in (million)	Hospitalization costs attributable to risk factor (%) in (million)	Follow up costs in (million)	Follow up costs attributable to risk factor (%) in (million)	Total costs in (million) Outpatient and Inpatient	Total cost attributable to risk factors (%) in (million)
	Women		Women		Women	
Obesity + Overweight	US$ 6.37	US$ 0.58 (9.2%)	US$ 1.81	US$ 0.05 (3.9%)	US$ 8.18	US$ 0.63
	Men		Men		Men	
Obesity + Overweight	US$ 7.65	US$ 0.75 (9.8%)	US$ 4.08	US$ 0.36 (8.4%)	US$ 11.73	US$ 1.11
Total Cost	US$ 14.02	US$ 1.33	US$ 5.89	US$ 0.41	US$ 19.91	US$ 1.74

4. Discussion

The projected costs of diseases related to overweight and obesity reach almost US$ 23.74717 million in one year. Using PAR factor, we could estimate that approximately 10% of these cost is attributable to overweight and obesity. The estimates of direct costs reviewed here may generally be conservative, probably underestimated. The reimbursement rates provided by the Andhra Pradesh health care system are widely recognized as average estimates of the costs of health care as revealed by cost-of-illness study by A Mitchell et al. in Andhra Pradesh (Mitchell et al., 2011).Although indirect costs such as out-of-pocket and home care expenses, days lost to sickness, and premature mortality had been included, the figure would have been much higher. Besides, this study focused only on the cost of care provided as inpatient at public and private empanelled hospital with Dr NTR Vaidya seva trust Govt of Andhra Pradesh. The analysis revealed the costs for men were greater than for women, mainly because of higher follow up expenditures (69.27% vs 30.73% of total costs for men and women, individually). Overweight and obesity-related prevalence rates in Andhra Pradesh varied little between gender, and women demonstrated almost half of PAR for selected diseases than men, be an indication of a greater use of health care system among them. The greatest share of costs was attributable to the treatment of cardiovascular diseases (43.44%), this could be because of higher prevalence of coronary artery disease 23.5%. In a study carried out in India, T Sekhri et al.and PD Murthy et al. in Andhra Pradesh (Sekhri et al., 2014; Murthy et al., 2012) also demonstrated that more than half of hospitalization costs were due to ischemic heart diseases in public health system in Andhra Pradesh. Cardiovascular diseases and Diabetes Mellitus, are common ailments with high morbidity and mortality rates. Also, Cardiovascular and Diabetes Mellitus Type II are responsible for a significant number of hospitalizations and high costs in Andhra Pradesh as comparable with study done by D Prabhakaran et al. and S Jitendra (Prabhakaran and Jeemon, 2016; Singh, 2011).Both the conditions are related to obesity and probably its prevalence and severity could be reduced with the reduced obesity rates. A study in the United States of America (USA), by Wang et al. demonstrated that a hypothetical programme that enables a 1% BMI reduction across the US population would avoid up to 2.1–2.4 million incident cases of diabetes, 1.4–1.7million cardiovascular diseases, and 73,000–127,000 cases of cancer (Wang et al., 2011). The another group of diseases with the highest costs to the public health system was neoplasms. With the trend on rise prevalence of obesity along with the aging population, the rise in cancer cases and costs involved will be huge and comparable with study done by P.L Christine et al. (Parr et al., 2014) This study have some limitations on methods; used in this study are well-intentioned of further consideration. First, we restricted our analysis to cohort studies carried out in Andhra Pradesh or India, since few data were available on relative risks based on Andhra cohorts. So, Attributable Risks (AR) may not reflect the real burden of the diseases in the Andhra Pradesh. Accordingly, our assumption is that the relative risks found in India or Asia specific studies could be applied to the Andhra Pradesh population. Second the prevalence was not categorised in to obesity and overweight as national survey report does not mention the same (International Institute for Sciences, 2016).So we could not estimate the cost of disease separately based on overweight and obesity. The strength of the study is that we restricted our analysis to metanalysis of cohort study with a minimum follow up of 10 Years and thus we minimise the confounding factors and focus on one exposure i. e BMI > 25 and BMI > 29.9. Second the prevalence of the obesity was obtained from the national survey done by Govt of India where trained professional use Anthropometric measurements. Lastly the data was obtained from Dr NTRVST Govt of Andhra Pradesh where they have epidemiologist who verify the data and check for duplicate of data and maintain the quality of the data (NTRVST Home page, 2018).

5. Conclusion

This study includes the economic impact on the Andhra Pradesh public health system for the disease related to overweight and obesity. The facts of these costs will be useful for future economic analysis of preventive and treatment interventions, such as education programmes or new drugs which may help reduce the obesity-attributable growth of health care expenditures in Andhra Pradesh.

Table 4
Annual costs separated by a group of diseases (women and men).

Group of Diseases		Follow up cost in (million)	Hospitalization cost in (million)	Total cost in (million)
Cardiovascular	Stroke	US$0.00159	US$1.75	US$1.75159
	Congestive heart failure	US$ 0.10317	US$2.32	US$2.33031
	Ischemic heart disease	US$0.48527	US$5.75	US$6.23527
Neoplasm[a]			US$9.75	US$9.75
Asthma			US$0.60	US$0.60
Diabetes mellitus Type II[b]			US$0.46	US$0.46
Osteoarthritis[c]			US$2.62	US$2.62

[a] Overweight and obesity-related neoplasms.
[b] Only as the first diagnosis.
[c] Only knee and hip.

Conflicts of interest

There are no conflicts of interests.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.obmed.2019.01.004.

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