Original Research Article

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Prevalence and risk for overweight among employees in a leading auto-mobile industry in India

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ABSTRACT

Background: Overweight is a major risk factor for the non-communicable diseases. India is home to nearly 164 million industrial workers (2017) and yet information about prevalence and risk of overweight among them is limited. Being overweight can adversely affect a person's productivity in his workplace and increase the risk of non-communicable diseases. The objective was to assess the prevalence of overweight and association between overweight and employee age, type of work and native origin.

Methods: The longitudinal analysis was conducted using periodical medical examination (PME) data of employees from 2010-2018. Relevant data were collected. Year-wise prevalence of overweight was estimated along with specific prevalence by age, type of work and region.

Results: The mean weight of employees increased from 68.1 kgs to 72.6 kgs (2010-2018). Overweight proportion was significantly higher in non-production departments. Overweight prevalence ranged between 15-29.8% among Karnataka regions in 2010 in production employees but reached 35-55.6% by 2018. Significant association was found between overweight with type of work and region.

Conclusions: The increase in weight over time indicates the trend of overweight and weight reduction interventions are needed in workplaces to prevent the risk of NCDs.

Keywords: Occupational health, Overweight, Industry, Non-communicable diseases, NCD risk factors, Healthy work place

INTRODUCTION

The global burden and threat of non-communicable diseases (NCDs) constitutes a serious public health challenge that undermines social and economic development globally and contributes to increasing inequalities between countries and populations. Globally, NCDs accounted for 73.4% (95% uncertainty interval 72.5-74.1) of all deaths in the year 2017. Between 2007 to 2017, number of NCD deaths increased by 22.7%, translating to additional 7.61 million (7.20-8.01) deaths in the year 2017. Of these deaths, high body mass index attributed to 4.72 million (2.99-6.70) deaths and 148 million (98.6-202) DALYs. In India, DALYs due to NCDs and injuries exceeded those due to communicable,

maternal, neonatal and nutritional diseases (CMNNDs). The major risk factors for NCDs including high systolic blood pressure, high fasting plasma glucose, high total cholesterol and high body-mass index, increased from 1990 to 2016. The India GBD collaborators found that leading cardiovascular diseases, ischaemic heart disease and stroke made the largest contribution to the total burden of mortality in India 28.1% (95% uncertainty interval (UI) (26.5-29.1).³

Worldwide, the prevalence of overweight and obesity have become more than double since 1980, reaching to 1.9 billion overweight and 600 million obese adults in year 2014.⁴ According to ICMR-INDIAB study, the prevalence of obesity and central obesity in India is

estimated at 11.8% to 31.3% and 16.9% to 36.3% respectively.⁵ More than 135 million individuals were affected by obesity and the prevalence of overweight and obesity in India was reportedly increasing faster than the world average.^{6,7}

Workers (an estimated 534 million in India), a sub-set of population, were likely to be influenced by ongoing macro level socio-economic determinants of overweight and obesity. As most young, middle age and productive section of the population were expected to be in workplaces, there was renewed interest in understanding work environment factors associated with overweight. Of the 534 million workers, around 8% were estimated be in organized sector. There were approximately 17.5 million workers in public sector in India.⁸ An estimated 339,931 registered industrial factories reported a total employment of around 164 million in the year 2017.⁹

Limited available studies indicated that overweight prevalence in industrial workers ranged between 17% to 65.5%. 10-12 Though incomparable from epidemiological sense, prevalence appeared to be similar or higher than population prevalence. In terms of number of young and productive people affected, this number was of significant size.

The WHO emphasized workplace as a priority setting for promotion of health and wellbeing including provision of a safe and healthy physical and psychosocial work environment. Reducing overweight proportion among the workers could contributed to a reduction in population prevalence of overweight. This requires implementation of evidence-driven, need-based and cost-effective workplace programmes. Understanding factors associated with overweight among employees could facilitate evidence-based programming of healthy workplace interventions aimed at weight reduction.

In this direction, a record analysis was conducted in a leading automobile industry in South India to assess the prevalence of overweight and association between overweight and employee age, type of work and native origin. This study was part of programmatic support provided to the industry to implement interventions to reduce NCDs and mental disorders and not a specifically conducted research study.

Due to unavailability of the formal institutional review board process, the principles outlined in the declaration of Helsinki were followed while conducting the study.

METHODS

The study was conducted in a leading automobile industry located in South India, where healthy workplace programme was being implemented by the occupational safety and health department. The department conducted PME for employees. We analyzed de-linked and anonymous periodical medical examination data of the

employees for years 2010-2018. This longitudinal record analysis was a part of the programmatic support provided for occupational safety and health (OSH) professionals to enable data backed programme implementation.

Data source

PME data was collected digitally using an occupational health software and provided to the investigators in MS excel format by the OSH department. Data regarding the employees native region (region within the state of Karnataka and those from other states of India), age, date of birth, work department and date of joining were provided by the human resource (HR) department. Both datasets were merged using employee number as unique ID using the VLOOK UP function in MS excel. The merged data set was used for analysis. Data was checked for consistency in entries, outliers and coding. We excluded female employees from analytical statistics as their numbers were significantly lesser in number.

Data computation

Body mass index (BMI) of workers was computed using the height and weight data,

$$BMI = \frac{weight in kg}{(height in meters)^2}.$$

Using the BMI values, employees were categorized as overweight and obese, based on WHO classification. All employees with BMI \geq 25 was defined as overweight and those with BMI \geq 30 was defined as obese. ¹⁴

Region and type of work

Information about the native region and the type of work/department were collected from the HR department. From the address provided in the data, we categorized native region of employees into the following four categories: coastal Karnataka, Malnad Karnataka, North Karnataka, South Karnataka and other states.

There were eight departments namely paint production, internal logistics control department (ILCD). assembly maintenance, office, press production, production, quality, weld production in the industry. We further categorized these departments operationally into production and non-production related departments. Employees' those who were directly involved in production line were categorised as production. This included employees from assembly, weld, paint, press, quality and ILCD. Employees working in office, senior management and maintenance staff were defined as nonproduction as they were not directly involved in the production but had managerial and technical duties.

Age was computed from date of birth. Age of employee as of 31 December 2018 was calculated and included for analysis. The age was further categorized into 18-24

years, 25-29 years, 30-34 years, 35-39 years and 40 years and above.

Duration of service

Duration of service was computed from date of joining. The date of joining was subtracted from 31 December 2018 to derive the service duration till end of year 2018 for all employees. It was further categorized as 0-5 years, 6-10 years, 11-15 years, 16 years and above.

Data analysis

The data was analysed by using SPSS version 25. Descriptive statistics for categorical variables, gender, region, type of work, service duration, age categories were estimated using frequency and percentages. Quantitative variables like age, weight and BMI were expressed as mean and standard deviation.

Prevalence of overweight and obesity per 100 employees was estimated yearwise=

No. of overweight employees in specific year

No. of employees attending periodical medical examination in same year 100.

Specific prevalence rates by age categories, type of work, region was presented per 100 employees.

Univariate analysis was done using Chi square test to examine association between overweight (present/absent) with type of work, region and age-categories. Chi square for trend (Mantel-Haenszel) was applied to test for significant change in trend of overweight prevalence between year 2010 to 2018. Results were considered

significant at p<0.05. One way analysis of variance (ANOVA) was used to find the differences in age, weight and BMI between year 2010-2018. Correlation statistics (Pearson r) was applied to test for relationship between mean age and overweight prevalence.

Based on the univariate analysis, we identified predictor variables namely type of work, region and service duration to assess the strength of association. Overweight (present/absent) was defined as the outcome variable. Binary logistic regression was used to find the association between the predictor variables and the outcome variable. The regression consisted of type of work, region and service duration as predictor variables and overweight as outcome variable for the year 2018. Goodness of fit was assessed by Hosmer-Lemeshow test and Wald test was used to assess significance of predictors in the model. Age-categories was not included in the model as it was strongly correlated with service duration and hence removed to prevent effects of multicollinearity. Strength of association was presented as adjusted odds ratio and 95% confidence intervals (p values less than <0.05 was statistically significant).

RESULTS

Sociodemographic details of employees was presented in Table 1. Majority (99.7%) of the employees were males. Participation in PME increased from 6.1% to 93.9% between 2010 to 2018 with highest being from production departments (78-94%). A significant increase in mean weight and mean BMI over the years, 2010-2018 was observed.

Table 1: Description of study subjects (year 2010-2018).

Year		2010	2011	2012	2013	2014	2015	2016	2017	2018
No. of en	nployees (n)	1814	2652	3342	3278	4198	4979	4833	4664	5505
Gender	Male (%)	1787 (98.5)	2635 (99.4)	3331 (99.7)	3268 (99.7)	4179 (99.5)	4920 (98.8)	4795 (99.2)	4634 (99.4)	5455 (98.8)
	Female (%)	27 (1.5)	17 (0.6)	11 (0.3)	10 (0.3)	19 (0.5)	59 (1.2)	38 (0.8)	30 (0.6)	68 (1.2)
Tunas	Production (%)	1398 (78.2)	2315 (87.9)	3054 (91.7)	3070 (93.9)	3823 (91.5)	4282 (87.0)	4255 (88.7)	4101 (88.5)	4517 (82.8)
Type of work	Non- production (%)	389 (21.8)	320 (12.1)	277 (8.3)	198 (6.1)	356 (8.5)	638 (13)	540 (11.3)	533 (11.5)	937 (17.2)
	Coastal Karnataka (%)	117 (6.5)	193 (7.3)	292 (8.8)	284 (8.7)	367 (8.8)	448 (9.1)	428 (8.9)	417 (9.0)	478 (8.8)
Region	Malnad Karnataka (%)	208 (11.6)	392 (14.9)	550 (16.5)	556 (17.0)	660 (15.8)	758 (15.4)	754 (15.7)	731 (15.8)	795 (14.6)
	North Karnataka (%)	374 (20.9)	567 (21.5)	693 (20.8)	686 (21.0)	875 (20.9)	1025 (20.8)	995 (20.8)	949 (20.5)	1081 (19.8)
	South Karnataka	1026 (57.4)	1423 (54.0)	1747 (52.4)	1695 (51.9)	2203 (52.7)	2486 (50.5)	2485 (51.8)	2385 (51.5)	2843 (52.1)

Continued.

	2010	2011	2012	2013	2014	2015	2016	2017	2018
(%)									
Other states	62	60	49	47	74	203	133	152	258
(%)	(3.5)	(2.3)	(1.5)	(1.4)	(1.8)	(4.1)	(2.8)	(3.3)	(4.7)
18-24 (%)	361	864	1429	1207	1013	704	396	161	108
	(20.2)	(32.8)	(42.9)	(36.9)	(24.2)	(14.3)	(8.3)	(3.5)	(2.0)
25 20 (0/)	659	841	1082	1247	1865	2305	2240	2002	1784
23-29 (70)	(36.9)	(31.9)	(32.5)	(38.2)	(44.6)	(46.8)	(46.7)	(43.2)	(32.7)
20. 24 (%)	675	794	630	574	826	1114	1245	1467	1910
30-34 (%)	(37.8)	(30.1)	(18.9)	(17.6)	(19.8)	(22.6)	(26.0)	(31.7)	(35.0)
35 30 (%)	83	134	188	239	468	791	846	869	1043
33-37 (70)	(4.6)	(5.1)	(5.6)	(7.3)	(11.2)	(16.1)	(17.6)	(18.8)	(19.1)
40 and	9 (0.5)	2 (0.1)	2 (0.1)	1 (0.0)	7 (0.2)	6 (0.1)	68 (1.4)	135	610
above (%)	7 (0.5)	2 (0.1)	2 (0.1)	1 (0.0)	7 (0.2)	0 (0.1)	00 (1.4)		(11.2)
0-5 (%)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	16 (0.4)	90 (1.8)	114 (2.4)		183 (3.4)
5 40 (01)	277	1147	2140	2190	2704	3128			3314
6-10 (%)	(15.5)	(43.5)	(64.2)	(67.0)	(64.7)	(63.6)	(65.1)	(64.7)	(60.8)
11 15 (0/)	546	505	440	393	545	678	624	607	744
11-15 (%)	(30.6)	(19.2)	(13.2)	(12.0)	(13.0)	(13.8)	(13.0)	(13.1)	(13.6)
16 years	064	002	751	605	014	1024	027	907	1214
and above									
(%)	(33.9)	(37.3)	(22.3)	(21.0)	(21.9)	(20.8)	(19.5)	(19.4)	(22.3)
an±SD)	28.42±3.9	27.27±4.4	26.3±4.4	26.85±4.4	28±4.4	29±4.3	39.7±4.4	30.7±4.4	32.4±5.2
Weight (mean±SD)		67.2±9.7	66.3±9.6	66.6±9.1	68.3±9.2	69.8±9.5	70.7±9.3	71.2±9.2	72.6±9.4
BMI (mean±SD)		23.6±3.1	23.2±3	23.3±2.9	23.9±2.9	24.6±3	24.7±2.9	24.9 ± 2.7	25.3±2.9
	Other states (%) 18-24 (%) 25-29 (%) 30-34 (%) 35-39 (%) 40 and above (%) 0-5 (%) 6-10 (%) 11-15 (%) 16 years and above (%) an±SD) mean±SD) an±SD)	(%) Other states 62 (%) (3.5) 18-24 (%) 361 (20.2) 25-29 (%) 659 (36.9) 30-34 (%) 675 (37.8) 35-39 (%) 83 (4.6) 40 and above (%) 9 (0.5) 0-5 (%) 0 (0.0) 6-10 (%) 277 (15.5) 11-15 (%) 546 (30.6) 16 years and above (%) 964 (53.9) and ±SD) 28.42±3.9 mean±SD) 68.1±9.25 an±SD) 23.7±2.8	(%) Other states (%) 62 60 (2.3) 18-24 (%) 361 864 (20.2) (32.8) 25-29 (%) 659 841 (36.9) (31.9) 30-34 (%) 675 794 (37.8) (30.1) 35-39 (%) 83 134 (4.6) (5.1) 40 and above (%) 9 (0.5) 2 (0.1) 0-5 (%) 0 (0.0) 0 (0.0) 6-10 (%) 277 1147 (15.5) (43.5) 11-15 (%) 546 505 (30.6) (19.2) 16 years and above (%) 964 983 (53.9) (37.3) an±SD) 28.42±3.9 27.27±4.4 mean±SD) 68.1±9.25 67.2±9.7	Other states 62 60 49 (%) (3.5) (2.3) (1.5) 18-24 (%) 361 864 1429 (20.2) (32.8) (42.9) 25-29 (%) 659 841 1082 (36.9) (31.9) (32.5) 30-34 (%) 675 794 630 (37.8) (30.1) (18.9) 35-39 (%) 83 134 188 (4.6) (5.1) (5.6) 40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 0-5 (%) 0 (0.0) 0 (0.0) 0 (0.0) 6-10 (%) 277 1147 2140 (15.5) (43.5) (64.2) 11-15 (%) 546 505 440 (30.6) (19.2) (13.2) 16 years and above (%) 964 983 751 (39) (37.3) (22.5) (39) (37.3) (22.5) (30.5) (37.3) (22.5) (30.5) (37.3) (22.5) (30.5)	Other states 62 60 49 47 (%) (3.5) (2.3) (1.5) (1.4) 18-24 (%) 361 864 1429 1207 (20.2) (32.8) (42.9) (36.9) 25-29 (%) 659 841 1082 1247 (36.9) (31.9) (32.5) (38.2) 30-34 (%) 675 794 630 574 (37.8) (30.1) (18.9) (17.6) 35-39 (%) 83 134 188 239 (4.6) (5.1) (5.6) (7.3) 40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 0-5 (%) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 6-10 (%) 277 1147 2140 2190 (15.5) (43.5) (64.2) (67.0) 11-15 (%) 546 505 440 393 (15 (3).9) (37.3) (22.5) (21.0) </th <th>Other states 62 60 49 47 74 (%) (3.5) (2.3) (1.5) (1.4) (1.8) 18-24 (%) 361 864 1429 1207 1013 (20.2) (32.8) (42.9) (36.9) (24.2) 25-29 (%) 659 841 1082 1247 1865 (36.9) (31.9) (32.5) (38.2) (44.6) 30-34 (%) 675 794 630 574 826 (37.8) (30.1) (18.9) (17.6) (19.8) 35-39 (%) 83 134 188 239 468 (4.6) (5.1) (5.6) (7.3) (11.2) 40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 7 (0.2) 0-5 (%) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 16 (0.4) 6-10 (%) 277 1147 2140 2190 2704 (15.5) (43.5) (64.2) (67.0) (64.7) 11-15 (%)</th> <th>Other states 62 60 49 47 74 203 (%) (3.5) (2.3) (1.5) (1.4) (1.8) (4.1) (18-24 (%) 361 864 1429 1207 1013 704 (20.2) (32.8) (42.9) (36.9) (24.2) (14.3) (25-29 (%) 659 841 1082 1247 1865 2305 (36.9) (31.9) (32.5) (38.2) (44.6) (46.8) (37.8) (30.1) (18.9) (17.6) (19.8) (22.6) (35-39 (%) (4.6) (5.1) (5.6) (7.3) (11.2) (16.1) (40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 7 (0.2) 6 (0.1) (45.5) (45.</th> <th>Other states 62 60 49 47 74 203 133 (%) (3.5) (2.3) (1.5) (1.4) (1.8) (4.1) (2.8) 18-24 (%) 361 864 1429 1207 1013 704 396 (20.2) (32.8) (42.9) (36.9) (24.2) (14.3) (8.3) 25-29 (%) 659 841 1082 1247 1865 2305 2240 (36.9) (31.9) (32.5) (38.2) (44.6) (46.8) (46.7) 30-34 (%) 675 794 630 574 826 1114 1245 (37.8) (30.1) (18.9) (17.6) (19.8) (22.6) (26.0) 35-39 (%) 83 134 188 239 468 791 846 40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 7 (0.2) 6 (0.1) 68 (1.4) 6-10 (%) (15.5) (43.5)</th> <th>Other states 62 60 49 47 74 203 133 152 (%) (3.5) (2.3) (1.5) (1.4) (1.8) (4.1) (2.8) (3.3) 18-24 (%) 361 864 1429 1207 1013 704 396 161 25-29 (%) 659 841 1082 1247 1865 2305 2240 2002 25-29 (%) 665 794 630 574 826 1114 1245 1467 30-34 (%) 675 794 630 574 826 1114 1245 1467 35-39 (%) 83 134 188 239 468 791 846 869 40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 7 (0.2) 6 (0.1) 68 (1.4) 135 (2.9) 0-5 (%) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 16 (0.4) 90 (1.8) 114 (2.4)<!--</th--></th>	Other states 62 60 49 47 74 (%) (3.5) (2.3) (1.5) (1.4) (1.8) 18-24 (%) 361 864 1429 1207 1013 (20.2) (32.8) (42.9) (36.9) (24.2) 25-29 (%) 659 841 1082 1247 1865 (36.9) (31.9) (32.5) (38.2) (44.6) 30-34 (%) 675 794 630 574 826 (37.8) (30.1) (18.9) (17.6) (19.8) 35-39 (%) 83 134 188 239 468 (4.6) (5.1) (5.6) (7.3) (11.2) 40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 7 (0.2) 0-5 (%) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 0 (0.0) 16 (0.4) 6-10 (%) 277 1147 2140 2190 2704 (15.5) (43.5) (64.2) (67.0) (64.7) 11-15 (%)	Other states 62 60 49 47 74 203 (%) (3.5) (2.3) (1.5) (1.4) (1.8) (4.1) (18-24 (%) 361 864 1429 1207 1013 704 (20.2) (32.8) (42.9) (36.9) (24.2) (14.3) (25-29 (%) 659 841 1082 1247 1865 2305 (36.9) (31.9) (32.5) (38.2) (44.6) (46.8) (37.8) (30.1) (18.9) (17.6) (19.8) (22.6) (35-39 (%) (4.6) (5.1) (5.6) (7.3) (11.2) (16.1) (40 and above (%) 9 (0.5) 2 (0.1) 2 (0.1) 1 (0.0) 7 (0.2) 6 (0.1) (45.5) (45.	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BMI=body mass index; SD=standard deviation.

Table 2: Prevalence of overweight (%) and obesity (%) among employees (year 2010-2018).

Prevalence	2010	2011	2012	2013	2014	2015	2016	2017	2018
N	1814	2652	3342	3278	4198	4979	4833	4664	5505
Over all	579	827	850	888	1399	1987	2131	2080	2910
overweight, N (%)	(31.9)	(31.2)	(25.4)	(27.1)	(33.3)	(39.9)	(44.1)	(44.6)	(52.7)
Chi-square for trend	$X^2 = 1170.$	5, p=0.000							
050/ CT	29.76-	29.44-	23.92-	25.58-	31.87-	38.54-	42.7-	43.17-	51.38-
95% CI	34.04	32.96	26.88	28.62	34.73	41.26	45.5	46.03	54.02
Overweight, N (%)	536	757	781	822	1254	1758	1913	1875	2562
Overweight, N (70)	(29.5)	(28.5)	(23.4)	(25.1)	(29.9)	(35.3)	(39.6)	(40.2)	(46.4)
Obesity, N (%)	43 (2.4)	70 (2.6)	69	66 (2.0)	145	229	218	205 (4.4)	348
Obesity, N (70)	43 (2.4)	70 (2.0)	(2.1)	00 (2.0)	(3.5)	(4.6)	(4.5)	203 (4.4)	(6.3)
Chi-square for trend	$X^2 = 1202.$	1, p=0.000							

Table 3: Association of overweight and the type of work (production versus non-production), region and agecategories.

Variables	Year-w	ise overv	veight pr	evalence						Chi-square for trend as per type of work
	2010	2011	2012	2013	2014	2015	2016	2017	2018	
n	1787	2635	3331	3268	4179	4920	4795	4634	5455	
Overweight	574	824	849	887	1392	1961	2116	2068	2883	
Overweight	(32.1)	(31.3)	(25.5)	(27.1)	(33.3)	(39.9)	(44.1)	(44.6)	(52.9)	
Type of work										
Production, N	400	665	696	777	1186	1565	1805	1738	2309	$X^2=1105.8$,
(%)	(28.6)	(28.7)	(22.8)	(25.3)	(31.0)	(36.5)	(42.4)	(42.4)	(51.1)	p=0.000

Continued.

Variables	Year-w	ise overv	veight pr	evalence						Chi-square for trend as per type of work
Non-production,	174	159	153	110	206	396	311	330	574	X ² =49.99,
N (%)	(44.7)	(49.7)	(55.2)	(55.6)	(57.9)	(62.1)	(57.6)	(61.9)	(61.3)	p=0.000
Region										
Coastal Karnataka n=3024, N (%)	27 (23.1)	36 (18.7)	38 (13.0)	56 (19.7)	78 (21.3)	119 (26.6)	143 (33.4)	121 (29.0)	175 (36.6)	X ² = 83.34, P= .000
Malnad Karnataka n= 5404, N (%)	37 (17.8)	88 (22.4)	101 (18.4)	99 (17.8)	175 (26.5)	245 (32.3)	287 (38.1)	291 (39.8)	383 (48.2)	X ² = 273.72, P= .000
North Karnataka	112	162	167	175	277	400	425	403	543	$X^2 = 233.84, P = .000$
n=7245, N (%)	(29.9)	(28.6)	(24.1)	(25.5)	(31.7)	(39.0)	(42.7)	(42.5)	(50.2)	
South Karnataka	362	509	520	537	822	1064	1184	1154	1613	X ² = 566.95, P= .000
n=18292, N (%)	(35.3)	(35.8)	(29.8)	(31.7)	(37.3)	(42.8)	(47.6)	(48.4)	(56.8)	
Other states	36	29	23	20	40	133	77	99	169	$X^2 = 21.79, P = .005$
n=1038, N (%)	(58.1)	(48.3)	(46.9)	(42.6)	(54.1)	(65.5)	(57.9)	(65.1)	(65.5)	
Age-categories (in	n years)									
18-24 years	35	79	124	163	162	146	112	40	32	$X^2 = 187.11, P = .000$
n=6243 N (%)	(9.7)	(9.1)	(8.7)	(13.5)	(16.0)	(20.7)	(28.3)	(24.8)	(29.6)	
25-29 years,	180	215	238	272	499	690	810	710	795	$X^2 = 319.21, P = .000$
n=14,025 N (%)	(27.3)	(25.6)	(22.0)	(21.8)	(26.8)	(29.9)	(36.2)	(35.5)	(44.6)	
30-34 years,	309	447	368	304	424	607	627	691	994	$X^2 = 44.83, P = .000$
n=9235 N (%)	(45.8)	(56.3)	(58.4)	(53.0)	(51.3)	(54.5)	(50.4)	(47.1)	(52.0)	
35-39 years,	46	82	117	148	301	514	529	535	672	X ² = 5.79, P= .670
n=4661 N (%)	(55.4)	(61.2)	(62.2)	(61.9)	(64.3)	(65.0)	(62.5)	(61.6)	(64.4)	
40 years and above, n=840 N (%)	4 (44.4)	1 (50.0)	2 (100.0)	0 (0.0)	6 (85.7)	4 (66.7)	38 (55.9)	92 (68.1)	390 (64.0)	

Year-wise specific prevalence of overweight by type of work= $\frac{\text{employees who are overweight in the specific department}}{\text{number of all the employees in these department}} \times 100,$

Year-wise specific prevalence of overweight by type of work—

number of all the employees in these departments

Year-wise specific prevalence of overweight by region—

number of all the employees in these regions × 100,

Year-wise specific prevalence of overweight by different age-categories $\frac{\text{number of all the employees in these regions}}{\text{number of all the employees who are overweight in different age-categories}} \times 100$.

number of all the employees in that age-categories

Table 4: Year-wise prevalence of overweight by work-department and region.

Regions	2010	2011	2012	2013	2014	2015	2016	2017	2018		
N	1787	2635	3331	3268	4179	4920	4795	4634	5455	Chi-square	
Overweight	574 (32.1)	824 (31.3)	849 (25.5)	887 (27.1)	1392 (33.3)	1961 (39.9)	2116 (44.1)	2068 (44.6)	2883 (52.9)	values	
Production depa	Production department										
Coastal Karnataka n=3024, N (%)	17 (19.1)	28 (16.5)	29 (10.5)	52 (19.1)	65 (19.0)	90 (22.6)	122 (31.1)	99 (26.0)	145 (34.9)	X ² =82.10, p=0.000	
Malnad Karnataka n=5404, N (%)	28 (15.8)	78 (21.1)	92 (17.5)	90 (16.7)	163 (25.9)	217 (30.7)	270 (37.8)	274 (39.6)	352 (48.0)	X ² =279.82, p=0.000	
North Karnataka n=7245, N (%)	99 (29.0)	146 (27.1)	154 (23.2)	168 (25.0)	257 (30.5)	368 (37.9)	393 (41.5)	376 (41.6)	492 (49.3)	X ² =222.47, p=0.000	
South Karnataka n=18292, N (%)	251 (32.1)	408 (33.4)	415 (26.4)	461 (29.4)	689 (34.8)	877 (40.3)	1005 (46.3)	974 (46.5)	1297 (55.6)	X ² =565,96, p=0.000	
Other states n=1038, N (%)	5 (50.0)	5 (38.5)	6 (31.6)	6 (30.0)	12 (41.4)	13 (41.9)	15 (46.9)	15 (53.6)	23 (63.9)	X ² =9.76, p=0.282	
Non-production	departme	ent									

Regions	2010	2011	2012	2013	2014	2015	2016	2017	2018	Chi-square
Coastal Karnataka n=3024, N (%)	10 (35.7)	8 (34.8)	9 (52.9)	4 (33.3)	13 (54.2)	29 (58.0)	21 (58.3)	22 (61.1)	30 (47.6)	$X^2=10.14$, p=0.255
Malnad Karnataka n=5404, N (%)	9 (29.0)	10 (45.5)	9 (39.1)	9 (52.9)	12 (40.0)	28 (53.8)	17 (42.5)	17 (43.6)	31 (50.8)	X ² =6.86, p=0.552
North Karnataka n=7245, N (%)	13 (39.4)	16 (57.1)	13 (44.8)	7 (46.7)	20 (60.6)	32 (58.2)	32 (66.7)	27 (60.0)	51 (61.4)	X ² =9.45, p=0.305
South Karnataka n=18292, N (%)	111 (45.3)	101 (50.5)	105 (59.0)	76 (59.8)	133 (59.4)	187 (60.5)	179 (56.8)	180 (62.3)	316 (62.2)	X ² =28.08, P=0.000
Other states n=1038, N (%)	31 (59.6)	24 (51.1)	17 (56.7)	14 (51.9)	28 (62.2)	120 (69.8)	62 (61.4)	84 (67.7)	146 (65.8)	X ² =10.18, p=0.252

Table 5: Distribution of year-wise prevalence of overweight by age-group and work department.

Age group (in years)	2010	2011	2012	2013	2014	2015	2016	2017	2018	Chi aayaya
N	1787	2635	3331	3268	4179	4920	4795	4634	5455	Chi-square values
Overweight	574 (32.1)	824 (31.3)	849 (25.5)	887 (27.1)	1392 (33.3)	1961 (39.9)	2116 (44.1)	2068 (44.6)	2883 (52.9)	values
Production depa	rtment									
18-24, n (%) N= 6243, N (%)	23 (7.1)	70 (8.4)	116 (8.2)	157 (13.2)	153 (15.4)	132 (19.6)	93 (26.3)	26 (19.5)	17 (20.7)	X ² =147.24, p=0.000
25-29, n=14,025, N (%)	131 (24.8)	184 (24.1)	207 (20.3)	247 (20.7)	456 (25.7)	594 (27.7)	753 (35.5)	665 (35.0)	730 (44.2)	X ² =344.56, p=0.000
30-34, n=9235, N (%)	238 (44.8)	380 (57.1)	307 (58.3)	265 (52.1)	346 (49.7)	448 (52.0)	523 (48.4)	575 (44.3)	861 (50.5)	X ² =53.78, p=0.000
35-39, n=4661, N (%)	8 (50.0)	31 (58.5)	66 (65.3)	108 (61.0)	228 (64.4)	389 (64.7)	424 (62.6)	426 (60.4)	504 (64.9)	X ² =6.423, p=0.600
40 and above, n=840, N (%)	Data not	available	;		3 (100.0)	2 (50.0)	12 (57.1)	46 (70.8)	197 (65.7)	X ² =3.143,p=0.49
Non-production	departme	ent								
18-24, n=6243, N (%)	12 (31.6)	9 (28.1)	8 (36.4)	6 (33.3)	9 (47.4)	14 (48.3)	19 (45.2)	14 (50.0)	15 (57.7)	X ² =9.312, p=0.317
25-29, n=14,025, N (%)	49 (37.4)	31 (40.3)	31 (49.2)	25 (48.1)	43 (48.3)	96 (58.5)	57 (48.3)	45 (44.1)	65 (49.2)	X ² =15.73, p=0.046
30-34, n=9235, N (%)	71 (49.3)	67 (52.3)	61 (59.2)	39 (60.0)	78 (60.0)	159 (62.8)	104 (63.4)	116 (68.6)	133 (65.2)	X ² =18.91, p=0.015
35-39, n=4661, N (%)	38 (56.7)	51 (63.0)	51 (58.6)	40 (64.5)	73 (64.0)	125 (65.8)	105 (62.1)	109 (66.5)	168 (63.2)	X ² =3.456, p=0.903
40 and above, n=840, N (%)	4 (44.4)	1 (50.0)	2 (100.0)	0 (0.0)	3 (75.0)	2 (100. 0)	26 (55.3)	46 (65.7)	193 (62.5)	

Table 6: Association of overweight with type of work, region and service duration for the year 2018.

Predictors	N (%)	Unadjusted OR (CI)	P value	Adjusted OR (CI)	P value
Type of work					
Non-production	937 (17.2)	1		1	
Production	4517 (82.8)	0.661 (0.573-0.764)	0.000	0.809 (0.682-0.96)	0.015
Region					
South Karnataka	2843 (52.1)	1		1	

Continued.

Predictors	N (%)	Unadjusted OR (CI)	P value	Adjusted OR (CI)	P value
Other states	258 (4.7)	1.447 (1.108-1.89)	0.007	1.428 (1.064-1.918)	0.018
Coastal Karnataka	478 (8.8)	0.44 (0.36-0.538)	0.000	0.484 (0.395-0.593)	0.000
Malnad Karnataka	795 (14.6)	0.708 (0.605-0.829)	0.000	0.789 (0.672-0.927)	0.004
North Karnataka	1081 (19.8)	0.769 (0.668-0.885)	0.000	0.799 (0.693-0.922)	0.002
Service duration (in year	rs)				
16 and above (%)	1214 (22.3)	1		1	
0-5 (%)	183 (3.4)	0.405 (0.296-0.555)	0.000	0.336 (0.242-0.468)	0.000
6-10 (%)	3314 (60.8)	0.457 (0.398-0.524)	0.000	0.492 (0.428-0.567)	0.000
11-15 (%)	744 (13.6)	0.71 (0.588-0.857)	0.000	0.716 (0.591-0.867)	0.001
Hosmer and Lemeshow	test=0.198 (signific	cance)			
Nagelkerke R square=0.	055				

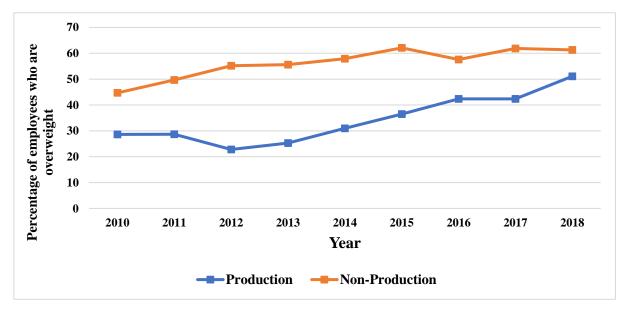


Figure 1: Year-wise prevalence of overweight by type of work (2010-18).

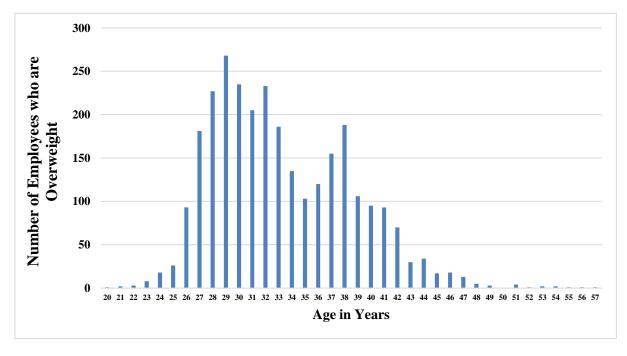


Figure 2: Age-wise distribution of overweight employees (year 2018).

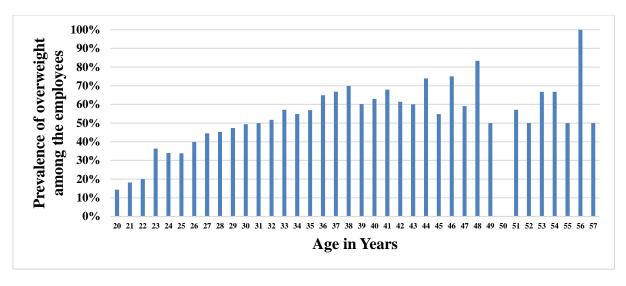


Figure 3: Age-specific prevalence of overweight among the employees in 2018.

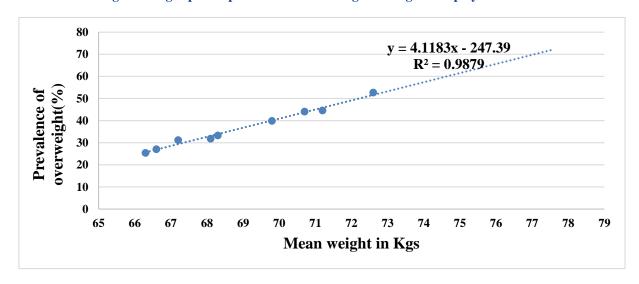


Figure 4: Relationship between mean weight of employees and overweight prevalence in year 2018.

Year-wise overall prevalence of overweight and obesity among employees is shown in Table 2. Prevalence of overweight ranged between 25.4% to 33.3% between year 2010 to 2018. Highest prevalence was at 52.7% in year 2018. A significant increase in trends in overweight prevalence among employees was observed between year 2010-2018 (Chi square for trend, p<0.05).

Specific prevalence rates by age group, work type and region are presented in Table 3. Prevalence of overweight was significantly higher among employees in non-production department (Figure 1), hailing from South Karnataka. It was also significantly higher among employees aged between 35-39 years in all the years between 2010-2018. Age-wise distribution of overweight and age-specific prevalence of overweight for the year 2018 have been shown in Figure 2 and 3, respectively. Specific prevalence for overweight in production departments ranged between 22.8% to 51.1% as against

44.7% to 62.1% amongst non-production between 2010-2018.

Overweight was higher among employees from South Karnataka (29.8-56.8%) and amongst employees aged between 35-39 years (55.4-65%), irrespective of their type of work (Table 4). It ranged between 29-45.3% among all Karnataka regions in the year 2010 in non-production group but reached 47.6-62.2% by the year 2018. Though the overweight prevalence was higher in the employees who work in non-production, the trend was not significant over the regions except for employees from South Karnataka. Similar findings were observed for different age groups among employees of non-production (Table 5). Age group wise specific prevalence in 18-24 years ranged from 7.1-26.3% in the production department whereas 28.1-57.7% in the non-production department.

For the year 2018, we estimated the risk of being overweight based on type of work, native region and service duration (Table 6). Employees working in the production department had 19.1% less risk of being overweight (OR=0.809: 95% CI 0.682, 0.96) than the employees working in the non-production department. Employees of other states had 42.8% high risk of being overweight (OR=1.428: 95% CI 1.064, 1.918) in respect to South Karnataka, whereas the risk is comparatively less for the other regions of Karnataka. Also, employees who were working for 0-5 years had 66.4% less risk of being overweight (OR=0.336: 95% CI 0.242, 0.468) than those who were working for 16 years and more.

DISCUSSION

This record analysis study was conducted across a large sample of workers in an automobile industry. It was implemented as part of an ongoing healthy workplace programme to reduce overweight and to enable the health managers to make data-driven decisions for programme improvement. It provided prevalence estimates of overweight, obesity and risk by type of work and region of residence; the evidence for which was currently limited in Indian settings.

We observed a significant increase in overweight prevalence between years 2010 (31.9%) to year 2018 (52.7%), reflecting a concurrent increase in mean weight of employees during the same time (68.1 kg to 72.6 kg). Change of mean weight by 4.5 points resulted in change in overweight prevalence by 20.8 percent points, among the employees. Mean BMI increased from 23.7 to 25.3. This modest increase in mean weight and mean BMI resulted in bigger increased in prevalence of overweight from 31.9% in year 2010 to 52.7% in 2018.

Population prevalence of overweight (males, 15-49 years) in India was estimated at 18.9% (NFHS-4, year 2015-2016). Though the industrial population rates cannot be directly compared with general population in epidemiological parlance, citing role of healthy worker effect, we nevertheless compared our results with NFHS as the gender and age groups were similar (15-49 years). We observed higher overweight prevalence in industrial workers (31% to 52%). This could be due to regular screening, better socio-economic conditions and nutritional support in industries. Our findings were similar to evidence from other independent research studies from industries across India which reported overweight prevalence between 17-65.5%, mostly clustered around 31%. 12,16-19

High prevalence of NCD risk factors was observed in Indian industrial settings and was a cause of concern as well as an opportunity for carrying out workplace interventions. But seldom was evidence available for association between work type, region, age and overweight prevalence. Our study showed work type and region was also a significant factor for stratifying risk for

being overweight. Further research is needed to correlate various cultural practices which might influence the risk profiling for overweight and subsequent NCDs. Service duration and overweight were closely linked as age correlated with both the variables. As age increased along with service duration, the risk of being overweight also increased likewise indicating the age-cohort effect.

Prevalence of overweight was higher among employees from non-production related departments across the total study period and this finding was consistent for all the other study variables, irrespective of region and agegroups. This was probably due to insufficient physical activity, sedentary nature of a desk-job and higher age of employees (more than 60% of the employees were aged 30+ years in the non-production department, as against the production departments).

Industrial medical officers, during their routine work, hypothesized that employees from South Karnataka were observed to be more overweight than other employees. Our study tested this hypothesis and observed that prevalence of overweight was more among employees hailing from region of South Karnataka as against other regions and employees from other states. Most people from South Karnataka were rice eaters. Nearly 55% of South Karnataka employees were aged 30+ years and 57% were involved in non-production departments. Thus, dietary practices, higher age and predominantly non-production work differentials between south Karnataka and others could have resulted in increased overweight prevalence.

We observed that mean weight and overweight prevalence were strongly correlated (Pearsons r=0.994, p<0.05) (Figure 4). Linear regression-based forecasting revealed that for every unit change in mean weight, the overweight prevalence could increase by 4 units. This implies the prevention paradox for which the intervention should focus to reduce the mean weight of the employees in a way that even if the mean weight was reduced to a smaller extent, it will help in a major reduction of overweight prevalence by shifting the curve to the left. Hence, interventions should aim to reducing mean weight of employees.

The validity of anthropometric measurement was also important from quality perspective. Discussion with medical officers indicated that industry followed a standard system of weight recording, considering average of 2 readings using a calibrated instrument (same instrument manufacturer for all employees). Data was extracted from a robust HMIS software, minimising chances of entry errors. The WHO standard categorisation of BMI was used to enable comparisons across different studies.

Assuming similar prevalence as observed in our study (52.7%) for nearly 90 million industrial employees (2019) in India, we expected nearly 47 million workers to be

overweight and who needed support to reduce their weight. in India. Significant underreporting is expected though and actual number maybe higher. Figures were higher in senior employees. Studies from different industries indicated prevalence of NCDs at 90.2% in the age group of 50-59 years with 56.9% of the employees being overweight. Unless intervened, it is expected that significant number of middle-aged workers may develop NCDs in later years of their service. This could be averted by healthy workplace programmes.

Proportion of workers with overweight was reportedly more than workers with classical exposure related occupational diseases like silicosis. Though overweight was not categorised as an occupational disease, it was a health priority owing to its common prevalence. Unfortunately NCDs are currently ignored in current legislations governing health systems in industries. There is a need to include NCDs, NCD risk factors in existing regulatory framework and legislations governing industrial health to ensure universal coverage of health promotion interventions in industries.

The industry is implementing weight reduction interventions but a reduction in prevalence was not observed, indicating a need to introspect the ongoing health promotion programmes. Linear forecasting estimated the overweight prevalence to rise to 38.5% and 42.6% by the year 2020 and 2025 respectively (data not shown). Apart from NCDs, overweight is associated with reduced productivity due to associated musculoskeletal problems, it also led to increased cost of care and repeat visits to onsite clinics. Hence, clinical surveillance was important to halt the progress of overweight among the employees. There is a need for a comprehensive review to strengthen the ongoing health promotion interventions with emphasis on weight reduction.

Limitations

Though the sample size is big, the study was limited to one industry. There was a need for a multi-site study.

Clinical significance

This record analysis study was conducted across a large sample of workers in an automobile industry. There is a need to include NCD risk factors surveillance in existing regulatory framework and legislations governing industrial health through occupational clinics setup to ensure universal coverage of health promotion interventions in industries.

CONCLUSION

Overweight is commonly prevalent among industrial employees and the prevalence is increasing year-on-year. Small increase in mean weight is resulting in bigger increase in overweight prevalence. Risk for overweight is higher among employees aged 30+years, from southern

Karnataka and those working in non-production-line related employment. PME data is useful to understand overweight prevalence and risk, indicating scope for regular surveillance. There is much benefit in upscaling and strengthening PME based overweight surveillance in all industries. This could help to improve overall NCD situation in the country.

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