

Occupational Health Risk and Blood Pressure among Salt Workers of Marakkanam, Villupuram District of Tamil Nadu

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Abstract: *Tamil Nadu is the second biggest producer of salt in India, next just to Gujarat. The salt in the state is produced from saltpans along the seacoast. Specialists' workers working near salt processing plants might breathe in salt particles skimming noticeable all around, prompting an ascent in plasma sodium, which, thus, might build the pulse or blood pressure and the danger of hypertension.*

The goal of the present study is to explore work related wellbeing hazard i.e occupational health risk and circulatory strain or blood pressure of salt workers of Marakkanam, Villupuram locale of Tamil Nadu. This cross-sectional study was attempted to determine the prevalence of blood pressure and the danger of hypertension among workers of 18 years or above. The specialists working in brine pans (water with high concentration of salt) situated far from processing plants were characterized as " brine workers " while the workers or laborers who worked with dry salt in the region of salt processing plants were characterized as " non-brine workers". Blood pressure (BP) was measured amid each clinical examination. An aggregate of 142 brine workers and 176 non-brine workers were interviewed and measured using a predesigned and pretested questionnaire.

The outcome uncovered that prevalence Mean systolic blood pressure of non-brine workers (122.1 ± 13.3 mm Hg) was significantly higher than that of brine workers (118.8 ± 12.8 mm Hg, $p < 0.01$). Mean diastolic blood pressure of non-brine workers (71.5 ± 10.4 mm Hg) was significantly higher than that of brine workers (69.7 ± 9.4 mm Hg, $p = 0.02$). The prevalence of hypertension was essentially higher in non-brine workers (12.2%) than in brine workers (7.0%, $p = 0.02$). 16 laborers were monitored while they utilized face masks and spectacles, for six days. Systolic, and diastolic, blood pressure of these laborers started declining on the third day and kept on declining on the fourth day, however stayed stationary up to the 6th day. The concentration of salt particles in the breathing zone of these laborers was 376 mg/m³ air. Inhalation of salt particles in non- brine workers may be a word related reason or occupational cause for increased blood pressure

Keywords: *Occupational Health, Blood pressure, Salt Workers, Occupational Health Risk.*

1. INTRODUCTION

Salt workers are exposed to word related risks like contact with salt crystals and saline solution, physical anxiety, sunlight and glare because of sunlight reflected by salt crystals stones. Not very many studies have recorded the morbidity among the salt laborers. All through the world, most grown-ups or adult spend quite a bit of their waking hours at work. Work gives various monetary and other advantages. At the same time, people at work face a variety of hazards owing to chemicals, biological agents, physical factors, adverse ergonomic conditions, allergens, a complex network of safety risks, and many and varied psychosocial factors. WHO reports that every year an expected 160 million new instances of work-related illness happen and takes 1.7 million lives, representing 3% of all deaths (1). There is an abundance of scientific evidence showing a direct relation between salt intake and blood pressure (2).

Several studies were carried out on different animals by (3), large population-based studies (2,4,5,6, 7), epidemiological studies (8,9,10), meta-analyses of clinical trials (11, 12, 13), and randomized controlled trials (14, 15) have shown that blood pressure is directly related to salt intake. People's occupations also have varying impact on their blood pressure (16; 17,18, 19, 20).

Salt workers involved in the process of manufacturing, processing or milling, and packing of salt are exposed to salt through their surroundings or their environment. Since most salt processing plants in India are not completely enclosed, salt particles float in the air in the vicinity of the workers i.e. all

around in the region of the laborers. These workers may therefore breathe in considerable amounts of salt during working hours. These salt particles may be inhaled or breathed in and therefore absorbed in the airway surface epithelium (16, 19, 21, 22, 23) or the lungs (24). These same fine particles are also able to translocate from the lungs into the circulatory system (24).

Breathed in salt particles may be carried through a continuous upward mucocilliary current on the airway surface to throat, where they can be swallowed. This is liable to increase the plasma sodium level, which in turn may increase the BP (25) and the risk of hypertension in the exposed workers. However, this issue may be totally preventable. This objective was tested through a cross-sectional and experimental study involving salt workers; the results are presented and discussed below.

2. METHODS

A cross-sectional study was conducted among 318 salt workers of Marakkanam, Tamil Nadu. Marakkanam is one of the 22 community development blocks in Villupuram district of Tamil Nadu, around 130 kilometers south of Chennai. The major occupations are agriculture; fishing and salt production with salt pans spread over 2000 acres. Around 2000 salt workers dwell in 10 permanent villages located adjacent to the salt pans.

The aim of the study was explained to the subjects. Their age (in years), sex, detailed occupational history (including exact nature of job and duration of working in salt industry) were recorded on schedules especially designed for occupational health examinations.

After obtaining the informed consent, the anthropo-medical examination was carried out like stature or height, weight and blood pressure. Height was measured in centimeters, using an anthropometric rod, while the subject stood erect on a flat platform. After the subject had rested for five minutes in a supine position, the blood pressure was measured in the right arm using digital blood pressure equipment. Three readings were taken. The initial two readings were to acquaint the subjects with the procedure and the third reading was recorded for analysis.

The workers who were involved in crushing, grinding, milling, packing, and loading salt, and who did not work with brine or saline solution, were defined as non-brine workers (176). These workers worked in the vicinity of salt processing plants. Workers who worked with brine pans for the purpose of crystal reshuffling and raw salt heaping were defined as brine workers (142); their site of work was far away from the salt milling plants. The workers who worked as non-brine workers for some time and also worked as brine workers on some other days were excluded from analysis. Workers who were involved in only administrative and other related activities were also excluded from the analysis.

Hypertension was defined as systolic blood pressure more than 139 mmHg and/or diastolic blood pressure 90 mmHg or above (26). Body mass index was calculated as $(\text{Weight in Kg} / (\text{Height in meters})^2)$. Systolic and diastolic blood pressure was compared in the brine workers and non-brine workers. Student's t-test and Chi square test were used to determine the statistical significance of the differences.

Since mean systolic and diastolic blood pressure, and prevalence of hypertension were found to be significantly higher in non-brine workers as compared to brine workers, an intervention study was carried out to test the hypothesis that exposure of non-brine workers to salt particles floating in environment may contribute to rise in their blood pressure.

For this reason, twenty one non-brine workers, working at or near salt processing plants, who volunteered to take an interest in the study, were enrolled. We clarified the study hypothesis and provided them with face masks and spectacles with plain glasses. The masks were dust monitors made of poly vinyl chloride, containing a disposable filter cartridge of nitrocellulose, these covers or masks could filter 82.8% dust particles of size 10 μm or less (27). The workers were trained and motivated to utilize them appropriately while working, and were observed and followed for six successive days. Amid this period, their resting blood pressure was measured in the supine position, before beginning work in the morning. Only sixteen of them regularly attended the worksite and used the face mask and eyeglasses for all six consecutive days, while others were present on some days, but absent on others.

The dust sampler was put at two sites for six days. The particles of 10 μm or more were collected at the base of the cyclone of the sampler and those smaller than 10 μm were deposited on the filter paper of the sampler. Volume of total air entering the sampler and weight of particles gathered or collected were used to calculate the average concentration of both types of dust in the environment.

3. RESULTS

Table1. Distribution of Study Subjects According to their Characteristics Features

Characteristics		Brine workers			Non- brine workers			P value
		N	%	Mean± SD	N	%	Mean± SD	
Age (Yrs)	Males	119	83.8	30.7± 9.8	137	84.0	28.3±9.4	<0.01*
	Females	23	16.2	34.2±8.9	39	16.0	35.4±8.5	0.49
	Both Sexes	32.4±8.9			31.4±9.4			0.01*
Literacy (%)		34.4			44.6			0.04
Income (Rs Per annum)		18510±134.8			197660±146.8			0.05
Smoking Habit (%)		32.7			34.8			0.26
Alcohol users (%)		11.7			12.7			0.16
BMI (Kg/m ²)		18.8±1.4			18.6±3.6			0.29
Dietary Habit (%)	Veg.	32.3			37.7			0.14
	Non Veg.	67.7			62.3			0.14
Duration of Work (Yrs)		12.5±8.1			9.8±5.8			<0.01*

Above table explain the distribution of Brine workers and Non- brine workers according to their Characteristics features like Age, Sex, Literacy, Income (Rs Per annum), Smoking Habit, percentage of Alcohol users, BMI, Dietary Habit and Duration of Work. Nearly 83-84% of workers studied were male, working in both the sectors and only 16% of them are female. Their mean age was about 34-35 years (female) and 28-30 years (male). Nearly 55% workers were non-brine workers and nearly 44% were brine workers.

The literacy of non-brine workers (44.4) was higher than brine workers (34.4), similarly the per annum income of non-brine workers was also more than the brine workers. Similar kinds of result was also found in the case of smoking habit, and percentage of alcohol users, as 32.7% and 11.7% workers were brine workers and 34.8 % and 12.7% were non-brine workers. However the BMI of both the groups was almost same and most of the workers of the both the sectors were non vegetarian, only 32.3% in case of brine workers and 37.7% in case of non-brine workers were vegetarian. Eventhough the duration of exposure of salt was more in case of brine workers than non brine workers

hardly much significant differences was observed between brine workers and non- brine workers in the case of smoking habit, percentage of alcohol users, literacy, income (Rs Per annum), dietary habit and body mass index.

Table2. Distribution of Brine Workers and Non-Brine Workers According to Systolic and Diastolic Blood Pressure

Blood pressure		Brine workers		Non- brine workers		P value
		N	Mean± SD	N	Mean± SD	
Systolic BP (Average)	Males	119	118.8±10.6	147	121.7±11.5	<0.01*
	Females	23	112.3±15.7	29	117.4±15.4	0.01
	Both Sexes	142	117.7±11.9	176	121.2±12.4	<0.01*
Diastolic BP (Average)	Males	119	68.5±8.5	147	71.7±11.3	0.09
	Females	23	70.2±6.7	29	74.3±9.4	0.02*
	Both Sexes	142	68.6±8.5	176	70.6±9.5	0.01*

*Difference significant; Z-test and Student's t-test (two-tailed)

Table 2 reflects the distribution of brine workers and non-brine workers according to Systolic and Diastolic Blood Pressure. Mean systolic blood pressure of male (118.8±10.6) and female (112.3±15.7) brine workers were lower than the non-brine workers. However it was higher in the case male workers (118.8±10.6, 121.7±11.5) of both the groups than female (112.3±15.7, 117.4±15.4) workers of both the groups. Similarly the Mean diastolic blood pressure of male (68.5±8.5) and female (70.2±6.7) brine workers were lower than the non-brine workers (71.7±11.3(male), 74.3±9.4 (female)). However it was higher in the case female workers (70.2±6.7, 74.3±9.4) of both the groups than male (68.5±8.5, 71.7±11.3) workers of both the groups. Statistical calculation like two-tailed Student's t-test and Z-test explains a significant difference in both the sexes in the case of Mean systolic blood pressure.

Table3. Prevalence of Hypertension in Brine Workers and Non-Brine Workers According to Various Characteristics

Characteristics		Brine Workers			Non-Brine Workers		
		N	Hypertensive Cases		N	Hypertensive Cases	
			No.	%		No.	%
Age (Yrs)	<40	104	6	5.7	136	12	8.8
	>40	38	4	10.5	30	7	23.3
Gender	Male	119	9	7.5	147	17	11.5
	Female	23	1	4.3	29	4	13.8
Literacy	Illiterate	92	8	8.7	99	14	14.1
	Literate	50	2	4.0	77	7	9.1
Annual income (Rs.)	<18000	90	5	5.6	95	12	12.6
	>18000	52	5	9.6	81	9	11.1
BMI (Kg/m ²)	< 18	55	2	3.6	68	6	8.8
	18+	87	8	9.1	108	15	13.8
Duration of Work (Yrs)	<10	58	2	3.4	113	11	9.7
	10 +	84	7	8.3	63	10	15.8
Smokers or ex smokers	Smokers	95	7	7.3	117	16	13.6
	Non smokers	47	2	4.2	59	5	8.5
Alcohol users OR ex user	Yes	129	8	6.2	159	20	12.6
	No	13	1	7.6	17	1	5.8
Tobacco Chewing	Yes	108	7	6.4	120	15	12.5
	No	34	3	8.8	56	7	12.5
Diet Pattern	Vegetarian	89	7	7.8	118	15	12.7
	Mixed	55	2	3.6	58	6	10.3
Total Prevalence		142	10	7.0	176	21	11.9

The above table highlights the prevalence of hypertension in brine workers and non-brine workers according to various characteristics like Age, sex, literacy, annual income, duration of work or exposure, smoking status, Alcohol users, Tobacco users, Diet Pattern and total prevalence.

Most of the hypertension cases in the case of brine workers were male (7.5%), more than 40 years of age (10.5%), illiterate (8.7%), having a income of more than 18000 per annum (9.6%), BMI was more than 18 (9.1%), more than 10 years of exposure (8.3%), smokers (7.3%) but non alcoholic and not chewing tobacco and are vegetarian in their diet pattern.

Similarly Maximum hypertension cases in the case of non-brine workers were found in case of female (13.8%), more than 40 years of age (23.3%), illiterate (14.1%), having a income of less than 18000 per annum (12.6%), BMI was more than 18 (13.8%), more than 10 years of exposure (15.8%), smokers (13.6%), alcoholic (12.6%), chewing tobacco (12.5%) and are vegetarian in their diet pattern.

However various characteristics like Age, sex, literacy, annual income, duration of work or exposure, smoking status, Alcohol users, Tobacco users, Diet Pattern shows that the prevalence of hypertension was higher in case of non-brine workers than brine workers, even the total prevalence of hypertension was also higher in case of non-brine workers (11.9) than brine workers (7.0).

Results of Experimental Intervention

Table4. Mean Working Hours, Period of Use of Protective Devices and Morning Blood Pressure of Workers on the Days of Intervention (N = 16)

Day of intervention	Mean no. of hours Worked	Mean no. of hours masks used	Mean no. of hours glasses used	Mean Systolic Blood Pressure (mm Hg)	Mean Diastolic Blood Pressure (mm Hg)
I st Day	6.3 ± 0.6	3.8 ± 1.1	4.7 ± 0.7	128.9 ± 11.2	81.8 ± 8.9
II nd Day	10.1 ± 1.5	5.4 ± 1.4	6.4 ± 1.5	128.8 ± 11.9	81.7 ± 11.8
III rd Day	9.8 ± 1.7	4.5 ± 1.2	5.1 ± 1.8	124.5 ± 10.4	77.5 ± 8.7
IV th Day	7.8 ± 0.6	4.3 ± 1.8	4.7 ± 1.2	118.6 ± 9.8	63.7 ± 7.9
V th Day	9.4 ± 0.8	4.1 ± 1.0	4.4 ± 0.8	114.9 ± 7.1	64.9 ± 8.1
VI th Day	9.2 ± 1.4	4.7 ± 1.3	5.1 ± 1.4	115.7 ± 6.4	64.0 ± 5.6
Total	8.6 ± 1.8	4.7 ± 1.4	5.0 ± 1.6		

The above table shows the result of experimental intervention, in this experimental intervention, data were filtered based on mean number of working hours, mean number of hours of masks used, mean number of hours glasses used along with mean systolic and diastolic blood pressure of workers according to days of intervention from one to six.

Maximum mean number of working hours was found on IInd Day followed by IIIrd, Vth day and VIth day and minimum mean number of working hours was found on Ist day. However in case of mean number of hours of masks used, Maximum was also found on IInd day followed by VIth and IIIrd day and minimum was found on Ist day. A similar response was also observed in the case of mean number of hours glasses used, as the maximum was found on IInd day. But when we discuss about the mean systolic and diastolic blood pressure of workers, maximum mean systolic and diastolic blood pressure was found on Ist day (128.9 ± 11.2 and 81.8 ± 8.9) followed by IInd (128.8 ± 11.9 and 81.7 ± 11.8) and minimum mean systolic blood pressure was found on (114.9 ± 7.1) Vth day and diastolic blood pressure was found on (63.7 ± 7.9) IVth day. So the mean values of both systolic and diastolic blood pressures were decreasing on the IIIrd Day and continue to fall even on IVth day. But remained stationary after that each day.

Table5. Comparison of Mean Systolic and Diastolic Blood Pressures of the Workers on Consecutive Days of Intervention

Day of intervention	Mean Systolic Blood Pressure (mm Hg)	p value	Mean Diastolic Blood Pressure (mm Hg)	p value
I st Day	128.9 ± 11.0	0.98	81.8 ± 8.7	0.95
II nd Day	128.8 ± 11.9		81.7 ± 12.7	
II nd Day	128.8 ± 11.9	0.04*	81.7 ± 12.7	0.16
III rd Day	124.5 ± 10.2		77.5 ± 8.7	
III rd Day	124.5 ± 10.2	0.03*	77.5 ± 8.7	0.001*
IV th Day	118.6 ± 9.8		63.7 ± 7.7	
IV th Day	118.6 ± 9.8	0.08	63.7 ± 7.7	0.55
V th Day	114.9 ± 7.0		64.9 ± 8.1	
V th Day	114.9 ± 7.0	0.68	64.9 ± 8.1	0.65
VI th Day	115.7 ± 6.4		64.1 ± 5.6	

The above table explains the comparison of mean systolic and diastolic blood pressures of the workers on consecutive days of intervention. Statistically significant difference was observed in the case of mean systolic blood pressure between IInd and IIIrd day (0.04*), between IIIrd and IVth day (0.03*) but was not found in between Ist and IInd day (0.98) intervention, between IVth and Vth day (0.08) and also between Vth and VIth day (0.68) intervention. However in the case of mean diastolic blood pressure between IIIrd and IVth day, (0.001*) but was not found in between Ist and IInd day (0.95) intervention, between IInd and IIIrd day (0.16) between IVth and Vth day (0.55) and also between Vth and VIth day (0.65) intervention.

4. DISCUSSION

There is an abundance of scientific evidence showing a direct relation between salt intake and blood pressure. Salt workers involved in the process of manufacturing, processing or milling, and packing of salt are exposed to salt through their surroundings or their environment. Since most salt processing plants in India are not completely enclosed, salt particles float in the air in the vicinity of the workers i.e. all around in the region of the laborers. These workers may therefore breathe in considerable amounts of salt during working hours. Breathed in salt particles may be carried through a continuous upward mucocilliary current on the airway surface to throat, where they can be swallowed. This is liable to increase the plasma sodium level, which in turn may increase the BP (25). Keeping in mind the objective of the study, a cross-sectional study was conducted among 318 salt workers of Marakkanam, Tamil Nadu. both systolic and diastolic blood pressure and prevalence of hypertension were recorded to be more in non-brine salt workers who were exposed to a chemical called sodium chloride particles, which is present in the air of the breathing area (27).

After inhaling the salt may be absorbed from respiratory tract (16, 18, 19, 21, 22) or may be the mucocilliary current may transmit the salt to pharynx, where it may be swallowed and then absorbed from the digestive tract. This may result in increase in plasma sodium and may be responsible for high blood pressure (21, 22).

as we all know urinary sodium (indicator of sodium intake) and plasma sodium are related with blood pressure differences, which are of high importance for the clinical and health expert (28). Eventhough the main or exact reason or mechanism between increased plasma sodium and increased blood pressure are not very clear but present knowledge and concept, explains the idea for an increase in extracellular fluid volume but high plasma sodium increases a transfer of fluid from the intracellular to the extracellular space, and stimulates the thirst center

In this way plasma sodium is responsible for an increase in extracellular fluid volume. Eventhough the change in Extra Cellular liquid Volume might have a weight impact, the increase in plasma sodium itself may be responsible for increasing the blood pressure (21, 22).

Blood pressure (Systolic and diastolic) and the predominance of hypertension among non-brine (uncovered) workers were contrasted and brine workers, who were not exposed to salt particles in air. BP is influenced by various components, like Age, Sex, Literacy, Income (Rs Per annum), Smoking Habit, percentage of Alcohol users, BMI, Dietary Habit and Duration of Work. Both groups of studied workers did not differ on these parameters.

Nonetheless, Mean systolic blood pressure of male and female brine workers were lower than the non-brine workers. However it was higher in the case male workers of both the groups than female workers of both the groups. Similarly the Mean diastolic blood pressures of male and female brine workers were lower than the non-brine workers (male), (female)). However it was higher in the case female workers of both the groups than male workers of both the groups. Statistical calculation like two-tailed Student's t-test and Z-test explains a significant difference in both the sexes in the case of Mean systolic blood pressure,

However, various characteristics like Age, sex, literacy, annual income, duration of work or exposure, smoking status, Alcohol users, Tobacco users, Diet Pattern shows that the prevalence of hypertension was higher in case of non-brine workers than brine workers, even the total prevalence of hypertension was also higher in case of non-brine workers than brine workers and this consistency further strengthens the above observation. It can, therefore, safely be concluded that blood pressure and prevalence of hypertension of non-brine workers were higher than brine workers. To give new dimension to the study, an experimental intervention was performed; the decline in blood pressure while using face masks and glasses during work time again strengthens this objective. The exact mechanism by which the decline of salt intake could significantly reduce the blood pressure is not clear; similarly the clear cut role of eye glass using it as protective measure and its role in lowering the blood pressure is also not clear. Thus, the results of this intervention study do not fully support the objective that the cause of higher blood pressure and higher prevalence of hypertension in non-brine workers is inhalation of salt particles from the environment. Further studies on salt workers are needed to elucidate our findings.

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