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High prevalence of occupational environment influenced high Blood pressure observed among Saltpan workers of Thoothukudi

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Abstract: The aim of the present study was to assess the distribution of blood pressure cases in stable and homogeneous population of unskilled, low wage earning salt industry workers. The Prevalence of high blood pressure was established for this specific group. The subjects were 657 active employees at a saltpan in Thoothukudi. These subjects underwent blood pressure measurements, and clinical examination. The results were compared with those of similar studies carried out among other white collared workers of Thoothukudi. The crude prevalence of high blood pressure detected in this group of workers was very high. The risk of hypertension has a close relationship with the nature of work, age and experience of the workers. Prevalence of hypertension in the group studied is significantly higher than that observed in other groups of workers studied in Thoothukudi. Such a finding points to the need for further investigation so as to isolate those factors involved in the increased blood pressure found in this group.

Keywords : Hypertension, saltpan workers, occupational disorders.

Introduction

Hypertension, is a very important public health issue because hypertension is a major risk factor for premature death and disability from heart attack, heart failure, stroke, and many other afflictions^{1,2}. Heredity, high salt intake, physical inactivity, obesity and psychosocial stress interact to cause hypertension, the price we pay for urbanization and industrialization. The workers in the higher noise environment had higher systolic and diastolic blood pressure after adjusting for confounding factors³. People's occupations also have varying impact on their blood pressure⁴⁻⁷. In humans, the issue has been whether variation in sodium diet generally aimed at producing a difference of 70 to 100 m.mol of sodium or an amount equal to 50% to 75% of usual daily intake-would produce a measurable difference in blood pressure. However, there has been enormous variation between individuals regarding the effect of salt on pressure. Reducing average salt intake in the population to reduce overall blood pressure have been debated vigorously⁸⁻¹¹. One recent review concluded that interventions to reduced dietary sodium have trivial effects and do not support the need for public health action⁹. Salt sensitivity also increases with age in both hypertensive and normotensive persons¹².

Salt workers involved in the process of manufacturing, milling, and packing of salt are exposed to salt via their environment. Since most salt milling plants in India are not fully enclosed, salt particles float in the air and in the vicinity of the workers. These workers may therefore inhale considerable amount of salt during working hours. The dust and salt fumes that are evolved during various salt producing operations may enter into the body of the workers through respiratory air and also crakes of the skin especially in palm and foot may result in various physical and physiological complications including high blood pressure.

Materials and Methods

A cross-sectional study was conducted 10 important among salt workers of saltmanufacturing sites Thoothukudi of area, Tamilnadu. Occupational health check-up camps were held at these ten sites for the collection of relevant data. The procedures followed were in accordance with the Kripa Ram Haldia¹³. The camps were organized in collaboration with the owners of salt manufacturing units. Each camp lasted for 3 days. All the workers from nearby salt manufacturing units were invited for a free health examination. All relevant information were collected from both the sexes of the workers by supplying a questionnaire. The blood pressure was observed with the help of a physician. Workers who were absent on the dates of the health camp were not included in the study. During the camp the blood pressure (BP) of the workers, were carefully noted using mercury type Sphygmomanometer. A total of 657 workers including both sexes, employed in various salt manufacturing units, milling and packing units were turned up in the camp.

Blood pressures of the subjects were measured after a five-minute period of rest, with the back supported and the legs uncrossed. Constrictive clothing was removed from around the upper arm, and it was rested on a table at heart level. Abnormal blood pressures observed were confirmed after a check up for two subsequent days. Optimal blood pressure considered was 120/80 mmHg. High blood pressure, or hypertension, was defined as either a systolic blood pressure greater than 140 mmHg or a diastolic blood pressure greater than 90 mmHg. Systolic blood pressure is a more powerful predictor of cardiovascular events than diastolic blood pressure. In order to test the validity of the observed results and to test the significance of difference between the observed value and hypothetical value (normal population) of samples, the 'Z' test was calculated. To test the test of significance between the control and the sample and within the samples the coefficient of variance and ANOVA was employed using Microsoft excel equation version 6.1.

In the saltpan environment there is every possibility for the entry of salt particles into the body of workers through the nasal tract, mouth openings, opening and cracks in the skin and ulceration in the skin especially in the palm of the foot during their working time in the saltpan. The salt particles enter into the mouth and nasal cavity may enter into the blood plasma through the airway surface epithelium of the lung and mucosal layer of the alimentary tract. The salt particles enter into the body through the cracks and ulcers directly dissolved in the body fluid and resulted in the increase sodium level in the blood plasma. Consequent increase in plasma sodium may be resulted in the increase of blood pressure among workers. Wardener¹⁴ was of the opinion that the plasma sodium plays a vital role in the increase of hypertensive cases among humans. Kriba Ram Haldiya¹⁵ observed that the sodium chloride particles enter into the body fluid of saltpan workers especially brine workers through the ulcers and fissures that are found in the foot resulting in alteration in their blood pressure.

The workers fall under the age group of 46-55, a high percentage of blood pressure cases were observed, 25% had high Bp, 15% had very high Bp and 17.5% had low Bp. The mean Bp observed in case of low blood pressure, high blood pressure and very high blood pressure was $108.1 \pm 4.9/77.1 \pm 1.9$, $135.4 \pm 3.8/94.8 \pm 8.1$ and $145.3 \pm 1.6/110 \pm 3.1$ mmHg respectively. The 'Z' test showed that all the observed values among the male saltpan workers were significantly different in low blood pressure, high blood pressure and very high blood pressure groups. The values of 'CV' calculated using the blood pressure values of the different age group of male workers also showed a definite change (Table 1). More or less the same trend was observed in almost all age group of female workers also. But the percentage of high blood pressure observed among the age group 46-55 was very high (50%) when compared to male of the same age (Table 2). The analysis of variance of data on blood pressure between the male and female group of workers indicated a significant association between the sexes of workers and blood pressure (Table 2.2).

Table 1 Age-wise distribution of male saltworkers of Thoothukudi in relation to their blood pressure. The total number observed, the mean blood pressure with SD of the respective categories are also given. The values in the parenthesis are the percentage observed. The values of Z –test and Co-efficient of variation (CV) in relation to control also incorporated.

	Norm	al Bp	Low	Вр	Hig	h Bp	Very H	ligh Bp	
Age (Years)	SBP (120-130)	DBP (80-90)	SBP (110-119)	DBP (70-79)	SBP (131-140)	DBP (91-110)	SBP (>141)	DBP (>110)	
15 - 25	55 (84.6)		10 (15.4)						
	124.0 ± 2.0	82.5 ± 3.4	118.1 ± 1.4	78.2 ± 1.2	_	_	_	_	
C.V	1.6	4.2	1.2	1.6	-	-	-	-	
Z Test	4.44	0.31*	10.80	10.85					
26 - 35	46 (62.2)		25 (33.4)		3 (4.0)				
	124.9 ± 2.7	84.9 ± 3.5	113.7 ± 4.6	76.7 ± 2.4	140.3 ± 0.6	95.3 ± 3.0			
C.V	2.1	4.1	4.0	3.2	0.4	3.2	-	-	
Z Test	5.42	4.92	9.92	11.7	52.6	7.3			
36 - 45	55 (63.9)		11 (12.8)		16 (18.6)		4 (4.6)		
	128.7 ± 0.9	85.7 ± 3.5	117.0 ± 1.3	77.4 ± 3.6	138.8 ± 2.3	103.0 ± 5.9	144.7 ± 1.2	109.2 ± 3.4	
C.V	0.7	4.1	1.1	4.6	1.6	5.7	0.9	3.1	
Z Test	46.8	6.95	14.34	4.57	28.01	14.09	34.88	15.77	
46 - 55	17 (42.5)		7 (17.5)		10 (25.0)		6 (15.0)		
	127.8 ± 1.9	86.3 ± 4.9	108.1 ± 4.9	77.1 ± 1.9	135.4 ± 3.8	94.8 ± 8.1	145.3 ± 1.6	110.0 ± 3.1	
C.V	1.5	5.7	4.6	2.5	2.7	8.5	1.1	2.8	
Z Test	10.84	3.28	7.78	7.13	10.55	4.86	33.8	22.04	
Above 56					15 (75.0)		3 (15.0)		
	1 (5.0)		1 (5.0)		136.8 ± 3.7	94.5 ± 9.7	146.0 ± 1.7	1153 ± 3.8	
C.V		-		-	2.6	10.3	1.2	3.3	
Z Test					15.18	4.81	23.2	15.07	

Blood Pressure – SBP, Diastolic Blood Pressure - DBP, Male normal population SBP 122.8 \pm 2.8, Male normal population DBP 82.4 \pm 3.1, * Non-significant at 0.05% level

Table 2 Agewise distribution of female workers of Thoothukudi in relation to their blood pressure level. The total number observed, the mean blood pressure with SD of the respective categories are also given. The values in the parenthesis are the percentage observed. The values of Z –test and co-efficient of variation (CV) in relation to control also incorporated.

Age	Norm	al Bp	Low	Bp	High	Вр	Very High Bp		
(Years)						1			
	SBP	DBP	SBP	DBP	SBP	DBP	SPD (\1/1)	DBP	
	(120-130)	(80-90)	(110-119)	(70-79)	(131-140)	(91-110)	SDI (>141)	(>110)	
15 - 25	110 (85.9)		18 (15.4)						
	127.7 ± 2.0	87.1 ± 3.1	116.9 ± 2.4	77.6 ± 1.9					
C.V	1.6	3.5	2.1	2.5	-	-	-	-	
Z Test	31.85	22.40	7.93	6.42					
26 - 35	60(62.8)		22 (22 4)		10 (10 6)		2(21)		
	125.0 ± 2.1	916 29	22(23.4)	76.0 + 2.1	10(10.0)	088144	2(2.1)	110 + 2.8	
	123.0 ± 2.1	04.0 ± 3.0	110.9 ± 1.7	70.9 ± 2.1	134.1 ± 1.4	90.0 ± 4.4	144.3 ± 0.7	110 ± 2.0	
C.V	2.1	4.0	1.3	2.7	1.02	4.4	0.5	2.3	
Z Test	10.02	8.07	12.51	0.22	29.08	15.05	40.0	14.7	
36 - 45	26 (30.9)		33 (39 3)		19 (22 6)		6 (7 1)		
	125(30.7)	853+36	1149 + 32	768+21	1363 ± 19	97.9 ± 6.0	146 + 1.4	1117+37	
	123.4 ± 2.7	4.2	28	28	130.3 ± 1.9 1 4	62	140 ± 1.4 0.9	33	
C.V	7.25	6.54	11 74	10.01	33.3	12.44	12 13	20.43	
Z Test	1.25	0.54	11./4	10.01	55.5	12.44	42.43	20.43	
46 - 55	16 (25.0)		6 (9.3)		32 (50.0)		10 (15.6)		
	127.5 ± 3.1	87.4 ± 3.1	117.3 ± 1.8	76.8 ± 1.7	137.3 ± 2.4	100 ± 6.5	147.6 ± 2.1	111.8 ± 7.0	
~ .	2.4	3.6	1.6	2.2	1.8	6.5	1.4	6.3	
C.V	7.69	8.65	5.48	5.36	37.03	16.91	38.96	13.99	
ZTest									
Above 56									
	_	-	-	-	1 (50.0)		1 (50.0)		
C.V									
Z Test									

Systoloic Blood Pressure - SBP, Diastolic Blood Pressure - DBP, Female normal population SBP 121.5 \pm 2.8, Female normal population DBP 80.6 \pm 4.2, All values are significant at 0.05% level.

Source of variation	Sum of Sq	d.f	Mean Square	F 0.05
Between Column	35516.375	3	11838.79167	132.338612
Between Rows	946.125	1	946.125	10.5761528
Residual	268.375	3	89.4583333	
	36194.125	7		

Table	2.1. Analysis	of variance	(ANOVA)	of data on	blood pre	ssure between	the male a	nd female	groups of	workers.
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All values are significant at 0.05% level. $F_{.05}(3,3) = 9.28$ $F_{.05}(1,3) = 10.13$

Table 2.2.	Analysis of variance (ANOVA) of data on blood pressure level between
	the age-wise distribution of workers

Age		15 - 25			26 - 35		36-45			
Source of variation	Sum of Squares	Mean Square	F 0.05	Sum of Squares	Mean Square	F 0.05	Sum of Squares	Mean Square	F 0.05	d.f
Between Column	9312.25	3104.083	0.4293	3281	1093.67	41.531*	1298.5	432.833	1.942	3
Between Rows	4160	4160	0.575	50	50	1.898	0.5	0.5	0.0022	1
Desidual	21693.5	7231.167		79	26.333		668.5	222.833		3
Kesiuuai	16541.25			3252			630.5			7
Age		46 - 55								
Source of variation	Sum of Squares	Mean Square	F 0.05	d.f	Sum of Squares	Mean Square	F 0.05	Degrees	s of freed	om
Between Column	287	95.667	1.6033	3	76.5	25.5	1.2644		3	
Between Rows	72	72	1.2067	1	40.5	40.5	2.0082	1		
Decidual	179	59.667		3	60.5	20.1667			3	
Kesidual	180			7	56.5				7	

* Significant at 0.05% level. $F_{.05}(3,3) = 9.28$ $F_{.05}(1,3) = 10.13$

	Norn	nal Bp	Lov	v Bp	High	ı Bp	Very I	High Bp
Experience	SBP	DBP	SBP	DBP	SBP	DBP	CDD (+ 141)	DDD (+ 110)
(Years)	(120-130)	(80-90)	(110-119)	(70-79)	(131-140)	(91-110)	SBP (>141)	DBP (>110)
Male	80 (94.1)		3 (3.5)		2 (2.3)			
1-10	123.7 ± 2.1	83.3 ± 3.6	117 ± 1.0	78 ± 2.0	131 ± 1.4	85.0 ± 1.4		
C.V	1.7	4.4	0.8	2.5	1.1	1.7	-	-
Z Test	3.79	96.68	10.04	38.79	8.2	37.8		
11-20	90 (66.7)		22 (16.3)		18 (13.3)		5 (3.7)	
	128.3 ± 1.6	85.4 ± 3.6	117.8 ± 1.2	77.2 ± 2.0	136.3 ± 3.1	96.7 ± 7.2	144 ± 1.0	108.2 ± 2.6
C.V	1.3	4.2	1.0	2.6	2.8	7.4	0.7	2.4
Z Test	32.25	97.93	19.79	104.10	18.48	15.4	47.40	12.61
21 - 30	4 (6.1)		29 (44.6)		24 (36.9)		8 (12.3)	
	129.5 ± 1.0	91.2 ± 4.6	111.6 ± 4.8	77.5 ± 4.0	139.0 ± 2.3	100.2 ± 8.9	146.1 ± 1.1	113.2 ± 3.3
C.V	0.7	5.0	4.3	5.2	1.7	8.9	0.8	2.9
Z Test	13.4	13.8	12.48	60.61	33.87	12.44	58.59	8.22
Female	123 (87.8)		13 (9.3)		3 (2.1)			
1-10	125.3 ± 2.4	85.7 ± 4.0	118.3 ± 0.5	78.6 ± 1.4	133.7 ± 0.6	91.2 ± 2.8	1 (0.7)	
C.V	1.9	4.7	0.4	1.8	0.4	3.1		-
Z Test	17.59	98.49	23.96	106.96	36.5	17.9		
11-20	89 (55.9)		39 (24.5)		22 (13.8)		9 (5.7)	
C.V	128.7 ± 1.9	86.9 ± 2.7	117.5 ± 1.0	76.9 ± 1.9	134.7 ± 1.3	98.0 ± 5.8	144.8 ± 0.8	110.7 ± 6.3
Z Test	1.5	3.1	0.8	2.5	0.9	5.9	0.5	5.7
	34.87	120.69	24.52	142.73	48.5	18.85	89.76	5.11
21 -30			27 (36.9)		37 (50.7)		9 (12.3)	
21 -30 C V			113.1 ± 2.5	76.4 ± 2.0	137.8 ± 2.1	100.3 ± 5.8	148.2 ± 1.4	112.8 ± 4.9
C.V Z Tost	-	-	2.2	2.7	1.5	5.8	0.9	4.4
L Test			17.23	114.9	48.02	22.07	57.28	5.26

Table 3 Experience wise distribution of male and female saltpan workers in relation to their blood pressure level.	The total number observed, their
percentage, the mean blood pressure level with SD of the respective category are also g	given.

 $\begin{array}{l} \mbox{Male normal population SBP 122.8 \pm 2.8, Male normal population DBP 82.4 \pm 3.1, Female normal population SBP 121.5 \pm 2.8, \\ \mbox{Female normal population DBP 80.6 \pm 4.2, All values are significant at 0.05\% level} \end{array}$

Experience 1–10 Years					11-20 Years	21–30 Years				
Source of variation	Sum of Squares	Mean Square	F 0.05	Sum of Squares	Mean Square	F 0.05	Sum of Squares	Mean Square	F 0.05	d.f
Between Column	14417.375	4805.791	24.134*	7974.5	2658.167	89.601*	1200.5	400.167	13.799*	3
Between Rows	378.125	378.125	1.8989	72	72	2.427	8	8	0.276	1
Decidual	597.375	199.125		89	29.667		87	29		3
Kesiuuai	14198.125			7957.5			1121.5			7

Table 3.1. Analysis of variance of data on blood pressure level between the experiencewise distribution of workers.

* Significant at 0.05% level. $F_{.05}(3,3) = 9.28$ $F_{.05}(1,3) = 10.13$

 Table 4 Work wise distribution of saltpan workers of Thoothukudi in relation to their blood pressure level. The number observed, the mean blood pressure values with SD are also given. The values in the parenthesis are the percentage observed.

	Norm	al Bp	Low	Вр	High	Bp	Very H	ligh Bp	X ² Test
Nature of	SBP	DBP	SBP	DBP	SBP	DBP	SDD (>1/1)	DDD (> 110)	
work	(120-130)	(80-90)	(110-119)	(70-79)	(131-140)	(91-110)	5DP (>141)	DDP (>110)	
Male Brine	75 (62.5)		22 (18.3)		17 (14.2)		6 (5.0)		
workers	126.3 ± 3.3	84.2 ± 3.6	114.8 ± 5.1	77.2 ± 2.3	138.9 ± 2.3	101.2 ± 5.9	144.7 ± 1.0	108.2 ± 2.3	
C.V	2.6	4.3	4.4	2.9	1.6	5.9	0.7	2.1	
Z Test	9.12	4.39	7.31	10.71	29.23	12.92	51.86	27.24	0.40
Female	31 (58.5)		12 (22.6)		7 (13.2)		3 (5.7)		0.49
Brine	126.3 ± 2.6	85.4 ± 4.4	117.2 ± 1.8	77.2 ± 2.2	134.8 ± 2.3	95.8 ± 2.4	147 ± 1.0	111.7 ± 1.5	
workers	2.0	5.1	1.5	2.8	1.7	2.5	0.7	1.4	
C.V Z Test	10.50	6.19	8.34	5.32	15.58	16.75	44.17	35.23	
Male	99 (60.0)		32 (19.4)		27 (16.4)		7 (4.2)		
Non- Brine	126.2 ± 2.9	84.9 ± 4.1	114.2 ± 4.5	77.6 ± 3.7	136.5 ± 3.6	95.7 ± 9.8	145.7 ± 1.6	113.7 ± 2.4	
workers	2.3	4.9	3.9	4.8	2.6	9.9	1.1	2.1	
C.V Z Test	11.91	6.11	10.73	7.23	19.58	7.29	37.81	34.09	0.52
Female	181 (56.7)		67 (21.0)		55 (17.2)		16 (5.0)		0.52
Non- Brine	127.1 ± 3.5	86.4 ± 3.4	115.9 ± 2.8	77.0 ± 2.0	136.7 ± 2.3	99.5 ± 6.2	147 ± 2.3	111.4 ± 6.1	
workers	2.8	3.9	2.5	2.6	1.7	6.2	1.6	5.4	
C.V Z Test	21.34	22.86	15.79	14.38	48.49	22.54	43.10	20.26	

All values are significant at 0.05% level.

the work-wise distribution of workers												
Experience		Brine workers		Non-brine workers								
Source of variation	Sum of Squares	Mean Square	F 0.05	Sum of Squares	Mean Square	F 0.05						
Between Column	2783.375	927.792	5.443	18445	6148.33	12.787						
Between Rows	561.125	561.125	3.291	2964.5	2964.5	6.165						
Decidual	511.375	170.458		1442.5	480.833							
Kesiuuai	2833.125			19967								
			1 5 (2	A) A A A	(1 0) 10 10							

 Table 4.1 Analysis of variance (ANOVA) of data on blood pressure level between the work-wise distribution of workers

All values are significant at 0.05% level $F_{.05}(3,3) = 9.28$ $F_{.05}(1,3) = 10.13$

As the years of experience of the workers increased the blood pressure also showed an increasing trend. It was observed that there were about 13.3% of high blood pressure cases in 11-20 years of experienced male workers but in case of workers with 21-30 years of experience the percentage of high blood pressure cases increased to 36.9%. Similar trend had been observed in case of female workers also. The mean blood pressure observed among the workers showed that there was a significant raise in both systolic pressure and diastolic pressure as the year of experience of the workers increased when compared to the control both in case of male and female workers. The elevated values are statistically significant at 5% level (Table 3 and 3.1).

Among male brine workers, 14.2% were affected by high blood pressure 5.0% were affected by very high blood pressure and 18.3% were affected by low blood pressure. In female the observed percentage was 13.2, 5.7 and 22.6 respectively. More or less the same trend was noted in non-brine workers also. The mean blood pressure observed among the workers showed a significant difference, that of the control. It was noted that there was a significant raise in the systolic as well as diastolic pressure of the brine and non-brine workers. The increases in the pressure value were statistically significant at 5% level. A significant difference was noticed in blood pressure in persons working in different categories in the unit in a different way. The blood pressure observed among the different types of workers showed a significant increase when compared to the control groups (Table 4 and 4.1).

There is an abundance of scientific evidence demonstrating a direct relation between salt intake and blood pressure¹⁶⁻²⁰. Recent expert committees in the United States from the National High Blood Pressure Education Program and the American Heart Association have recommended to limit the daily sodium intake in adults not more than 100 m.mol of sodium, or 6gram salt per day^{21,22}. The results of the

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present study showed that most of the workers irrespective of sex and nature of work in which they are engaged are affected by high blood pressure. The increasd high blood pressure observed among workers in the present study might be due to the increase of sodium level in their blood which may inturn increase the blood pressure and the risk of hypertension and other cardiac disorders²³. The vicinity of the workers are always fully loaded with salt particles, dust and salt fumes which are constantly inhaled by the workers. The inhaled salt passed via a continuous upward particles mucocilliary current on the airway surface to the throat, where they can be swallowed and absorbed by the airway surface epithelium²⁴ or the lungs²⁵. These fine particles may also enter into the circulatory system through the lung²⁶. Incase of the brine workers the salt particles may directly enter into their blood plasma or tissue fluid through the ulcers or fissures that are present in their foot and palm¹⁵.

Conclusion

The working environment indirectly enhanced the serum sodium and chloride among the workers. The entry of sodium into the blood of workers enhanced through the nasal inhalation and through the cracks and ulcers present in their limbs. The increased volume of sodium on the other hand resulted in hypertension. The increased sodium among workers may be influenced by their anemic status and hyper ventilation that prevailed in their working environment. Dehydration developed due to their hard continuous and strenuous work in the scorching sun for several hours also influenced the enhancement of sodium. In order to reduce the stress and strain of the workers, recreations must be provided. Sufficient resting time, holidays with salary must be provided to the workers. The workers mut be advised to wear gloves and gumboots during theirnworking hours.

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