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Evaluation of Pulmonary Function Parameters in Street Vendors of Telangana Region Using Portable Spirometer

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Abstract: The association between exposure to pollution and pulmonary function was studied in street vendors using a portable handheld spirometer. The aim of this study was to evaluate the extent of impairment in lung function in street vendors compared to the general population (control group). It is a prospective observational study conducted in the Warangal region for a period of 7 months. This study was conducted by collecting and assessing the various pulmonary parameters using portable spirometry on 300 street vendors (test group) and general population (control group). We observed that Street vendors had a significant decline in pulmonary function parameters. Of total, 60.7 % had abnormal Peak expiratory flow (PEF), 43 % had abnormal Forced Expiratory Volume in 1 second (FEV_1), 35.6 % had abnormal Forced Vital Capacity (FVC), whereas there were negligible changes in the pulmonary function parameters of the general population. The effect of pollution by vehicular exhausts may be responsible for the pulmonary function impairment and the street vendors should use certain preventive measures that protect them from the risks of respiratory diseases. Clinical Pharmacist play vital role in educating public and create awareness regarding preventive measures.

Key words: Forced Vital Capacity (FVC), Peak expiratory flow (PEF), Spirometry, Street vendors

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I. INTRODUCTION

Street vending is a dominant occupation in urban areas of developing countries. Vendors get exposed to several environmental pollutants that constitute fine Particulate Matter, nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO) and volatile organic chemicals (VOCs).Rapid population growth and industrial development of urban areas with its deterioration in environmental conditions, increased vehicular traffic and industrial emissions, and poor waste management are the causes of urban air pollution in developing countries [1].

A major contribution of particulate matter in urban areas is believed to be attributable to emissions from diesel-powered vehicles and traffic [2].

Air pollution has an impact on most of the organs and systems of human body. Air pollutants can induce and aggravate diseases like respiratory, cardiovascular disease and ischemia heart disease [3-7].Air pollution is the cause and aggravating factor of many respiratory diseases like chronic obstructive pulmonary disease (COPD) and restrictive diseases [8,9].

Warangal is district headquarters of Warangal urban and rural districts in the state of Telangana. Air pollution is an important environmental health problem in the Warangal area because of limited number of roads and the rapidly increasing number of vehicles.

II. MATERIAL AND METHODS

This is a prospective observational study conducted in the Warangal region for a period of 7 months. This study was conducted by collecting and assessing the various pulmonary parameters using portable spirometry on 300 street vendors (test group) and general population (control group).

Study site: This study was conducted in the areas of Warangal.
Study design: Prospective observational study.
Study period: Study was conducted for a period of 7 months from February to September 2017.
Sample size: A total of 600 individuals, who were divided into 2 groups.
Group –I - Street vendors (n=300)

Group-II - Control group (n=300)

Participants:

Street vendors of Warangal region

Control group (general population) – Housewives and people working in offices, who are very mildly exposed to pollution.

Inclusion criteria:

1. Street vendors with minimum work exposure of 7hrs per day.
2. Street vendors having minimum work experience of 5 years.
3. Street vendors above the age of 28 years were included, because they are contingent to have pulmonary dysfunction.
4. General population was taken as control group.
5. Their other co-morbid conditions and social habits were also considered.

Exclusion criteria:

1. Street vendors of age above 60 years.
2. Street vendors with work experience of less than 5 years.

Source of data:

1. Direct communication with coal miners and street vendors.
2. Obtained spirometry readings were noted.
3. Past medical history was taken.

Procedure methodology

Data was obtained by direct communication with street vendors and control group. Spirometry analysis was performed using a portable electronic Spirometer (Model- Contec SP 10) to measure the pulmonary function. A questionnaire that includes demographics, Body Mass Index (BMI), past medical history, occupation, Duration of exposure in the occupation and all other pertinent information was collected. All the required data was collected from the participants after obtaining an informed consent.

Statistical analysis

Statistical analysis was done using nonparametric unpaired T test in Graphpad prism software. The level $P < 0.05$ was considered as the cutoff value or significance.

III. RESULT

Street vendors and general population were categorized as group A and group B.

Group A: street vendors

Age wise distribution: The mean age was noted to be 43.63 ± 8.67. Of the total street vendors, 20.6 % were in the age range of 46-50 years, 18.3% were of 36-40 years.

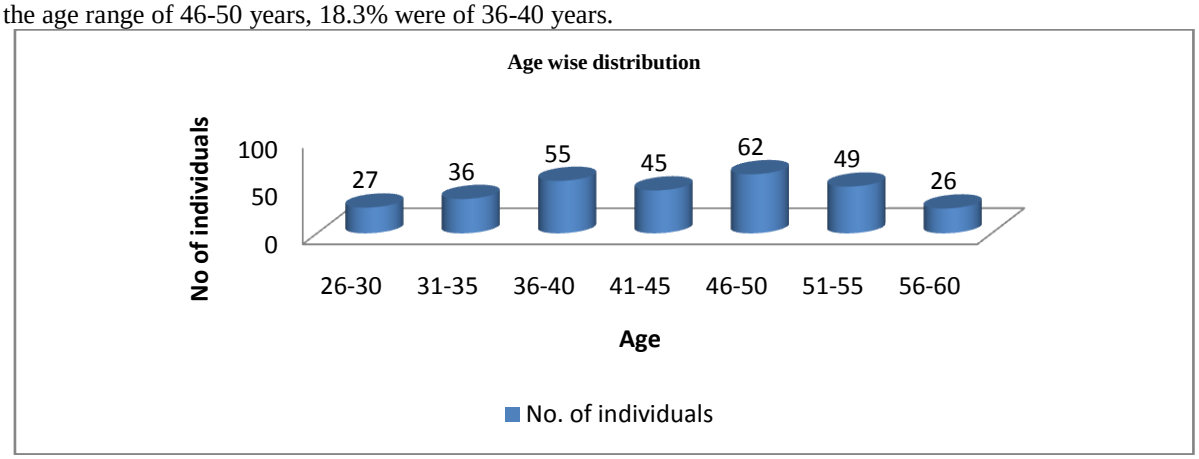

Fig 1: Age wise distribution

Gender wise distribution: Of 300 street vendors, 81 % (243) were male and 19 % (57) were female.

Severity wise distribution: When FVC taken as assessing parameter 54 (18 %), 45 (15 %) and 8 (2.6 %) street vendors had mild, moderate and severe restrictive lung function respectively. When all the parameters were considered, street vendors had 35.6 % restrictive lung function and 9.3% had obstructive lung function.

Table 1: Severity wise distribution of Street vendors

Parameter	Normal	Mild	Moderate	Severe
FVC	193(64.3 %)	54 (18 %)	45 (15 %)	8(2.6 %)
FEV1	171(57 %)	63 (21 %)	49 (16.3 %)	17(5.6 %)
PEF	118(39.3 %)	101 (33.6 %)	45 (15 %)	36(12 %)
FEF_{25-75}	197(65.6 %)	46 (15.3 %)	26 (8.6 %)	31(10.3 %)

Duration of exposure wise distribution of FEV1: The mean exposure was 21.93 ± 8.61. Of the total 300 street vendors, highest FEV1 abnormality (59.2 %) was found in work exposure group of 26-30 years.

Table 2: Duration of exposure wise distribution of FEV1:

Exposure duration (years)	Normal	Mild	Moderate	Severe
6-10	23	2	0	1
11-15	38	14	1	1
16-20	39	13	12	2
21-25	25	13	9	4
26-30	22	15	12	5
>30	24	6	15	4

Duration of exposure wise distribution of PEF: The mean exposure was 21.93 ± 8.61. Highest affected group was 26-30 years of exposure (81.6 %) and the lowest affected exposure group was 11-15 (18.5 %).

Table 3: Duration of exposure wise distribution of PEF

Exposure duration (years)	Normal	Mild	Moderate	Severe
6-10	17	7	1	1
11-15	26	17	7	4
16-20	31	22	5	8
21-25	17	18	8	8
26-30	18	17	13	6
>30	9	20	11	9

Duration of exposure wise distribution of FEF_{25-75}(Forced Expiratory Flow at at 25-75% of the pulmonary volume)**:** Among 300 street vendors, highest affected exposure group was 26-30 years of exposure (44.4%) and the lowest affected exposure group was 6-10 (19.2 %)

Duration of exposure wise distribution of FVC: Among 300 street vendors, highest affected exposure group was 26-30 years of exposure (50 %) and the lowest affected exposure group was 11-15 (18.5 %).

Social history wise distribution: Among the total 300 street vendors, Smokers 29 % (87) were smokers. FVC abnormality was more in >3-6 pack year interval in 19 individuals. FEV1 abnormality was more in >3-6 pack year interval in 24 individuals. PEF abnormality was more in >3-6 pack year interval in 21 individuals. FEF_{25-75}abnormality was more in >3-6 pack year interval in 15 individuals.

Table 4: Social history wise distribution: Smoking: Total smokers: 87 (29 %)

Pack year	FVC abnormality	FEV1 abnormality	PEF abnormality	FEF_{25-75}abnormality
0-3 (n=15)	8	7	7	5
>3-6 (n=27)	19	24	21	15
>6-9 (n=13)	10	10	9	8
>9-12 (n=16)	10	16	15	10
>12 (n=16)	7	0	15	11

Pack-years = No. of cigarettes smoked per day × No. of years smoked ÷ No. of cigarettes in a pack

Co-morbid condition wise distribution: Hypertension was the most prevalent (27 %) co-morbid condition among street vendors, followed by Diabetes Mellitus (DM)-13.3 %, Hypertension with DM-7.3 % and Hypothyroidism-6.6 %.

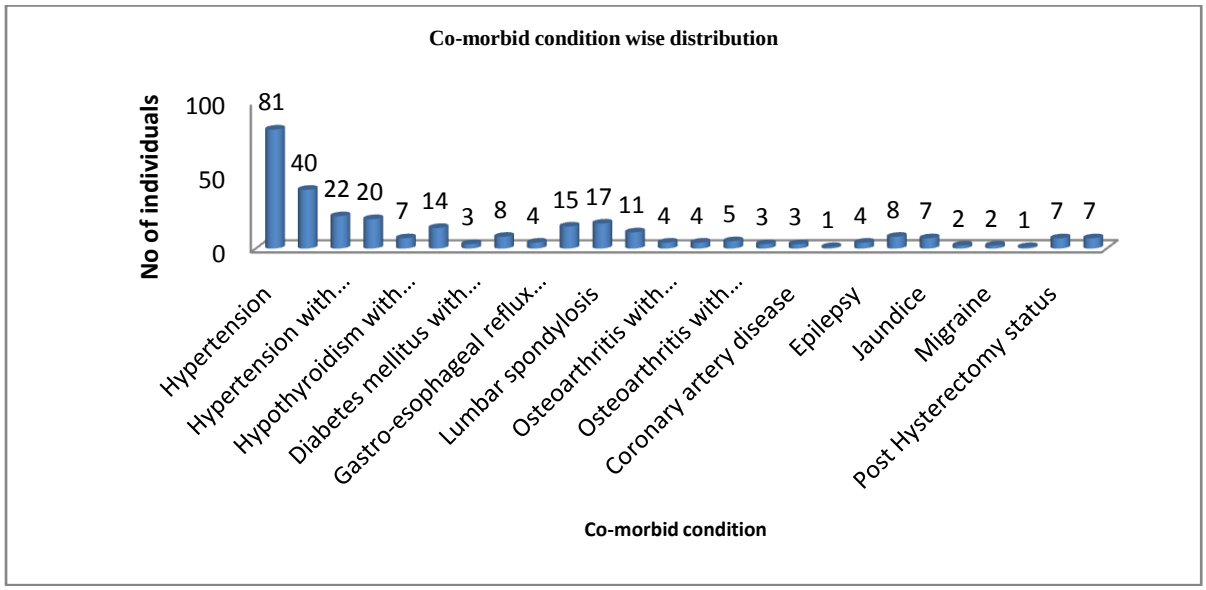

Fig 2: Co-morbid condition wise distribution

Body Mass Index (BMI) wise distribution: Out of 300 street vendors, 194 had normal BMI, among them FVC abnormal in 70(36%), FEV1 was abnormal in 78 (39%), PEF was abnormal in 119(64.4%), FEF_{25-75} was abnormal in 65 (33.5%).

Table 5: Body Mass Index (BMI) wise distribution:
Mean BMI of street vendors was found to be 24.39 ± 2.06

BMI	FVC Abnormal	FEV1 Abnormal	PEF Abnormal	FEF_{25-75} Abnormal
<18.5(underweight)	1	1	1	1
18.5-24.5(Normal)	70	78	119	65
25-29.9 (overweight)	35	47	58	35
>30(obese)	2	3	4	2

FVC wise distribution of other parameters:

FVC Vs distribution of FEV1: Of 300, FVC was normal in 193 individuals. Among them, 33(17%) has abnormal FEV1. Among 54 mild FVC, FEV1 was abnormal in 43 (79.6%) individuals. Among 45 moderate FVC, FEV1 was abnormal in 45 (100%) individuals. Among 8 severe FVC, FEV1 was abnormal in 8 (100%) individuals.

FVC Vs distribution of PEF: Of 300, FVC was normal in 193 individuals. Among them, 104 (53.8 %) had abnormal PEF. Among 54 mild FVC, PEF was abnormal in 31 (57.4%) individuals. Among 45 moderate FVC, PEF was abnormal in 39 (86.6 %) individuals. Among 8 severe FVC, PEF was abnormal in 8(100 %) individuals.

FVC Vs distribution of FEF_{25-75}: Of 300, FVC was normal in 193 individuals. Among them, 41 (21.2 %) had abnormal FEF_{25-75}. Among 54 mild FVC, FEF_{25-75} was abnormal in 20(37 %) individuals. Among 45 moderate FVC, FEF_{25-75} was abnormal in 34 (75.5 %) individuals. Among 8 severe FVC, FEF_{25-75} was abnormal in 8 (100 %) individuals.

Group B: control group (300)
Mean age: Among 300 control group, the mean age was found to be 42.80 ± 7.07
Gender wise distribution: Among 300 control group, 260 (86.6%) were male and 40 (13.3%) female.
Severity wise distribution (control): Mean FVC of control group was 5.26±22.35. In 300 control group, FVC deficit was observed in 12(4 %). Among them, 3.6 %, 0.3 % had mild, moderate FVC deficit respectively. FEV1 deficit was observed in 5(1.7 %). Among them, 1.3 %, 0.3 % had mild, moderate FEV1 deficit respectively. PEF deficit was observed in 18(5.7 %). Among them, 4.3 %, 0.3%, 1.3% had mild, moderate and severe PEF deficit respectively. FEF_{25-75}deficit was observed in 4(1.3%). Among them, 1.3% had moderate FEF_{25-75} deficit respectively.

Table 6: Severity wise distribution (CONTROL)

Parameter	Normal	Mild	Moderate	Severe
FVC	288(96 %)	11 (3.6 %)	1(0.3 %)	0(0 %)
FEV1	295(98.3 %)	4 (1.3 %)	1(0.3 %)	0(0 %)
PEF	283(94.3 %)	13 (4.3 %)	1(0.3 %)	4(1.3 %)
FEF_{25-75}	296(98.6 %)	0(0 %)	4(1.3 %)	0(0 %)

Statistical analysis:

Table 7: Statistical analysis street vendors Vs control:

Parameter	P Value	R^2	t	95 %Confidence interval
FVC	0.0612	0.0058	1.875	-4.958 to 0.1146
FEV1	<0.0001	0.4946	24.19	-1.446 to -1.229
PEF	<0.0001	0.4215	20.87	-3.070 to -2.543
FEF25-75	<0.0001	0.4398	21.67	-2.297 to -1.915

IV. DISCUSSION

Among 300 street vendors, 35.6 % had restrictive lung function and 9.3 % had obstructive lung function.

a) FVC: It is the amount of air which can be forcibly exhaled from the lungs after taking a deepest possible breath. It contains FEV1 within it. FVC is used to determine both the presence and severity of restrictive lung diseases.

In a study conducted by Amrith Pakkala et al 2013 [10], it was stated that the mean FVC was 3.39 ± 0.56 and P value <0.001. A study conducted by Nur Afiqah Amaran et al 2016 [11], they observed that the mean FVC was 2.94 ± 0.50 and P value 0.6. In another study conducted by Alice Y.M. Jones et al 2008 [12], they found that the mean FVC was 2.84 ± 0.09 and P value <0.0005. In our study the mean FVC was less compared to the above studies. Street vendors work on the road side located near traffic junctions where vehicular pollution is high, inhalation of these pollutants induces decreased lung capacity, which may be responsible for the decline in FVC.

Age: In a study conducted by Amrith Pakkala et al 2013 [10], they stated that the mean age was 23.45 ± 2.84. A study conducted by Alice Y.M. Jones et al 2008 [12], they observed that the mean age was 45.1 ± 13 that was similar to our study. 46.1 % street vendors had abnormal FVC in the age group of 56-60, which was the highest compared to other age groups. While the highest severity was noted in the age group range of 51-55years. This decrement of FVC in the elderly age group may be due to dust exposure for prolonged duration.

Smoking: In a study conducted by Alice Y.M. Jones et al 2008 [12], total number of smokers was found to be 18.2 %. In contrast, we observed higher number of smokers in our study (29%). Among these, the highest abnormality was noted in >6-9 pack year interval. Of these smokers, 46.1 %, 30.7 % had a mild and moderate deficit in FVC respectively.

BMI: In a study conducted by Amrith Pakkala et al 2013 [10], they stated that the mean BMI was 20.60 ± 1.75. In another study conducted by Alice Y.M. Jones et al 2008 [12], they found that the mean BMI was 22.8 ± 3.1. In our study we found that the mean BMI was slightly higher compared to the above studies.

Co-morbid conditions: Street vendors with a past medical history were only included in our study. Hypertension was the most frequently observed co-morbid condition which constitutes to 27 % followed by Diabetes mellitus 13.3 %.

Duration of exposure: In a study conducted by Alice Y.M. Jones et al 2008 [12], they stated that the mean year of work was 11.4 ± 10.7. In contrast, we found that the mean exposure was very high (21.93 ± 8.61). Half of the street vendors with work exposure duration of 26-30 years had FVC deficit, and the severity was found to be increasing significantly from 16-30 and above years of work exposure.

b) FEV_1 (Forced expiratory volume in 1st second): It is the volume of air forcefully exhaled in the 1st second of total expiratory time

In a study conducted by Amrith Pakkala et al 2013 [10], they observed that the mean FEV1 was 2.51 ± 0.53 and P value <0.001. A study conducted by Nur Afiqah Amaran *et al* 2016 [11], they found that the mean FEV1 was 2.82 ± 0.47 and P value 0.04. In another study conducted by Alice Y.M. Jones et al 2008 [12], they stated that the mean FEV1 was 2.63 ± 0.07 and P value <0.0005. In our study, we found that the mean FEV1 was less compared to the above studies. The deficit in FEV1 was may be due to vehicular emissions, industrial air pollution and airborne dust which play a vital role in longitudinal decline of FEV1.

Age: In a study conducted by Alice Y.M. Jones et al 2008 [12], they stated that the mean age was 45.1 ± 13.1. In our study we observed that the similar mean age. Half of the street vendors had FEV1 deficit in the age group of 46-50 years, which was highest, compared to the other age groups. The highest severity was noted in the age group of 50-55 years.

Smoking: In a study conducted by Alice Y.M. Jones et al 2008 [12], they found that total number of smokers to be 18.2 %. In contrast, we observed higher number of smokers in our study 29%, among these the highest abnormality was noted in >9-12 pack year interval as 100 %. The study suggests that 9.3 % of street vendors had obstruction in the airways, which could be due to an enhanced effect of smoking along with occupational exposure to pollution.

Duration of exposure: In a study conducted by Alice Y.M. Jones et al 2008 [12], they stated that the mean exposure was 11.4 ± 10.7. In our study, we observed that the mean exposure was higher compared to the above study (21.93 ± 8.61). More than half of the street vendors with work exposure duration of 26-30 years had FEV1 deficit. The severity was found to be increasing significantly in the work exposure group 11-30 years.

c) PEF: It is the maximal flow/peak (or speed) achieved during the maximal forced expiration. It is mostly dependent on person's force of exhalation.

In a study conducted by Amrith Pakkala et al 2013 [10], they observed that the mean PEF was 7.82 ± 1.26 and P value <0.001.Whereas, we observed that the mean PEF was less compared to the above study. Of 300 street vendors, more than half of the individuals had abnormal PEF, among these 33.6 %, 15 % and 12 % had a mild, moderate and severe decline in PEF respectively.

Age: In a study conducted by Alice Y.M. Jones et al 2008[12], they found that the mean age was 45.1 ± 13.1. We observed the similar mean age in our study. More than half of the street vendors had PEF deficit in the age group of 51-55 years, which was the highest, compared to other age groups. The highest severity was noted in the age group of 50-55 years.

Smoking: In a study conducted by Alice Y.M. Jones et al 2008 [12], they stated total number of smokers was found to be 18.2 %. In contrast, we observed higher number of smokers in our study-29%. Among these, the highest abnormality was noted in >9-12 pack year interval.

Duration of exposure: In a study conducted by Alice Y.M. Jones et al 2008 [12], they stated that the mean exposure was 11.4 ± 10.7. In our study mean exposure was higher compared to the above study. More than half of the individuals with work exposure duration of >30 years had PEF deficit. The severity was found to be gradually increasing between 6-25 years work exposure group and highest severity was noted was in the work exposure group of above 30 years.

d) FEF_{25-75}: Forced expiratory flow (FEF) is the flow of air coming out of the lung during the middle portion of a forced expiration. The usual intervals are 25 % and 75 % of FVC.

In a study conducted by Amrith Pakkala et al 2013 [10], they observed that the mean FEF_{25-75} was 3.48 ± 0.61 and P value <0.001 which was similar to our study. Out of 300 street vendors, less than half of the individuals had abnormal FEF_{25-75}.

Age: In a study conducted by Amrith Pakkala et al 2013 [10], they stated that the mean age was 23.45 ± 2.84. In another study conducted by Alice Y.M. Jones et al 2008 [12], they observed that the mean age was 45.1 ± 13 which was similar to our study. 44.8% had abnormal FEF_{25-75} in the age group of 51-55years, which was highest compared to other age groups. The highest severity was noted as in the age group 41-45years.

Smoking: In a study conducted by Alice Y.M. Jones et al 2008 [12], they found that the total number of smokers was found to be 18.2 %. In contrast, we observed higher number of smokers in our study-29%, among these the highest abnormality was noted in >12 pack year interval. The study suggests that 9.3 % of street vendors had obstruction in the airways, which could be the reason for decline in FEF_{25-75}.

Duration of exposure: In a study conducted by Alice Y.M. Jones et al 2008 [12], they stated that the mean exposure was 11.4 ± 10.7. In our study mean exposure was higher compared to the above study. 44.4 % individuals with work exposure duration of 26-30 years had FEF_{25-75} deficit. The severity was found to be gradually increasing in the work exposure groups of 21- 30 years and above.

Street vendors Vs Control group

The pattern of restrictive lung abnormality was found to be confined and moderate among street vendors (35.6 %) and very less in control (4 %). 43 % street vendors had abnormal FEV1 compared to 1.6 % in the control group. 60.6 % street vendors had abnormal PEF compared to 5.3 % in the control group. 34.3 % street vendors had abnormal FEF_{25-75} compared to 1.3 % in the control group. The reason being, very limited dust exposure among control group and modest dust exposure among street vendors. Individual pulmonary effects in street vendors cannot be attributed to specific constituents of the vehicular emissions, because it consists of blend of multiple pollutants and the duration of exposure also differs between both the groups.

V. CONCLUSION

We observed that the street vendors have a higher risk of obtaining restrictive and obstructive lung disease than general population. The obtained spirometry analysis shows that there is a statistical significance for FEV1, PEF, FEF_{25-75} parameters and it was found that FEV1 deficit was more among smokers in street vendors. Street pollution is more effective in inducing FEV1, PEF deficit. We noticed that FVC deficit had an impact on reducing the other spirometry parameters. Hypertension and Diabetes mellitus were the frequently observed co-morbid conditions in the study groups.

There was an increase in the incidence of restrictive lung disease in street vendors of our study compared to other studies. Our results support the fact that increased dust levels and duration of dust exposure precipitate restrictive lung function in street vendors. Early detection, patient education programs regarding the use of dust preventive face masks, lifestyle modifications and regular lung function tests can reduce the progression of obstructive, restrictive disorders and improve prognosis of the disease. Clinical Pharmacist can play vital role in educating public and create awareness regarding preventive measures.

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