PULMONARY FUNCTION TESTS AMONG THE STUDENTS OF SIKKIM MANIPAL INSTITUTE OF MEDICAL SCIENCES, GANGTOK

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ABSTRACT

BACKGROUND

Pulmonary Function Tests are designed to determine as to how well the lungs are working. Differences in lung function is observed among people residing at high altitudes and those belonging to plain terrains. A number of researchers in India have investigated the use of drugs and smoking among medical students. We wanted to evaluate the regional differences in the lung function between students of the North Eastern States and the students from the rest of the country and to identify the differences between lung function among smokers and non-smokers in people from the two groups.

METHODS

The research was carried out among 326 young healthy individuals in the age group of 17- 35 years of the college. The students were asked to fill a questionnaire asking their demographic details and details of smoking habits. Following which they were asked to fill Fagerstrom Questionnaire if they were smoking currently. A spirometric analysis was performed thereafter on them using a computerised spirometry.

RESULTS

The results suggested that smokers had lower lung function values as compared to non-smokers and majority of the smokers had moderate dependence on nicotine. There was no significant difference among the students of north eastern states and those from other parts of the country.

CONCLUSIONS

There was no significant difference in lung functioning in the two groups because of the presence of migratory population in the hilly areas and since the ethnic difference was not taken into account. The lower FVC value in smokers could be attributed to weakened muscles and lung changes as compared to non-smokers.

KEYWORDS

Forced Vital Capacity (FVC), Fagerstrom Questionnaire.

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BACKGROUND

Pulmonary Function Tests are a group of tests that are designed to measure how well the lungs are working.[1] A spirometer is the main piece of equipment used for basic Pulmonary Function Tests (PFTs). Spirometry is a physiological test that measures how an individual inhales or exhales volumes of air as a function of time, and it is invaluable as a screening test of general respiratory health.[2] The essential indices of spirometric analysis used in the study are assessing the Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC), the ratio of Forced Expiratory Volume in one second and Forced Vital Capacity (FEV1/FVC).[3]

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Differences in pulmonary function in normal people may be due to ethnic origin, physical activity, environmental conditions, altitude, tobacco smoking, age, height, sex, and socioeconomic status.[4] Permanent residents at high altitudes usually have larger lungs than dwellers of comparable stature at lower altitudes. This explains the relatively large lungs of the mountain people of the Himalayas including the Borders of Ladakh in Kashmir, the high-altitude natives of Nepal and the inhabitants of Lumana region of Bhutan.[4]

The picture in Northern India is further complicated by a mongoloid component and this also contributes to ethnic differences in South East Asia and elsewhere. Mongoloids have mainly been found to have lung volumes which are intermediate between those of Caucasians on one hand and negroes and South Indians on the other.[4] The wide range of geographical and climatic conditions in a large country such as India may be associated with regional differences in lung function in healthy individuals, as shown in previous studies.[5,6] In this study the investigators shall measure pulmonary function, including spirometric indices and static lung volumes, in healthy young adults in the medical college premises where people come from different corners of the country.

Smoking leads to rapid decline in pulmonary function test specially those indicating diameters of airways such as forced expiratory flow in one second (FEV).[7,8,9] In India tobacco kills 8-10 lakh people each year and many of the deaths occur in people who are very young.[10] Here, approximately 5,500 children and adolescents starts using tobacco daily, some as early as 10 years.[11] Teaching about the use of tobacco is essential for college students, both medical and non-medical, because they would be physicians, future teachers and other responsible citizens of the country. So they should not be sanctimonious.[12]

The response is dose dependent, so heavy and long-term smokers and those who inhale tobacco smoke incur more damage than subjects whose exposure is less. The Nicotine dependence is analysed on the basis of the Fagerstrom Tolerance Questionnaire.[13,14,15]

Such kind of study on medical students have not been performed in this region and the study would help in comparing the pulmonary function between smokers and non-smokers from northeast and other parts of the country and outside. The study will include regional differences and also effect of smoking on lung capacities.

METHODS

Study Type

Descriptive, Cross Sectional Study.

Study Site

Respiratory Medicine Unit, Department of Medicine, Central Referral Hospital.

Study Population

Students of the college in the age group of 17-35 years.

Period of Study

13th May 2016 – 13th July 2016.

Sample Size

A total of 326 subjects, both males and females in the age group of 17-35 years from different regional background and both smokers and non-smokers were drawn from students of the institute after their approval and informed consent (appendix 1).

Students who took part in the study were pursuing Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Physiotherapy (B.PT) and Bachelor of Science in Nursing (B.Sc. Nursing) courses in the college during the time of study and they were randomly selected for the study.

420 students were given the questionnaire, out of which 354 students consented for the study and 326 healthy individuals with no respiratory or cardiovascular illness for the past 3 months prior to the study were finally appointed in the study, with or without a history of smoking.

The individuals chosen were engaged in mild to moderate physical activity, with rice or wheat as the staple diet.

Detailed procedure of the study will be explained to all the subjects and an informed written consent will be obtained as per attached proforma.

The Body Mass Index is calculated by obtaining weight and height of the subject. Body Mass Index (BMI) = Weight of the subject in kilograms/ (Height of the subject in metres).[2]

BMI Categories (WHO Criteria)

Underweight	< 18.5
Normal weight	18.5 – 24.9
Overweight	25 -29.9
Obesity	30 or more

Inclusion Criteria

Healthy subjects with a) No previous history of upper respiratory tract infection within 3 months. b) No other clinically detected medical illness. c) No history of asthma or bronchitis in the family. d) Subjects with a BMI of 18.5- 24.9 (Normal Weight).

Exclusion Criteria

Subjects who have had history of respiratory disorders or diseases like tuberculosis, congenital cardiac disorders and musculoskeletal deformity of chest wall were excluded. All those who refuse to give consent, and the ex-smokers or past smokers will be excluded.

Primary Questionnaire

The students, willing to participate in the study are subjected to a set of questions asking the demographic details, i.e. name, age, sex, permanent address, community, height, weight, and also a note of allergy history, history of past respiratory illness in the family, history of alcohol, history of smoking, is made.

For Ethnicity, Racial and Regional Differences,

A detailed history of the caste, place of stay, permanent residential address is considered, and the population is divided into two groups-

Group A: Individuals from the North Eastern States of India (Assam, Manipur, Meghalaya, Arunachal Pradesh, Sikkim, Tripura, Nagaland).

Group B: Individuals from rest of the country and outside (Non Residentials of India).

The two groups A and B are further sub classified into smokers and non-smokers.

Criteria for Smoking Habits

1) Classification Criteria as Suggested by WHO (1998) Smoker:

Someone who, at the time of the study, smokes any tobacco product either daily or occasionally. Non-smoker: Someone who, at the time of the study, does not smoke at all. Ex-smoker: Someone who was formerly a daily or occasional smoker but currently does not smoke at all (for a period of 3 months). In this study a detailed record of smoking with

reference to duration of smoking (in years) and number of cigarettes / bidis smoked per day will be taken.

2) Fagerstrom Tolerance Questionnaire is used to find the Nicotine Tolerance among smokers. (Appendix 3).

The Fagerstrom Tolerance Questionnaire is a widely used screening instrument for measuring nicotine dependence related to smoking. The Fagerstrom Tolerance questionnaire consists of 10 questions. Scoring per item is either a three or four level response with values 0,1,2,3. Scores are added and a total score of 7 and above indicates a high dependence.

3) Spirometry

All participants were subjected to detailed examination and assessment of lung vital capacity by Spirometric Analysis using a computerised RMS Med-spirometer manufactured by Techno care Med systems, Surat.

Keeping the importance of clinical tests in mind, Spirometric Analysis will be done for more specific evaluation of lung vital capacity as it requires no additional equipment. The functional expiratory volume and ratio of Forced Expiratory Volume in one second and Forced Vital Capacity (FEV1/FVC) was evaluated.

The subjects were asked to perform the PFT at least three times to observe FVC, FEV1, FEV1/FVC. After appropriate coaching, the best of the three technically acceptable attempts were recorded and the best of the three results were considered for analysis.

Of the several blows ranging from 3 to 4, the best reading was selected for the study and recorded.

At least 3 technically acceptable manoeuvres were obtained ideally with less than 0.2 L variability for FEV1 between the highest and second highest result. The largest of the three FVC and FEV1 values were accepted even if the two volumes do not come from the same curve. The ratio of FEV1 to FVC were expressed as percentage.

The largest volume was quoted. The following guidelines were used for the manoeuvre performance.[16]

a) Minimum of 3 acceptable blows. b) Rapid start is essential. c) A minimum exhalation time of 6 seconds. d) Spirometer temperature being 17 to 400 C. e) Take largest FEV1 even if not from the same curve as the best FVC. f) Smooth rapid take-off with no hesitation, cough, leak, tongue obstruction, glottis closure, etc.

The values for FEV1, FVC, FEV1 /FVC ratio for each subject thus obtained was entered in the proforma and tabulated. Suitable statistical methods were applied using Microsoft Excel to analyse the data, such as mean, standard deviation, unpaired T test.

Statistics

Proper statistical analysis was done, and data was tabulated. Chi square test and P test was done.

RESULTS

A total of 326 individuals took part in the study out of which 128(39.26%) were males with a mean age of 20.77 years (SD = 1.881 years) and 198 were females (60.73%) with a mean age of 20.21 years (SD = 1.277 years).

Age	Sex		Total	p Value*	Significance
	Female	Male			
18	12	8	20		
19	47	31	78	0.000	p value is significant among males and females.
20	72	28	100		
21	35	23	58		
22	19	14	33		
23	12	6	18		
24	1	16	17		
26	0	2	2		
Total	198	128	326		

Table 1. Distribution of Population on The Basis of Age and Sex of The Population

*calculated using unpaired t test.

The above-mentioned data indicates a significant difference among males and females in various age groups in both the study population. A total of 198 females and 128 males took part in the study with highest number of females (72) in 20 years of age and highest number of males (31) in 19 years of age.

Parameters	Group A	Group B	p Value*
Age	20.7±1.66	20.20±1.44	0.003
Height	1.64±0.80	1.67±0.10	0.033
Weight	58.5±8.87	61.7±9.54	0.001
BMI	21.77±1.95	22.29±2.04	0.020

Table 2. Mean Age, Height and Weight of The Study Groups

*calculated using unpaired t test

There were significant differences in age and weight of the population ($p < 0.005$) in both the study groups. No significant difference was observed among height and BMI of the two study populations.

Regional Distribution

Total number of individuals in Group A	164	50.3%
Total number of individuals in Group B	162	49.7%

Table 3. Distribution of Population in Both the Study Groups

164 individuals belong to Group A (50.3%) and 162 individuals belong to Group B (49.7%). This was based on whether the individuals were residing in any of the 8 North-eastern States (Sikkim, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland, and Tripura) or the rest of the country and Non- Residents of India as well.

	Region		Total	p Value*	Significance
	Group A	Group B			
Smoker	65	55	120	0.421	Since p value is more than 0.05, for both the categories, it is not significant.
Non-Smoker	99	107	206		
Total	164	162	326		

Table 4. Regional Distribution of Smokers and Non-Smokers

*calculated using chi square test.

No significant differences were observed among the smokers and non- smokers from group A and group B which comprises of 120 smokers and 206 non-smokers, 65 of the smokers were from group A whereas 55 were from Group B.

Smoking History

	Sex		Total
	Female	Male	
Smoker	44	76	120
Non-Smoker	154	52	206
Total	198	128	326

Table 5. Classification of Population on The Basis of Smoking Details

Out of the total smokers, 44 of them were females and 76 of them were males. There were 154 females and 52 males who were non -smokers from both the groups.

Total Number of Smokers	120	36.8%
Total Number of Non-Smokers	206	63.2%

Table 6. Classification of Total Smokers and Non-Smokers

A total of 120 individuals (36.8 %) were smokers and a total of 206 individuals (63.2%) were non – smokers.

Family History

It comprises of two sets of population, one with family history of any respiratory disease like asthma or Chronic Obstructive Pulmonary Disease among the family members (mother/father/grandfather/grandmother/brother/sister) and the other not having any such history of disease.

History of Respiratory Illness	Group A		Group B		p Value
	Smoker	Non-Smoker	Smoker	Non-Smoker	
Family History Present	3 (4.6%)	5 (5.1%)	6 (10.9%)	18 (16.8%)	0.003 (using chi square tests)
Family History Absent	62 (95.4%)	94 (94.9%)	49 (89.1%)	89 (83.2%)	
Total Individuals	65	99	55	107	

Table 7. Presence/Absence of Any Respiratory Illness in The Family

There were significant differences in the p value among the two groups, Group A and Group B. All the individuals chosen did not suffer from any respiratory or cardiovascular illness in the past 3 months and filled the questionnaire in English.

The above data indicates absence of any family history of respiratory illness in 62 smokers and 94 non- smokers from Group A and 49 smokers and 89 non-smokers from Group B. Also 3 of the smokers from Group A and 6 of the smokers from Group B had a family history of respiratory disease such as Asthma, and COPD in the family.

	Group A			Group B		
Parameters	Smoker	Non-Smoker	p Value (using Unpaired t test)	Smoker	Non-Smoker	p Value (using Unpaired t test)
FVC	2.76± 0.67	3.27± 0.77	0.00	2.74± 0.65	3.05± 0.81	0.02
FEV1	2.69± 0.59	3.12± 0.69	0.00	2.67± 0.62	2.97± 0.75	0.01
FEV1/FVC	97.92± 4.08	95.64± 4.29	0.00	97.86± 4.67	97.87± 3.83	0.97
Total smokers and non-smokers	65	99		55	107	

Table 8. Mean Value of PFT Parameters of The Study Groups

The above data indicate a significant difference in FVC, FEV1 and FEV1/FVC ratio values among smokers and non – smokers in Group A ($p < 0.005$).

Also, significant differences in the FVC, FEV1 values are observed among smokers and non-smokers of Group B. But no significant difference in FEV1/FVC ratio is observed ($p > 0.005$).

Parameters	Group A	Group B	p Value
FVC	2.96±0.76	2.95±0.77	0.84
FEV1	2.86±0.67	2.88±0.72	0.78
FEV1/FVC	96.95±4.33	97.88±4.13	0.06
Total Individuals	164	162	

Table 9. The Overall Differences Among PFT Values in Group A and Group B

No significant differences in FVC, FEV1 and FEV1/FVC ratio is observed among Group A and Group B.

The Nicotine Tolerance as calculated using the Fagerstrom Questionnaire among all the smokers (120) is as under.

Score	Dependence	No. of Individuals	Percentage
1-2	Low Dependence	33	27.6%
3-4	Low to Moderate Dependence	74	61.6%
5-7	Moderate Dependence	13	10.8%
8	High Dependence	0	0%

Table 10. Nicotine Dependence Among Smokers

The above-mentioned data indicates that maximum of the individuals (74) from both the groups had low to moderate dependence whereas no one had high dependence (0) on nicotine.

DISCUSSION

Pulmonary function tests (PFTs) are a group of tests that measure how well your lungs work.[1] This includes how well you are able to breathe and how effective your lungs are able to bring oxygen to the rest of your body. The studies

conducted used spirometry as the best procedure for finding lung function and was also employed in this study.

The study was done on 326 subjects who were mostly in the age group of 18-25 years. The study included 128 males and 198 females in the ratio of 4:6. The study also comprised of 120 smokers and 206 non- smokers in the ratio of 4:6.

Most of the individuals belong to the 20 years of age and no significant correlation with body weight, weight or BMI of the individuals was established in this study. A study conducted by Amit Bandopadhyay on pulmonary function test among young Malaysians showed FVC and FEV1 exhibited significant correlation with body height and body mass among males whereas in the female group FVC and FEV1 exhibited significant correlation with body mass, body weight and also with age.[17]

The study also aimed at finding differences in lung functions between 164 individuals belonging to the North Eastern States of the country and 162 individuals belonging to the Rest of the Country and also Non-Residential of India. The study groups were age matched Mean weight and BMI was higher among people from the rest of the country when compared to Northeast though not significant.

Much difference in the mean values of PFT parameters was not observed between individuals belonging to the North East part of the country and those belonging to the other parts of the nation and outside. This can be attributed to the fact that only the residential address was used for classification and not the geography of the place of stay or the ethnicity of the population. Students participating in the study belonged to wide range of geographic variation, ranging from hilly areas, plains, terrains etc. which was not considered in the study. Also, the ethnicity varied from region to region. The presence of migrant population in the North Eastern states (Mongoloids, Aryan, Dravidians) could also be the reason for the insignificant differences. A similar study conducted by Buvana et al on racial influence on pulmonary function test in Indian and Nigerian Students showed significant difference in the FEV1, FVC and FEV1/FVC values among the two groups where lung functions among Nigerians was better than the Indian population.[18]

Intake of tobacco is widely prevalent all over the world and it continues to rise in the developing countries. By 2030 the developing world is expected to have 7 million deaths annually from tobacco use.[19]

In the present study history of cigarette smoking was taken. Students with any other form of substance abuse were excluded from the study. In a similar study by Arora et al on substance abuse among medical students in a developing country, various substances used by the study participants included alcohol (44, 19.13%), cigarettes (23, 10%), cannabis (smoking) (10, 4.34%), bhang (8, 3.48%), tobacco (chewing) (5, 2.17%) and other substances (gel and drugs) (5, 2.17%). Most of the abusers used more than one substance.[20]

In our study, smokers from both the study groups had a decreased value of FVC and FEV1 values (FVC=2.76 ± 0.67, FEV1= 2.69 ± 0.59 in Group A, FVC=2.74 ± 0.65, FEV1= 2.67 ± 0.62 in Group B) as compared to non – smokers (FVC=3.27 ± 0.77, FEV1=3.12 ± 0.69 in Group A, FVC=3.05 ± 0.81, FEV1=2.97 ± 0.75 in Group B).

A similar study conducted in a rural area between smokers and non- smokers by Rubeena et al revealed a decrease in PFT values among the smokers who were having low to moderate nicotine dependence.[21]

Another study done by Boskabadi M.H. et al on Pulmonary function tests and respiratory symptoms among smokers in the city of Mashhad (north east of Iran) revealed a decreased value of FVC, FEV1 in smokers as compared to non-smokers.[22]

All pulmonary function parameters like FVC, FEV1, FEV1 /FVC showed statistically highly significant association between smokers and non- smokers by applying unpaired t-test of significance ($p<0.005$). Similar observation showing lung function impairment in smokers were reported by Burrows et al, Pandya et al, Dhand et al and Gupta et al.[21,23]

Gold et al. found that FEV_1/FVC ratio decreased among adolescent smokers.[24] Because our subjects were youths with no apparent respiratory pathology, we did not expect to find advanced impairment of lung function. Indeed, the vast majority of youths demonstrated respiratory function values within the normal range.

Additionally, the low to moderate level of nicotine dependence, and the intensity and duration of smoking in our youth group were unlikely to cause the intense respiratory health effects that are usually observed in elderly smokers.

In this study, FVC of the non-smoker group was significantly greater than that of the smoker group. This result suggests that cigarette smoking affects the lung capacity of youth smokers, making the volume that is associated with the FVC test smaller than that of non-smokers. The reduction in FVC of smoker may be explained by the reduction in strength of the respiratory muscles.

The results for FVC may have been influenced by the instructions given to subjects, to perform maximal inhalation and then perform maximal exhalation as rapidly and as completely as possible. Hence, the FVC test relies on the strength of respiratory muscles.

The results for FVC may have been influenced by the instructions given to subjects, to perform maximal inhalation and then perform maximal exhalation as rapidly and as completely as possible. Hence, the FVC test relies on the strength of respiratory muscles. Cigarette smoking affects the respiratory muscles through the influence of free radicals on the vascular system,[25] leading to a reduction in respiratory muscle blood supply which adversely impacts respiratory function.

Our findings in terms of the forced vital capacity of smokers in the early smoking period are consistent with those of previous studies[26,27,28,29] that have reported that the early stage of smoking among youths reduces lung function. Even though the average number of cigarettes smoked per day recorded in this study was similar to other studies,[16,23] approximately 10 cigarettes per day, the average duration

of cigarette smoking recorded in this study was much less, 1–3 years compared to the 2–5 years reported in other studies. Thus, the early stage of smoking among youths does cause reduction in the lung function.

Several previous studies also showed reduction of different values of PFTs among smoker compared to normal subjects.

In this study the Fagerstorm Questionnaire was used, and it showed that maximum students had either low to moderate dependence on Nicotine which included both hostellers and day scholars. In a study on the Effects of Smoking on Chest Expansion, Lung Function, and Respiratory Muscle Strength of Youths by Anong Tantisuwat et al it showed, the majority of youth smokers self-reported a low level of nicotine dependence (91%).[30]

Separate analysis of nicotine dependence among day scholars and hostellers was not done in this study. In a similar study conducted on medical students by Sourabh Agarwal et al on knowledge and practise of tobacco among 225 students, it showed 32.5% hostellers admitted were using tobacco currently, compared to 15.78% day scholars. In their study, 62.5% students with positive family history of smoking were 'current smokers' compared to 45.45% 'ever users,' and 37.5% 'never users.' 68.75% current users of tobacco indicated that they would try to quit tobacco use in the future.[31]

The study by Vijayan et al also showed lung volumes are about 15-20% lower in South Indians than in Western subjects.[16] Their findings are similar to those of other studies from India and in highlanders from New Guinea.[32] Our study findings also correlate to other studies conducted by Jain et al and Amit et al on young healthy adults in other parts of the country.[33]

The decrease in PFT values in smokers in both the study groups could be attributed to factors such as presence of allergy or family history of any respiratory disease such as asthma or COPD. The questionnaire used in the study also accounted the same and it was found that smokers from both the groups had higher allergy history as compared to non- smokers. The allergy history included allergy to pollen, dust, smoke and dirt.

Family history of presence of any respiratory illness such as asthma and Chronic Obstructive Pulmonary Disease in the family was taken as it may also lead to a decrease in lung function. 3(4.6%) of smokers and 6(10.9%) smokers from both the study groups had a history of respiratory illness in the family. Also 5(5.1%) of the non- smokers from Group A and 18(16.8%) of the non- smokers from Group B have a history of Asthma in the family. No significant association of smoking and development of restrictive or obstructive disease was established in this study.

These along with other environmental and genetic factors might be responsible for the decrease in PFT values in both the groups. Hence the subjects with decreased lung functions need to be evaluated and monitored over longer time frame for finding the accurate cause for so. Although socio economic background and diet of the group was kept stable with a standard age, weight, height and BMI for both the groups, the variations can be attributed to ethnic origin, genetics, environmental factors, allergy or familial origin. The exact cause and chances of developing any restrictive or obstructive disease should be evaluated. The smokers should be made to know about the risks and health hazards of smoking and both active and passive smoking should be discouraged.

CONCLUSIONS

This study employed a simple questionnaire-based approach to classify students into two broad groups based on their smoking habits and regional variations.

From the above study, we can conclude that the PFT values were lower among smokers as compared to non-smokers among the healthy population of subjects of both the study groups. There were no significant regional differences in various lung parameters. This was attributed to the classification of subjects based on their place of stay made and not on the basis of topographical or ethnic differences.

A study with a larger study group and longer time period can be undertaken to find out the exact cause for decreased PFT values among subjects. Although smokers exhibited a decrease in lung function as compared to non-smokers, a long-term monitoring in those subjects is needed to inspect the development of any restrictive or obstructive disease.

It was also concluded that various other factors such as allergy to a particular substance, family history of any respiratory disease, environmental factors, etc. could also lead to altered lung function among normal individuals.

Since the study was conducted among the students of a medical college, who are going to be future physicians and health care providers of the country, they are expected to know, abide and follow abstinence from any kind of substance abuse which may risk their as well as the life of others. Hence, they should avoid cigarette smoking to abstain from any kind of obstructive or restrictive pulmonary diseases, as cigarette smoking is one of the most important causes.

Factors such as allergy and family history considered in the study showed a positive correlation among smokers. This could also be the factors for a decrease in lung function. Also, the study groups should be classified according to ethnical and geographical differences rather than regional differences to check for any variations in lung function, if any. The migrant population (with variant ethnicity) and people with same topographical origin but of different regions were merged into two broad groups based on their regional differences which should be looked upon in this study.

Most of the smokers studied upon were having low to moderate dependence on Nicotine. Various awareness programmes can be undertaken for them regarding the health hazards of smoking. Proper counselling can be undertaken.

There was no region-specific influence on smoking, i.e. the number of smokers from both the groups were almost the same. This may lead to identification of the cause of

cigarette smoking and various factors which should be governed in this part of the country.

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