4.1. SECTION-I

4.1.1. SOCIO-DEMOGRAPHIC CHARACTERISTICS

Table-3 represents the socio demographic characteristics of the study subjects (teachers). The mean age of the overall study subjects (teachers) was 40.25±8.53yrs. The proportion of male and female study subjects (teachers) was 34.76% (Mean41.0±7.48SD) and 65.52% (Mean39.94±8.87SD) respectively. Majority of the study subjects (teachers) are from the age group 40-49 with 42.86% (Mean45.45±3.0SD). The study subjects (teachers) from the secondary schools are more than 75.34%, (Mean 43.12±3.21SD) the primary school study subjects (teachers) 24.65% (Mean 37.24±2.57SD). About 56% of the study subjects (teachers) work load is 4-5 hours per day.

4.1.2. OCCUPATIONAL HEALTH HAZARDS BASED ON GENDER WISE

Table-4 represents the prevalence of occupational health hazards of teachers based on gender wise. The questionnaire analysis of 609 questionnaires from male study subjects (teachers) and 1143 from female study subjects (teachers) revealed that the incidence of Tired voice (P=.033) from vocal hazards, Back pain (P=.084) from musculoskeletal hazards, Rhinoparyngitis (P=.047), Eczema (P=.045) Dermatitis (P=.074), from chemical and biological hazards, Headache (P=.037), Hypertension (P=.033) and Dizziness (P=.022) are noticed with high prevalence ratio in both male and female study subjects (teachers). Chi square analysis was performed to test the prevalence of occupational health hazards on gender bias and corresponding p-values were mentioned in the table-4. In the present study, the occupational health hazards in association with gender observed that the male study subjects (teachers) were noticed with occupational health hazards like Otitis (P=.022) from chemical and biological
hazards, Hypertension (P=.033) from psychological hazards in high prevalence ratio and remaining all occupational health hazards were noticed with high incidence ratio in female study subjects (teachers). From the questionnaire observations, it is proved that the gender had a strong association with occupational health hazards. It is also observed that the female study subjects are vulnerable to multiple occupational health hazards (P=.033) than male study subjects (teachers). Based on observations, the incidence of occupational health hazards in female and male study subjects (teachers) were in the descending order Back pain (94.22%; 76.02%), Headache (87.80%; 76.19%), Tired voice (80.83%; 76.35%), Hoarseness (73.75%; 61.41%), Dizziness (68.76%; 52.70%), Loss of voice range (63.42%; 56.32%), Spondylytis (63.16%; 54.02%), Anxiety (57.48%; 53.53%), Sleeping problems (57.39%; 52.05%), Arthritis (54.15%; 23.31%), Eczema (53.28%; 38.25%), Hypertension (48.03%; 69.78%), Dermatitis (46.89%; 30.8%), Depression (43.56%; 38.42%), Asthma (37.09%; 15.27%), Varicose Veins (34.47%; 15.59%), Bronchitis (34.20%; 23.48%), Conjunctivitis (31.58%; 14.61%), Otitis (17.31%; 22.82) and Urinary tract infection (4.11%; 0) (Fig. 3).

4.1.3. OCCUPATIONAL HEALTH HAZARDS BASED ON AGE GROUP

Fig. 4 represents the occupational health hazards of study subjects (teachers) based on the age group. Questionnaire analysis of 202 study subjects (teachers) from the age group ranging from 20-29 revealed that they are suffering from the occupational health hazards like Back pain (98.5%) from musculoskeletal hazards, Rhinopharyngitis (50.9%) from chemical hazards and sleeping problems (75.2%) from psychological hazards (table-5). A total of 384 questionnaire analysis of the study subjects (teacher) from the age group ranging from 30-39 noticed that they are more prone to vocal hazards like Hoarseness (80.9%), Tired voice (93.4%), Loss of voice range (63.42%), musculoskeletal hazards like Spondylytis (63.16%) and Dizziness (68.76%).
The occupational health hazards like Bronchitis (55.5%), Conjunctivitis (35.5%), Asthma (41.4%) from chemical hazards, Depression (51.5%), Hypertension (60.4%), Anxiety (65.3%) and Headache (95.3%) were detected with greater prevalence ratio in the study subjects from the age group ranging from 40-49 from the 751 questionnaire investigation (Table-5).

Based on the results obtained, positive association between the age group and prevalence of occupational health hazards like Varicose veins (P=.021), Eczema (P=.041), Dermatitis (P=.139), Depression (P=.022) and Anxiety (P=.031) (Table-5). The occurrence of occupational health hazards in study subjects (teachers) of different age groups in descending order are as follows. In the study subjects (teachers) from the age group ranging from 20-29, the descending order of prevalence of occupational health hazards was Back pain (98.5%), Dizziness (80.6%), Sleeping problems (75.2%), Tired voice (66.8%), Rhinopharyngitis (50.9%), Hoarseness (50.4%), Hypertension (50.0%), Headache (36.1%), Spondylitis (33.6%), Loss of voice range (33.1%), Anxiety (32.6%), Dermatitis (32.1%), Eczema (29.3%), Arthritis (29.2%), Asthma (18.3%), Depression (17.8%), Varicose veins (16.8%), Bronchitis (15.8%) and Conjunctivitis (15.8%).

Prevalence of occupational health hazards of the study subjects (teachers) from the age group ranging from 30-39 was Tired voice (93.4%), Headache (88.7%), Dizziness (86.9%), Back pain (86.1%), Hoarseness (80.9%), Spondylitis (75.2%), Loss of voice Range (73.4%), Sleeping Problems (68.7%), Anxiety (56.7%), Eczema (50.5%), Depression (49.7%), Hypertension (46.6%), Dermatitis (40.1%), Arthritis (38.5%), Rhinopharyngitis (33.3%), Varicose veins (28.3%), Asthma (26.8%), Otitis (21.8%), Conjunctivitis (13.2%), Bronchitis (12.2%) and Urinary tract infection (7.0%).

In the study subjects (teachers) from the age group ranging from 40-49 the prevalence of occupational health hazards was Back pain (95.7%), Headache (95.3%), Tired voice (82.8%),
Hoarseness (75.6%), Anxiety (65.3%), Dizziness (65.1%), Spondylytis (60.8%), Hypertension (60.4%), Sleeping problems (60.0%), Loss of voice range (57.7%), Bronchitis (55.5%), Arthritis (51.6%), Depression (51.2%), Eczema (40.1%), Rhinopharyngitis (50.2%), Dermatitis (45.4%), Asthma (26.8%), Conjunctivitis (35.5%), Varicose veins (29.1%), Otitis (26.3%) and Urinary tract infection (1.1%).

The Descending order of the prevalence of occupational health hazards in the study subjects (teachers) from the age group ≥50 was Headache (87.5%), Loss of voice range (72.5%), Back pain (71.0%), Tired voice (65.7%), Hypertension (57.8%), Spondylytis (57.1%), Hoarseness (56.8%), Eczema (50.3%), Anxiety (50.1%), Rhinopharyngitis (49.8%), Arthritis (40.0%), Dermatitis (39.5%), Varicose veins (30.6%), Dizziness (28.5%), Depression (28.4%), Sleeping problems (25.5%), Conjunctivitis (24.0%), Asthma (18.3%), Otitis (13.2%), Bronchitis (8.6%) and Urinary tract infection (2.6%).

4.1.4. OCCUPATIONAL HEALTH HAZARDS BASED ON YEARS OF SERVICE

Fig. 5 illustrates the occupational health hazards of study subjects (teachers) based on their years of service. The questionnaire investigations from 163 study subjects (teachers) from the years of service 0-10 years reveal that the occupational health hazards like Back pain (86.44%) from musculoskeletal hazards, Dizziness (77.9%) from psychological hazards and Dermatitis (59.5%) chemical hazards are observed with high prevalence ratio(Table-6). The scrutiny of data from 391 questionnaires collected from the study subjects (teachers) who have 11-20 years of service reported with occupational health hazards like Headache (91.5%), Anxiety (70.0%) from Psychological hazards, Tired voice (91.3%), Loss of voice range (78.0%) from vocal symptoms, Spondylytis (65.6%), Varicose veins (28.6%) from the musculoskeletal hazards with dominance
Questionnaires data from years of service 21-30 revealed that Back pain (90.1%), Arthritis (55.7%), Hoarseness (75.0%) from vocal hazards, Eczema (57.9%), Rhinopharyngitis (52.4%) from chemical hazards and Depression (56.1%) were observed with elevated incidence ratios. Bronchitis (42.7%), Otitis (26.9%), Conjunctivitis (38.3%), Asthma (73.9%) from chemical hazards, Hypertension (66%) and Sleeping problems (94.4%) were identified with high prevalence ratio in the study subjects (teachers) with years of service >30 based on questionnaire study. The association between the occupational health hazards and the years of service was calculated by using chi square analysis. Based on the results obtained among all the occupational health hazards Varicose veins (P=.293), Otitis (P=.298), Conjunctivitis (P=.037) and Hypertension (P=.0184) were the occupational health hazards showed a positive association with the years of service (Table-6).

Based on the observations, the incidence of occupational health hazards was based on years of service in descending order are as follow. The incidence of occupational health hazards in the study subjects (teachers) with years of service 0-10 in descending order were Back pain (90.1%), Head ache (88.3%), Tired voice (83.4%), Dizziness (77.9%), Loss of voice range (73.0%), Spondylytis (61.9%), Dermatitis (59.5%), Hoarseness (55.8%), Sleeping problems (51.5%), Depression (48.4%), Hypertension (46%), Arthritis (44.1%), Anxiety (41.7%), Rhinopharyngitis (34.9%), Eczema (34.5%), Asthma (33.1%), Conjunctivitis (17.7%), Bronchitis (16.5%), Varicose Veins (9.2%), Urinary tract infection (61.%) and Otitis (5.5%).

The descending order of incidence of occupational health hazards in the study subjects (teachers) with years of service 11-20 are Headache (91.5%), Tired voice (91.3%), Back pain (86.44%), Loss of voice range (78.0%), Hoarseness (71.8%), Anxiety (70.6%), Dizziness (66.75%), Spondylytis (65.5%), Hypertension (59%), Sleeping Problems (58%),
Rhinopharyngitis (50.3%), Eczema (45.7%), Depression (45.2%), Asthma (37%), Dermatitis (33.5%), Arthritis (29.1%), Varicose Veins (28.6%), Bronchitis (28.1%), Otitis (19.9%), Conjunctivitis (17.6%) and Urinary tract infection (10.7%).

The incidence of occupational health hazards in the study subjects (teachers) with years of service 21-30 in descending order was Back pain (90.1%), Dizziness (77.7%), Tired voice (76.8%), Headache (75.2%), Hoarseness (75%), Spondylitis (59.5%), Anxiety (57.6%), Eczema (57.9%), Depression (56.1%), Loss of voice range (53.5%), Rhinopharyngitis (52.4%), Hypertension (50.0%), Dermatitis (36.1%), Sleeping problems (33.5%), Bronchitis (27.7%), Conjunctivitis (24.3%) and Otitis (17.4%).

The descending order of incidence of occupational health hazards in the study subjects (teachers) with years of service >30 was Sleeping problems (94.4%), Headache (89%), Back pain (85.3%), Varicose veins (38.1%), Tired voice (71.16%), Hypertension (66%), Hoarseness (62.5%), Loss of voice range (57.9%), Spondylitis (54.6%), Dermatitis (50.6%), Anxiety (46%), Bronchitis (42.7%), Conjunctivitis (38.3%), Varicose veins (38.1%), Eczema (37.2%), Rhinopharyngitis (36.9%), Arthritis (34.1%), Dizziness (28.3%), Otitis (26.9%), Depression (10.4%) and Urinary tract infection (5.1%).

4.1.5. OCCUPATIONAL HEALTH HAZARDS BASED ON THE LEVEL OF TEACHING

Fig. 6 represents the occupational health hazards in the study subjects (teachers) based on the level of teaching. A total of 432 questionnaire investigation of study subjects (teachers) from primary schools revealed that the occupational health hazards like Hoarseness (82.6%), Back pain (91.8%), Conjunctivitis (34.7%) and Dizziness were more prevalent (Table-7). The influence
of the levels of teaching was measured by using the Chi square analysis. High percentages of vocal hazards were noticed in study subjects (teachers) from secondary schools. The study subjects (teachers) from secondary schools complained more about the Tired voice (P=.027), Loss of voice range (P=.038). Spondylytis (P=.044), Varicose veins (P=.038). Incidence of Back pain is high in both the study subjects (teachers) (P=.044). Among all the chemical health hazards the incidence of Eczema was noticed with elevated percentages (P=.043). Psychological hazards, the symptoms like Headache (P=.038) and Anxiety (P=.037) were high in study subjects (teachers) from secondary schools.

Based on the results obtained from the influence of level of teaching on occupational health hazards in descending order was Back pain(91.8%), Hoarseness (82.6%), Headache (71.9%), Dizziness (70.1%), Loss of voice range (59.4%), Tired voice (48.8%), Sleeping problems (48.3%), Hypertension (46.5%), Arthritis (42.3%), Depression (38.8%), Anxiety (36.1%), Spondylytis (35.4%), Conjunctivitis (34.7%), Rhinopharyngitis (28%), Asthma (26.6%), Eczema (26.1%), Bronchitis (19.2%), Dermatitis (18.0%), Varicose veins (13.1%), Otitis (11.1%) and Urinary tract infection (8.1%) in study subjects (teachers) from primary school (Fig.6).

The prevalence of occupational health hazards in study subjects (teachers) from secondary school in descending order was Tired voice (89.2%), Headache (87.2%), Back pain (87.0%), Spondylytis (68.0%), Hoarseness (65.1%), Anxiety (62.6%), Loss of voice range (62.6%), Dizziness (60.9%), Hypertension (58.5%), Sleeping problems (57.8%), Eczema (55.2%), Rhinopharyngitis (52.1%), Dermatitis (48.9%), Arthritis (43.7%), Depression (42.7%), Conjunctivitis (24.2%) and Otitis (21.7%) (Fig.6).

4.1.6.OCCUPATIONAL HEALTH HAZARDS BASED ON SMOKING HABIT
Based on 215 questionnaire reviews from study subjects (teachers) with smoking habit and 1537 questionnaire reviewed from study subjects (teachers) without smoking habit revealed that significant difference between the smoking and nonsmoking participants in all the symptoms of vocal problems. The symptoms like Rhino pharyngitis (P=.091), Bronchitis (P=.153), Depression (P=.046) and Headache (P=.043) were high in smoking participants (Table-8).

Based on the observations the incidence of occupational health hazards in study subjects (teachers) of both smoking and non-smoking personnel’s in descending order are Headache (90.2%; 82.5%), Tired voice (88.8%; 77.9%), Back pain (88.8%; 87.7%), Hoarseness (85.1%; 67.2%), Loss of voice range (73%; 60.3%), Spondylytis (58.1%; 60.2%), Bronchitis (51.6%; 27.3%), Rhinopharyngitis (50.6%; 47.5%), Anxiety (50.6%; 56.8%), Depression (48.3%; 40.8%), Eczema (38.6%; 49.3%), Dizziness (38.6%; 66.6%), Dermatitis (35.3%; 45.4%), Sleeping problems (35.3%; 58.3%), Hypertension (26.5%; 59.6%), Asthma (26.5%; 29.9%), Arthritis (20.4%; 46.6%), Varicose veins (15.8%; 29.6%), Otitis (12.0%; 20.1%), Conjunctivitis (9.7%; 27.9%), Urinary tract infection (0; 29.9%) (Fig.7).

4.2. SECTION-II

The following elements were analyzed for each five locally available selective brands (dustless and dusted) of chalk sticks and chalk dust (suspended and settled) collected from classrooms

1. Calcium
2. Aluminum
3. Iron
4. Nickel
5. Silicon
6. Chromium  
7. Manganese  
8. Cobalt  
9. Lead  

4.2.1. TRACE ELEMENT CONCENTRATION IN DIFFERENT BRANDS OF CHALK STICKS USING ED-XRF

Table-9 illustrates the trace elemental concentration of locally available selective five brands of chalk sticks (dustless and dusted). In all the brands the Calcium was noticed in elevated concentrations (dusted chalks-6285.8ppm, the dustless chalks-8275.4ppm). Next to the Calcium, Silicon was noticed in second position based on concentration (dusted-3405ppm, dustless chalks-4454ppm). Except Calcium and Silicon other seven elements were observed with elevated concentrations in dusted chalks (Fig.8). Chromium was reported with lowest concentration in both dusted (17.84ppm) and dustless chalks (8.38ppm)(Table-9).

Based on the observations the trace element concentrations of selected brands of chalk sticks (both dusted and dustless) in descending was Ca>Si>Mn>Fe>Co>Pb>Al>Ni>Cr.

Calcium(8275.4ppm,6285.2ppm), Silicon(4454ppm,3405ppm), Manganese(848.6ppm,1155.9ppm), Iron(739.6ppm,1175.7ppm), Cobalt(397.1ppm,1039.6ppm), Lead(253.5ppm,791ppm), Aluminium (252.6ppm,327.7ppm), Nickel (22.7ppm,43.4ppm), Chromium (8.3ppm,17.8ppm).
4.2.2. TRACE ELEMENT CONCENTRATION IN SETTLED AND SUSPENDED CHALK DUST COLLECTED FROM CLASSROOMS USING ICP-MS METHOD

Table-11 demonstrates the trace element concentration in settled chalk dust where as the Table-12 illustrates the trace element concentration of suspended chalk dust samples collected from classrooms. The recovery rate was measured using spiked known concentration of all the investigated elements. The consistency of the results was confirmed by measuring the recoveries of the spiked elements to the sampled solutions. The percentage recovery of analyzed trace elements ranged between 70 and 110% (Table-10) indicating good accuracy, precision and validity of the method used (Liang et al 2012; Maruthi et al 2017). Among all the elements, Calcium, Silicon, Iron and Manganese are observed in high concentrations in both settled and suspended chalk dust (Fig.8). These three elements were observed with higher concentration in suspended chalk dust (Table-12).

Based on the observations, the trace element in chalk dust (settled and suspended) in descending order was Ca>Si>Mn>Fe>Al>Co>Pb>Cr>Ni

Silicon(2.16ppm, 3.5ppm), Manganese(0.79ppm, 1ppm), Iron (0.33ppm, 0.62ppm), Aluminium(0.50ppm, 0.30ppm), Cobalt(0.21ppm, 0.20ppm), Lead(0.19ppm, 0.21ppm), Chromium (0.13ppm, 0.20ppm) and Nickel (0.063ppm, 0.06ppm).

4.2.3. PARTICLE SIZE ANALYSIS OF SELECTED LOCAL BRANDS OF CHALK STICKS
The particle size analysis of the selected brands of chalk (Table-13) revealed that dusted chalk sticks has a particle size in the range of 3.9µm to 2.1µm, where as in dustless chalks the particle size was in the range of 4.0 to 3.3µm. The particle size analysis of selected five brands of chalks (dusted and dustless) clearly reveal that dustless chalk sticks have large particle size, which clearly indicates the dustless chalk particles settles faster than dusted chalks.

4.2.4. SCANNING ELECTRON MICROSCOPY STUDIES (SEM)

The SEM studies of filter papers (plate6 to 9) depicts that adsorption of chalk dust on filter paper(pm2.5) was so high. Filter papers pores were blocked with chalk dust. All the images of settled chalk dust showed elongated nature of chalk dust. (Plate 10 to 13) elucidates that fibrous shape of chalk dust, an index of good quality chalk sticks, i.e. non dust(Manish et al 2016), where as Image(Plate-14) shows circular but more aggregated nature of chalk dust of low quality chalksticks from which the dust production will be very high. The trace element concentration was high in suspended chalk dust; the fact can be correlated with the SEM images which have shown high density of adsorbed chalk dust.

4.3.1. SOCIO-DEMOGRAPHIC CHARACTERISTICS

The present study includes 51 normal healthy study subjects (teachers). Male study subjects (37) are dominating with mean age group of (Mean34.89±11.7SD). The years of service was almost similar in both the age groups (table-14). The other variables like height, weight and BMI (Body Mass Index) are shown in table-14.

4.3.2. SPIROMETRIC ANALYSIS (BOTH PRE AND POST)
No significant difference was noticed in context with gender. Most of the study subjects (teachers) are noticed with restrictive stage of pulmonary disorder (78.3% in male and 78.5% in females). Out of 78.3% males study subjects (teachers) with restrictive stage of Pulmonary disorder, 40.5% are observed severe stage of restrictive pulmonary disorder, whereas in female study subjects (teachers) 50% are observed with restrictive stage of pulmonary disorder (table-15). Normal stage of pulmonary function was noticed in 18.9% of male study subjects (teachers) and 21.4% of female study subjects (teachers).

A significant increase in few pulmonary function parameters (FVC) after implementing suggested protective methods was observed between pre and post spirometric analysis of male (Fig.10) and female (Fig.11) study subjects (teachers). Even though there is an increase in few Pulmonary Function parameters (FVC), the study subjects (teachers) are noticed with the restrictive stage of pulmonary disorders.
5.1. Occupational health hazards in teachers

In the present study occupational health hazards in study subjects (teachers) were studied. Questionnaire is used as a tool to collect the information from study subjects (teachers). The variables like gender, age, years of service and level of teaching were also considered to find out the relation with occupational health hazards. The occupational health hazards like Back pain, Headache and Tired voice were observed with high prevalence ratio in study subjects. Musculoskeletal hazards particularly Back pain is the frequent reported occupational health hazard in teachers (Patience et al 2014; Rajan et al 2016). Back pain is high in study subjects of the present study. Hence it is proved that Back pain is the most common musculoskeletal hazard in teachers. Improper gestures when working with computer as well as valuation of answer scripts and minimum of four hours per day standing and sitting are the key factors for musculoskeletal hazards in teachers (Mohammed et al 2014). Marta Regina et al (2015) reported that 59.5% of teachers were victims of Headache, common psychological occupational health hazard. In the present study, 83.50% of study subjects reported Headache. It is confirmed that Headache is also one of the regular occupational health hazard in teachers. Marta Regina et al (2015) stated that under employment, low pay, extra-curricular activities etc are the reasons for the headache in teachers. Tired voice is one of the vocal hazards noticed with high prevalence ratio in teachers. For vocal health hazards, three health hazards were studied in the present study and all most all the vocal health hazards were noticed with high prevalence ratio. Previous studies proved that teachers are highly susceptible to vocal hazards (Cartiona & Ray 2007). Ijomaki et al (2005) noticed that prevalence of voice related occupational health hazards was low in vocal therapy trained teachers when compared to un trained teachers.
Gender plays a significant role in occupation as well as in occupational health hazards also. In the study, Gender showed significant relationship with the occupational health hazards. Previous studies related to incidence of vocal (Smith et al 1998 a, Ilomaki et al 2005), Musculoskeletal hazards (Patience et al 2014) and Mental health (Elena et al 2009) occupational health hazards was high in female teachers than male teachers. There is a paucity in literature exists related to occupational respiratory health hazards with respect to gender.

In relation with the age group, occupational health hazards like Varicose veins, Eczema, Dermatitis, Depression and Anxiety were showed a positive association. Caqqiati et al 2006 reported that prevalence of Varicose veins was directly proportional to the age. Eczema and Dermatitis occurs mainly due to extensive usage of chalk (Monnica et al 2011). Nickel content in chalk causes dermatitis in study subjects (teachers) (Raith and Jaeger et al 1986). In the present study the Eczema and Dermatitis increased with age, which clearly indicates that use of chalk by study subjects (teachers) throughout the years of service increases the chance for incidence of Eczema and Dermatitis. Few health hazards varied with the age groups. In the age group 20-29 the occupational health hazards like Back pain, Rhinopharyngitis, Sleeping problems were observed with high incidence ratio. Young and middle age people are more prevalent to Back pain (Toshihiko 2003). He also stated that work pressure, unhealthy life style and overweight are the factors causing Back pain. There is a paucity exists related to occupational respiratory hazards in context with gender. Bannai et al (2015) reported that junior high school teachers are vulnerable to sleeping problems due to prolonged duration of work. The results of this study emphasizes that subjects from younger age group are suffering to Back pain and Sleeping problems. The age groups 30-39 are more susceptible to vocal hazards like Hoarseness, Tired voice, and Loss of voice range.
Similar results in school teachers were observed by Elena Nerriere et al 2009. So middle age group teachers are highly susceptible to vocal hazards. The occupational health hazards like Depression and Anxiety is less common in the older age group (Annu Rev 2010). In teachers of age group <50 the depressive health hazards like anxiety, headache were high due to work stress (Judi et al 2016)

Varicose veins, Otitis, Conjunctivitis and Hypertension showed a positive association with the years of service. Hamid sharif Nia et al (2015) revealed that the Varicose veins increase with the years of service and it is also proved in the present study. Vocal hazards are noticed with the study subjects with years of service 11-20. Lira Luce et al 2014 reported that vocal hazards did not show any correlation with years of service. The observed results are akin to past studies. Literature studies also showed that the years of service has a positive association with musculoskeletal hazards (Magdy et al 2013; Patience et al 2011) The results of this study also supports that like Varicose veins showed a positive association with years of service.

Except Hoarseness, Back pain, Conjunctivitis and Dizziness, remaining all the hazards were reported high in secondary school teachers. A primary school teacher has to sit continuously for more than 5 hours where as the secondary school teacher will have breaks between the lectures. So this might be the reason for the high occurrence of Back pain, Hoarseness and Dizziness in primary school teachers.

In smoker (teachers) the high incidence of vocal hazards were observed. The past studies on vocal hazards in teachers also revealed that smoking is one of the important reason for vocal hazards persistent in male teachers (El Tayeb 2012; Safar al saleem & Mohammed Al salem 2012). In addition to vocal problems the respiratory hazards were also high in smokers when
compared to non-smokers (Anil Vijay Kumar 2014). It is also proved from the results of present & earlier studies that the smokers are more prone to Depression (Jaimee et al. 2011).

5.2. Trace elemental characterization and Image studies of chalk and chalk dust

A few studies on chalk revealed that the chalk can cause the contact dermatitis (Monica Corroza et al. 2011) and few recent studies also revealed that the chalk can cause respiratory problems (Zhang et al. 2015b) but the constituents of chalk are non-toxic. To study the health impacts of elements in chalk, trace elemental characterization of different brands of chalk and also the chalk dust (both settled and suspended) collected from classrooms were carried out. ED-XRF technique was carried out for five locally available selected brands of chalk and for chalk dust collected from classrooms ICP-MS technique was performed. Due to lack reference standards, no qualitative analyses were performed for selected brands of chalk where as in case of dust collected from classroom the recovery percentages were calculated. The elements like Calcium was noticed with higher concentration in dustless chalks in comparison with dusted chalks which indicates the good quality of dustless chalk (Majumdar et al. 2011). Except Calcium remaining all the elements were noticed with high concentrations in dusted chalks. The Calcium Carbonate and Calcium Sulfate (gypsum) in combination with polymeric binders are used for manufacturing dusted and dustless chalk (Manish Thakker et al. 2015). Next to Calcium Aluminum, Silicon and Iron were noticed with high concentrations in chalk sticks. In the dust (Both suspended and settled chalk dust) collected from classrooms the elements like Calcium, Aluminum, Silicon and Iron were noticed in high concentration which clearly indicates that it is because of the usage of the chalk. The trace elemental concentration was high in suspended chalk dust and the fact can be correlated with the SEM images which showed more density of adsorbed chalk (Maruthi et al. 2017). The obtained concentrations were compared with ATSDR (Agency for Toxic Substances
and Disease Registry) minimum risk levels. The available and observed concentrations were of Chromium, Manganese, Cobalt and Iron were exceeded the minimal risk levels in chalk sticks and chalk dust. It clearly states that usage of chalk causes health hazards to teachers.

5.3. Particle size analysis of chalk sticks

The particle size analysis of chalk sticks revealed that the particle size of dustless chalk are larger when compared to dusted chalks. The recent study states that the particle size of dustless chalks are larger than dusted chalks (Manish Thakker et al 2015). The difference in the particle size of the chalks is due to the different morphological properties of chalk. He also stated that the “Difference in the particle size is presumably due to dustless properties of chalk, the larger particles in dustless chalk settles faster on ground rather than remain suspended in air”.

5.4. Spirometric analysis

The spirometric analysis of study participants in the present revealed that majority of the study subjects are with restrictive stage of COPD. Majority of the study subjects (teachers) are noticed with restrictive stage of pulmonary disorder (78.3% in male and 78.5% in females). Out of 78.3% male study subjects (teachers) with restrictive stage of Pulmonary disorder, 40.5% are observed with severe stage of restrictive pulmonary disorder, where as in female study subjects (teachers) 50% are observed with restrictive stage of pulmonary disorder. Normal stage of pulmonary function was noticed in 18.9% of male study subjects (teachers) and 21.4% of female study subjects (teachers).

Kamini et al (2013) observed that pulmonary function impairments in teachers. Based on the present study it is proved that the teachers are prevalent to pulmonary impairments. The key source for the pulmonary impairments in teachers is use of the chalk sticks. Dust released from
the chalk sticks remain suspended in the air for longer period as particulate matter and causes respiratory problems (Deepanjan Majumdar 2009). Bohadana et al (1996) reported that all pulmonary parameters were affected in workers with increase in exposure of chalk dust in chalk powder plant. It clearly elucidates that the chalk is the prime reason for the pulmonary impairments in teachers. To improve the health of study subjects (teachers) a few safety measures were suggested to implement for six months. Spirometric analysis was done to teachers after following the safety measures. There is an increase in FVC and FEV1 were noticed. Eleine Drakou et al (2015) noticed an increase in FVC and FEV1 in 6 months after Lobectomy for bronchial carcinoma in his experimental studies. From the Eleine Drakou (2015) it is proved that there can be a chance of an increase in FVC and FEV1 for six months. Even though there is an increase in FVC and FEV1 majority of the study subjects (teachers) are noticed with restrictive stage of COPD. Hence it is suggested that a long term implementation of safety measures against chalk usage in teachers for more than 2 to 3 years may decrease the risk of Pulmonary impairments in study subjects.
In the present study prevalence of occupational health hazards in teachers was studied and also the trace elemental characterization (Calcium (Ca), Aluminum (Al), Chromium (Cr), Manganese (Mn), Iron (Fe), Cobalt (Co), Nickel (Ni), Silicon (Si) and Lead (Pb)) of chalk and chalk dust (settled and suspended) was also studied to know about the chalk dust related occupational health hazards in teachers. A case study was also conducted to implement the proposed safety measures to teachers. From the results it is noticed that occupational health hazards like Back Pain, Headache and Tired voice was observed with high prevalence ratio in study subjects (teachers). The variables like gender, Age, Years of service, level of teaching and personnel habits like smoking showed a positive association with occupational health hazards. Trace elemental analysis of chalk sticks revealed that except Ca all the elements were high in dusted chalks where as in chalk dust (settled and suspended) the suspended chalk is noticed with high concentration of the trace elements when compared to settled chalk dust. The concentration of the elements were also compared with the ASTDR minimal risk levels and the elements like Chromium (Cr), Manganese (Mn), Iron (Fe), Nickel (Ni) and Cobalt (Co) were noticed beyond the minimal risk levels in both the chalk and chalk dust. SEM image studies discloses the crystalline nature of the chalk particles in chalk dust (settled) was confined to few chalk samples where as the majority of the chalk samples (dust) showed clustered flocs of chalk dust particles showing the substandard quality of chalk. The trace elements concentration was elevated in the suspended chalk dust and the SEM images of filter papers showed excess concentrations of adsorbed chalk dust indicating bad quality of chalk. Particle size analysis of the different brands of chalk also revealed that the dusted chalks are noticed with lower particle size which reflects that it remains suspended in air for longer period of time. In the case study The prespirometric analysis of study
subjects noticed with 52.9±25\% of FVC in male and 47.4±24.1\% in females were noticed. An increase of FVC parameters were noticed in both male and female study subjects after following the protective measures. But 40 study subjects are noticed with different stages of restrictive pulmonary impairments.

From the results of the study it is concluded that teachers are prevalent to different types of occupational health hazards and from the elemental analysis it is also proved that the chalk is toxic to the study subjects (teachers). The case study clearly revealed that the study subjects (teachers) are affected with respiratory health hazards due to the chalk dust. Hence it is suggested that study subjects (teachers) should follow the modern techniques of education like marker boards, digital boards, Voice amplification systems, etc. if not they should at least follow the safety measures suggested in the present study. The implementation of the safety measures for a longer period can reduce the occupational health hazards in study subjects (teachers).
1. It is recommended to carry out chalk dust toxic studies at cellular levels.

2. It also recommended to find out the recovery rates on vocal hazards in teachers by conducting vocal therapy classes.

3. In the present we implemented the protective measures in teachers for only six months. and the implementation of these protective measures for longer period can reduce the occupational health hazards in teachers. So it is recommended to perform observational studies in teachers by following these safety measures for longer period of time.