RESEARCH PAPER

CORRELATION OF LUNG FUNCTION WITH PERCEIVED DYSPNEA, FUNCTIONAL INDEPENDENCE AND QUALITY OF LIFE IN STROKE SURVIVORS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Background: Stroke is the leading cause of disability worldwide. Muscular weakness is one of the features of stroke in which respiratory muscles may be involved. Weakness of respiratory muscles associated with sedentary lifestyles and deconditioning, may increase dyspnea after stroke, increase the risk of respiratory complications leading to non-vascular death after stroke. Hemiparetic stroke survivors often show fatigue and dyspnea in conditions of higher effort demands which may interfere with activities of daily living and quality of life.

Objective: The aim of this study was to assess lung function (forced vital capacity [FVC], forced expiratory volume in 1 second [FEV_1], FEV_1/FVC ratio and peak expiratory flow [PEF]) and its correlation with perceived dyspnea, functional activities of daily living and quality of life in stroke survivors.

Methodology: This cross-sectional study included 72 stroke survivors (48 males, 24 females) between the age group of 18 to 50 years. They were selected on the basis of inclusion and exclusion criteria from New Civil Hospital, Surat. After taking consent from all the participants, outcome measures: Lung function by spirometer (CPFS/D^{TM} USB spirometer), Perceived Dyspnea by Modified Borg Dyspnea Scale after 6-minute walk test (6MWT), Functional Independence by Barthel Index and Quality of Life by Stroke Impact Scale 3.0 were measured. Statistical analysis of the data was performed using MATLAB. All the data was analyzed by application of descriptive statistics, Wilcoxon signed-rank test, Mann-Whitney U test, Spearman's rank correlation and Kruskal-Wallis one-way analysis of variance.

Result: The data of outcome measures of stroke survivors was correlated and compared using Descriptive statistics, Non-parametric tests and Spearman's rank correlation. The difference between absolute and predicted values for lung function indices (FVC [1.89±0.75 vs 3.62±0.724], FEV_1 [1.64±0.57 vs 2.94±0.62], FEV_1/FVC [88.04±10.86 vs 81.17±2.64] and PEF [3.38±1.67 vs 7.68±1.57]) were highly significant with $p<0.01$. Lung function parameters were statistically significant negatively correlated with post-test Modified Borg Dyspnea Scale (p-value<0.01) where as significant positively correlated with Barthel Index and Stroke Impact scale 3.0 (p-value<0.01) except FEV_1. There was a strong association between activities of daily living and quality of life with p-value less than 0.01. Out of 8 domains of Stroke Impact Scale 3.0, Emotion and ADL/IADL domains were affected the most. Abnormal lung function represented by stroke survivor was restrictive lung defect (46 out of 72 participants). No statistically significant difference was observed between acute, sub-acute and chronic stroke survivors.

Conclusion: Thus, we can conclude that stroke survivors had significant reduction in lung function and it was correlated with dyspnea, activities of daily living and quality of life. These findings will help to add valuable perspective to the prevention of respiratory complications following a stroke, inclusion of respiratory management in stroke rehabilitation programs and will provide inputs to current research on respiratory function.

Keywords: Stroke, Lung function, Perceived Dyspnea, Functional Independence, Quality of Life, Spirometer, forced vital capacity, forced expiratory volume in 1 second, peak expiratory flow, Modified Borg Dyspnea Scale, 6-minute walk test, Barthel Index, Stroke Impact Scale 3.0.

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BACKGROUND

The World Health Organization (WHO) definition of stroke is "Rapidly developing clinical signs of focal (or global) disturbance of cerebral function, with symptoms lasting 24 hours or longer or leading to death, with no apparent cause other than that of vascular origin. The pathological background for stroke may either be ischemic or hemorrhagic disturbances of the cerebral blood circulation and the second-leading cause of death globally and the leading cause of disability worldwide.[1,2] The cumulative incidence of stroke ranged from 105 to 152/100,000 persons per year, and the crude prevalence of stroke ranged from 44.29 to 559/100,000 persons in different parts of the country during the past decade.[3]

Muscular weakness is a feature of stroke of which the respiratory muscles may be involved.[8] Previous studies have demonstrated that stroke affects not only the muscles of the upper and lower limbs, but also those of the respiratory system.[2] The central nervous system controls the activity of the muscles of the chest wall, which constitute the pump of the respiratory system, and because these components of the respiratory system act in concert to achieve gas exchange, malfunction of an individual component may lead to disturbances in function. Stroke-induced brain injury can alter the central regulation of respiration, leading to sleep apnea or producing weakness of the respiratory muscles.[4] The cardiopulmonary functions of patients with hemiplegia caused by stroke diminish due to the decreased expansion of the damaged hemi-thorax and deterioration of the respiratory muscles. Upon paralysis of the diaphragm and respiratory muscles following stroke, the thorax cannot sufficiently expand. Continuation of this condition can lead to shortening of the thoracic cells and muscle fibrosis. Therefore, deterioration of cardiopulmonary function is one of the most significant factors associated with stroke patients.[5] During quiet breathing, there is a small reduction of movements of the upper chest, not of the lower, on the hemiplegic side. This reduction of movement is more marked in the whole hemithorax during voluntary deep breathing. It is suggested that the difference is due to asymmetrical supramedullary innervation. During deep breathing, movements of diaphragm are asymmetrical. On clinical examination, abdominal muscles appear more flaccid on the side of the paralysis, with navel pulling towards the sound side.[6]

Spirometry is fundamental in the assessment of general respiratory health. Spirometry enables measuring the effect of a disease on lung function, assessing airway responsiveness, monitoring disease course or the result of therapeutic interventions, assessing preoperative risk, and determining a prognosis for many pulmonary conditions.[7] The most important aspects of spirometry are:

1) Forced vital capacity (FVC): FVC is the maximal volume of air exhaled with maximally forced effort from a maximal inspiration, i.e. vital capacity performed with a maximally forced expiratory effort, expressed in litres at body temperature and ambient pressure saturated with water vapour (BTPS). [8]
2) Forced expiratory volume in one second (FEV_1): FEV_1 is the maximal volume of air exhaled in the first second of a forced expiration from a position of full inspiration, expressed in liters at BTPS. [8]
3) Ratio of FEV_1 and FVC (FEV_1/FVC)
4) Peak expiratory flow (PEF): PEF is the highest flow achieved from a maximum forced expiratory maneuver started without hesitation from a position of maximal lung inflation. When it is obtained from flow–volume curve data, it is expressed at BTPS in L/s. When PEF is recorded using a patient-administered portable PEF meter, it is often expressed in L/min. [8]

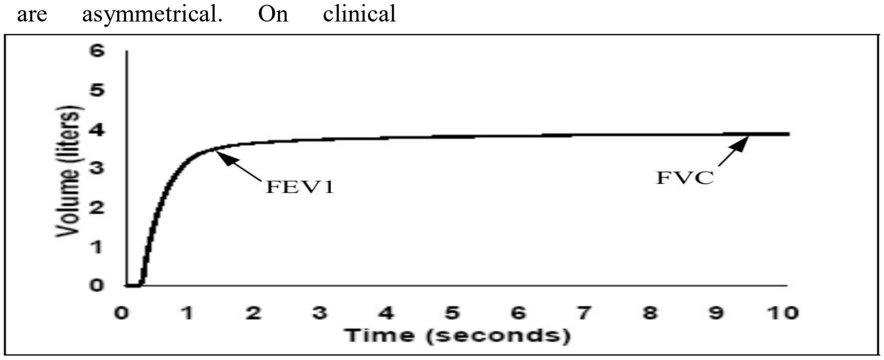


Fig 2: Normal volume-time curve

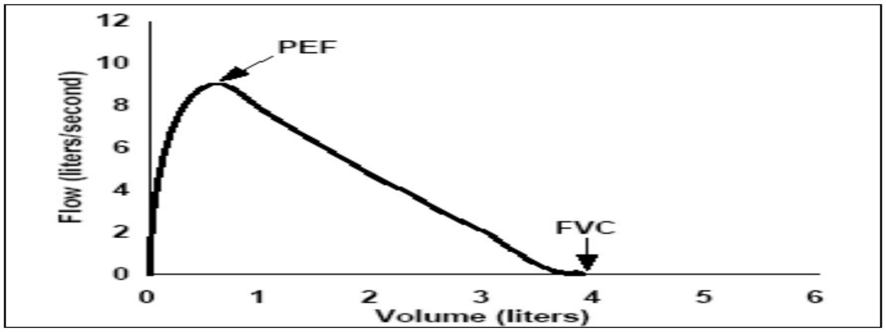


Fig 3: Normal flow-volume curve

A cross-sectional study found that lower pulmonary function was associated with subclinical cerebral infarctions and white matter lesions; structural abnormalities maybe precursors of clinical stroke. Impaired lung function could be an important prognostic factor after a stroke, since the survival is both determined by the severity of stroke and by co-morbidity.[9] A literature review carried out in 2011 showed that patients with chronic hemiplegia/hemiparesis after a stroke have limitations in their static and dynamic volumes and present respiratory muscle alterations and concluded that these responses should be considered during patient rehabilitation.[10] Dyspnea, or breathlessness, is defined as the subjective experience of breathing discomfort, which comprises qualitatively distinct sensations whose intensity can vary.[11] Weakness of the respiratory muscles, associated with sedentary lifestyles and deconditioning, may increase dyspnea after stroke, increase the risk of hospital admissions due to respiratory complications, which are the leading causes of non-vascular deaths after stroke.[12]

Functional independence can be defined as an individual's ability to perform activities of daily living.[13] Stroke causes both physical and mental problems which can be seen as physical disability and may have a tremendous impact on the patient's functionality or capacity to perform ADL.[14] It is estimated that 25% to 74% of the 50 million stroke survivors worldwide require some assistance or are fully dependent on caregivers for ADL after stroke.[15] Zheng et al. found that ADL negatively correlates with the degree of neurological impairment and stroke duration but positively correlates with the total time of weekly rehabilitation training for patients post-stroke. Maintaining independence in ADL is an important factor for the quality of life. Stroke survivors who need assistance for ADL always feel socially isolated, overwhelmed, and abandoned.[16] Weakened breathing functions consequently decrease the ability to perform physical functions and to walk independently.[17]

Quality of Life (QOL) has been defined by the World Health Organization as an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns. Stroke can result in survival with the permanent sequelae impairing in physical, psychological, and social functions. Dependence in activities of daily life living, alteration of emotional and psychological status, and deterioration in social communication can influence the QOL of patients with stroke. [18]

A number of clinical studies have identified that the respiratory muscle training has the potential to improve respiratory muscle function and cardiorespiratory fitness in stroke patients. Only few studies have focused on Lung Function performance and its effect on Perceived Dyspnea, Functional Independence and Quality of Life in stroke patients.This study will help in stroke rehabilitation, underscoring the need to include assessment of pulmonary system during examination of stroke patients and inclusion of interventions to improve lung function and carry-over effects on activities of daily living and quality of life.

METHODOLOGY

This cross-sectional study was conducted among 72 stroke survivors attended New Civil Hospital, Surat. Participants were selected using a purposive sampling technique to assess the variables of interest within the study population.

Selection Criteria:

- **Inclusion criteria:**
- Stroke survivors whose age ranged from 18 to 50 years including both male and female.
- Stroke with either side of involvement.
- Able to stand and walk with or without walking aids.
- Having no facial palsy that could prevent proper labial occlusion.

- Duration of stroke: Acute – less than 1 month after the stroke
  Sub-acute stroke – 1 to 6 months after the stroke
  Chronic stroke - > 6 months after the stroke
- Having no receptive aphasia.
- Subjects who understood commands.
- Subjects who were willing to participate.

➢ **Exclusion criteria:** Criteria mentioned in European and American Thiracic Society

Outcome Measures:

1) Lung Function by standard spirometer:
   - According to the American Thoracic Society/ European Respiratory Society guidelines, Lung function was measured by standard computer-based portable Spirometer (CPSF/DTM USB spirometer). A CPFS/DTM USB spirometer (Medical Graphics Corp., MN, USA) was used with the software BreezeSuite with Version 6.4.1.
   - Three lung function indices (FVC, FEV1 and PEF) were recorded.
   - The patient's age (in years), height (in centimeters), weight (in kilograms), birth sex and ethnicity were noted.
   - The experimenter demonstrated the procedure before its being performed by participants. [7]

✓ <u>Interpretation:</u>
   - Changes in the lung function indices can be known by difference in absolute values and predicted values.
   - The calculation of FEV1/FVC allows the identification of obstructive or restrictive ventilatory defects. A FEV1/FVC < 70 % where FEV1 is reduced more than FVC signifies an obstructive defect. A FEV1/FVC > 70% where FVC is reduced more so than FEV1 is seen in restrictive defects.[19]
   - The method of categorizing the severity of lung function impairment based on the FEV1 % predicted is given below:[20]

Degree of severity	FEV1 % predicted
Mild	>70
Moderate	60-69
Moderately severe	50-59
Severe	35-49
Very severe	<35

Table 1: Degree of severity based on % predicted FEV_1

2) Perceived Dyspnea by Modified Borg Dyspnea Scale after Six Minute Walk Test:
   - The test was carried out following the procedure and recommendations of American Thoracic Society. The walking course must be 30 meters in length and the length of the corridor should be marked every 3 meters. Assemble all necessary equipment (stopwatch, Sphygmomanometer, Borg scale, worksheets, pulse oximeter).
   - After the completion of six minutes, record blood pressure, pulse, oxygen saturation, post walk Borg dyspnea and fatigue levels. [21]

3) Functional Independence by Barthel Index:
   - The Barthel activities of daily living (ADL) index (BI) is one standardized scale widely used by clinicians and researchers to assess disability.[22]
   - The Barthel Index has excellent inter-rater reliability for standard administration after stroke (kw, 0.93: 95% confidence interval, 0.90-0.96 random effect modeling).[23]

4) Quality of life by Stroke Impact Scale 3.0.:
   - The Stroke Impact Scale 3.0 (SIS 3.0) is widely used to measure quality of life in stroke survivors. It is a stroke-specific, comprehensive, health status measure. [24]
   - Concurrent and Contrasting group validity was supportive and no floor and ceiling effect were found. Internal consistency and test-retest reliability ranged between 0.79 and 0.98.[25]

RESULTS

Table 2: Descriptive statistics

Variables	Male Mean ± SD	Female Mean ± SD	Z value	p-value (two-tailed test)
Age (years)	45.0769±10.9842	49.3846±10.7513	1.513	0.13028
Height (cm)	1.6667±0.0737	1.5267±0.0556	3.9441	0.00008
Weight (Kg)	68.8000±15.3743	69.0462±15.3534	0.37	0.71138
BMI (Kg/m2)	24.9066±6.2927	28.2600±6.0212	1.7752	0.0758

BMI, body mass index; SD, standard deviation

Table 1 represents descriptive statistics (Mean ± SD) of age, height, weight and BMI between male and female stroke survivors.

Table 3: Difference between Predicted values and Absolute values of Lung Function Indices of Stroke Survivors

Variables	Predicted values Mean ±SD	Absolute values Mean ±SD	Z value	p-value
FVC (L)	3.6242±0.7243	1.8969±0.7543	6.2724	0.00000000**
FEV_1 (L)	2.9417±0.6241	1.6398±0.5743	6.2724	0.00000000**
FEV_1/FVC (%)	81.1731±2.6474	88.0385±10.8609	3.8364	0.00012484**
PEF (L/sec)	7.6806±1.5720	3.3850±1.6717	6.2724	0.00000000**

FVC, forced vital capacity in litres; FEV_1, forced expiratory volume in 1 second in litres; PEF, peak expiratory flow in litres per second; SD, standard deviation

**Highly significant at p<0.01

*significant at p<0.05

Table 2 represents difference in predicted and absolute values of lung function indices (FVC, FEV_1, FEV_1/FVC and PEF) among stroke survivors by using Wilcoxon-signed rank test showing highly significant difference between them (p<0.01).

Table 4: Correlation of Lung Function Indices with Parameters of Six Minute Walk Test of Stroke Survivors

Variables	Total Distance covered		No. of rest periods		Post-test Modified Borg Dyspnea Scale	
	ρ	p-value	ρ	p-value	ρ	p-value
FVC (L)	0.795	0.00**	-0.641	0.0000002**	-0.820	0.00000**
FEV_1 (L)	0.772	0.00**	-0.631	0.0000005**	-0.788	0.00000**
FEV_1/FVC (%)	-0.253	0.0700	0.1653	0.2417	0.2634	0.0592
PEF (L/sec)	0.715	0.00**	-0.588	0.0000044**	-0.769	0.00000**

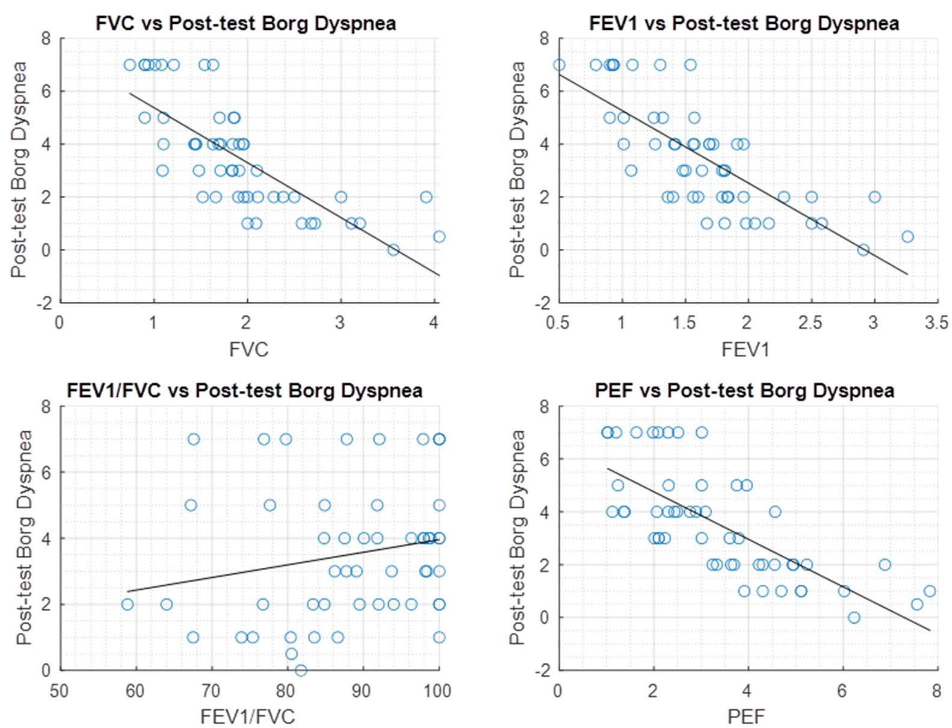
FVC, forced vital capacity in litres; FEV_1, forced expiratory volume in 1 second in litres; PEF, peak expiratory flow in litres per second

**Highly significant at $p<0.01$

*significant at $p<0.05$

Table 3 represents correlation of lung function indices (FVC, FEV_1, FEV_1/FVC and PEF) with total distance covered, no. of rest periods and post-test Modified Borg Dyspnea Scale by applying Spearman's rank correlation.

Graph 1. Scatter plot showing correlation of Lung Function indices with post-test Modified Borg Dyspnea scale



Graph 1 represents correlation of lung function indices (FVC, FEV_1, FEV_1/FVC and PEF) with post-test Modified Borg Dyspnea Scale through scatter plot.

Table 5. Correlation of Lung Function Indices with Functional Independence and Quality of Life

Variables	Barthel Index		Stroke Impact Scale 3.0	
	ρ	p-value	ρ	p-value
FVC (L)	0.815	0.000000**	0.8179	0.000000**
FEV_1 (L)	0.7801	0.000000**	0.7702	0.000000**
FEV_1/FVC (%)	-0.2428	0.0829	-0.2602	0.0625
PEF (L/sec)	0.6992	0.000000**	0.6996	0.000000**

FVC, forced vital capacity in litres; FEV_1, forced expiratory volume in 1 second in litres; PEF, peak expiratory flow in litres per second

**Highly significant at $p<0.01$

*significant at $p<0.05$

Table 4 represents that by using Spearman's rank correlation test, correlation of lung function indices (FVC, FEV_1, FEV_1/FVC and PEF) with functional independence and quality of life in stroke patients.

Table 6. Correlation of Functional Independence with Quality of Life of Stroke Survivors

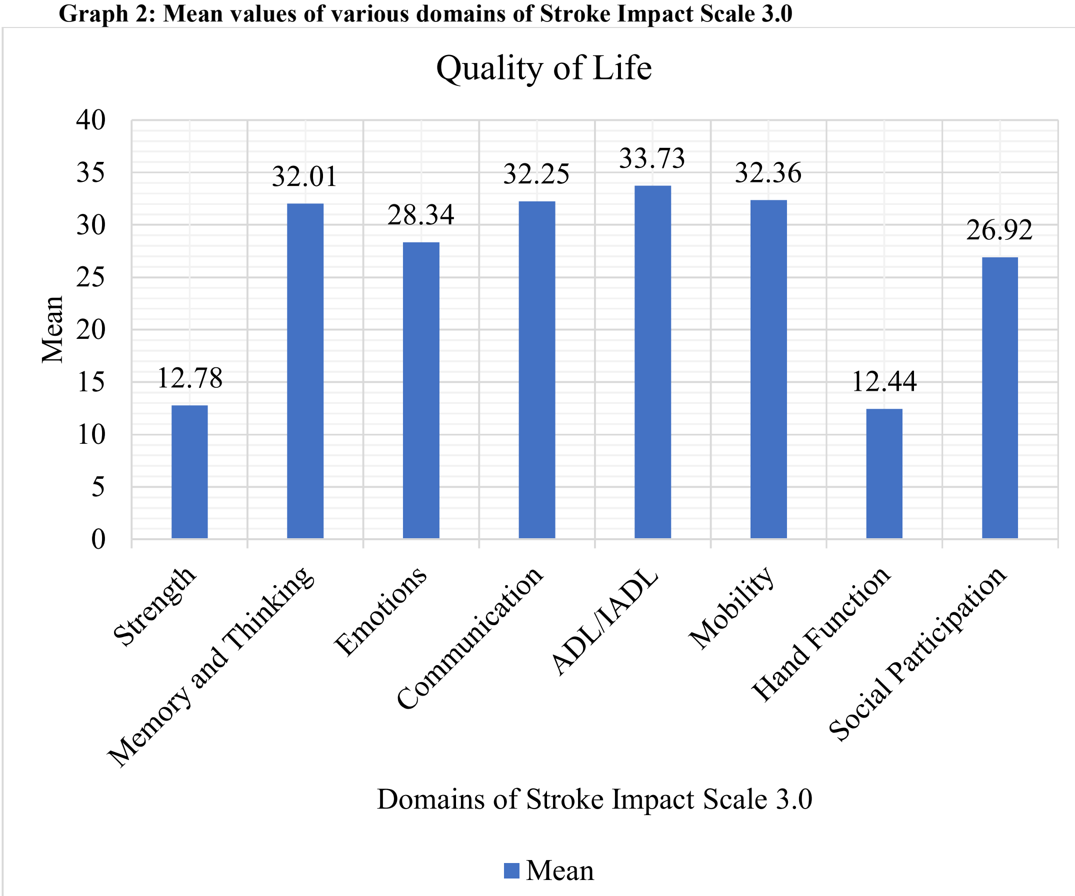
Domains of Stroke Impact Scale 3.0	Barthel Index	
	ρ	p-value
Strength	0.8938	0.000000**
Memory and Thinking	0.4843	0.0002745**
Emotions	0.5127	0.00010172**
Communication	0.5057	0.00013122**
ADL/IADL	0.8898	0.000000**
Mobility	0.9369	0.000000**
Hand function	0.8292	0.000000**
Social participation	0.7862	0.000000**
Stroke Recovery	0.977	0.000000**

**Highly significant at $p<0.01$

*significant at $p<0.05$

Table 5 shows the correlation of functional independence (Barthel index) and quality of life (Stroke Impact Scale 3.0) in stroke survivors.

Graph 2: Mean values of various domains of Stroke Impact Scale 3.0



Graph 2 Histogram shows mean values of various domains of Stroke Impact Scale 3.0

Table 7. Pattern of Abnormal Lung Function among Stroke Survivors

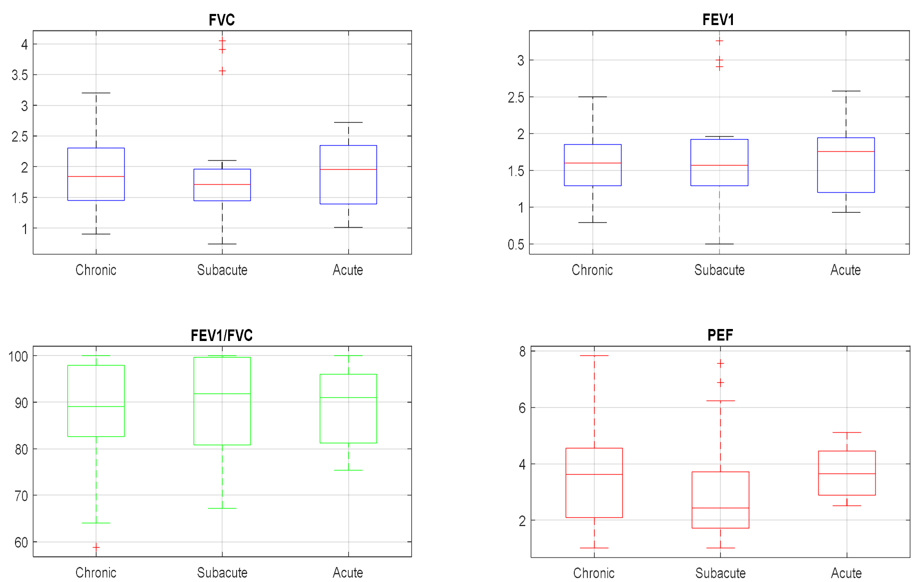
Abnormal Lung Function	Male	Female	Total
Restrictive lung defect	27	19	46
Obstructive lung defect	10	01	11
Mixed lung defect	4	0	4

Normal lung function	7	4	11
Total	48	24	72

Obstructive lung defect = $FEV_1/FVC\% < 70\%$, $FVC \geq 70\%$ of predicted value
Restrictive lung defect = $FVC < 70\%$ of predicted value, $FEV_1/FVC\% \geq 70\%$
Mixed lung defect = $FEV_1/FVC\% < 70\%$, $FVC\% < 70\%$ of predicted values

Table 6 represents different pattern of abnormal lung function among male and female stroke survivors by using formulas mentioned above.

Graph 3. Box plot representing difference in Lung Function indices among duration of stroke



Graph 3 representing box plot of difference in lung function variables (FVC, FEV_1, FEV_1/FVC and PEF) between acute, sub-acute and chronic stroke survivors.

DISCUSSION

Prior to start of analyzing tabulated data, normality was checked using Shapiro-Wilk test. To conduct normality and continue to scrutinize the data, MATLAB software was employed. The results for Shapiro-Wilk test showed an abnormal behavior implying data was not normally distributed.

Main lung function indices are considered into four variables: FVC, FEV_1, (FEV_1/FVC) & PEF, test subjects with the help of spirometer have given predicted and absolute values. Table 3 finds difference between predicted and absolute values for all indices individually using Wilcoxon, Non parametric test. The stroke survivors had significantly lower values for FVC (1.89±0.75 vs 3.62±0.724), FEV_1 (1.64±0.57 vs 2.94±0.62), FEV_1/FVC (88.04±10.86 vs 81.17±2.64) and PEF (3.38±1.67 vs 7.68±1.57) with p-values < level of significance (0.01). This implies there is statistically difference between predicted and absolute values, individuals after suffering from stroke had respiratory dysfunction.

A study by Victor Emeka Ezeugwu et al. (2012) found that the stroke survivors had significantly lower values for FVC, FEV_1 and PEF as compared to age-matched and sex-matched healthy controls because of weakness of respiratory muscle function contributed to decrease in lung function.[(4)] Another study by Khedr et al. report decreased diaphragmatic excursion in 41% of patients and reduced forced vital capacity (FVC), forced expiratory volume in the first second (FEV_1) and peak expiratory flow (PEF) by as much as 50% of values predicted for unaffected individuals, in addition to changes in breathing pattern and concentration of arterial blood gases because the diaphragm muscles are considered to contribute a major determinant of ventilatory function, any reduction in their strength or movement is likely to hinder respiratory function.[26]

Table 4 shows correlation of various lung function indices with parameters of six-minute walk test namely total distance covered, number of rest periods and Post-test Modified Borg Dyspnea Scale. Spearman correlation was utilized to find correlation between individual lung function indices only absolute values with different parameters of six-minute walk test. There was statistically significant positive correlation of FVC, FEV_1, and PEF with total distance covered in six-minute walk test ($\rho=0.795$, $\rho=0.77$ and $\rho= 0.715$ respectively, $p<0.01$). Statistically significant negative correlation of FVC ($\rho=-0.641$), FEV_1 ($\rho=-0.631$) and PEF ($\rho=-0.58$) with number of rest periods with $p<0.01$. Lung function variables (FVC, FEV_1 and PEF) were also statistically significantly negative correlates with post- test Modified Borg Dyspnea scale ($\rho=-0.8201$, $\rho=-0.7881$ and $\rho=-0.769$ respectively, $p<0.01$). Tabulated results for FEV_1/FVC shows an opposite trend for all remaining lung function indices. The above-mentioned discussion states that those stroke survivors who had better lung function performance can cover more distance with less number of rest periods and breathlessness.

Dyspnea is a significant common complaint in patients who have generalized muscle weakness. During inspiration, which is an active process, depends on adequate strength of the inspiratory muscles, to allow for the expansion of the rib cage and, consequently, the entrance of air into the airways. This musculature may not produce adequate expansion of the rib cage and, in turn, generate an unsatisfactory inspiration, which is the main descriptor of dyspnea. [27] The findings of the present study go with this theoretical rationale, by showing a significant association between lung function and dyspnea in individuals with stroke.

Kenia K. P. Menezes et al (2018) did a study to find a prevalence of dypsnea among stroke patients through telephone-based survey. Out of 285 participants with stroke, 124 (44%) reported having dyspnea after stroke. Severe symptoms were reported by 51% of the participants with dyspnea.[12] J.M. Annoni et al. (1990) showed weakness of the respiratory muscles after stroke may decrease the number and intensity of respiratory incursions, increase residual volume, and decrease pulmonary capacity. Therefore, these individuals may have fatigue and dyspnea in conditions of higher effort demands and develop a low tolerance to exercise.[6]

Table 5 represents Spearman's rank correlation of lung function parameters with functional independence and quality of life. Statistically Significant Positive correlation was found between lung function variables (FVC, FEV_1 and PEF) and Barthel index ($\rho=0.815$, $\rho=0.78$ and $\rho=0.699$ respectively with p value <0.01). Same trend was seen between lung function parameters and stroke impact scale 3.0 with correlation coefficient for indices being (0.8179, 0.7702 & 0.6996; p value less than 0.05). This shows that stroke survivors with better lung function are more independent in activities of daily living and improved quality of life.

The study which supported above mentioned discussion was by Britto et al. (2011) stated that respiratory muscle weakness may also be related to walking limitations and worse perceptions of quality of life. This condition may interfere with their performances in daily living activities and quality of life.[28] A randomized controlled trail by Serap Tomruk Sutbeyaz et al. (2009) conducted a respiratory muscle training on stroke patients and the results demonstrated improvements in their performance of ADL and their quality of life.[29]

Table 6 represents spearman correlation of Barthel index and Stroke Impact Scale 3.0. All the eight domains of stroke impact scale 3.0 (Strength, Memory and thinking, Emotions, communication, ADL/IADL, Mobility, Hand function, Social participation and stroke recovery) have statistically positive correlation (0.8938, 0.4843, 0.5127, 0.5057, 0.8898, 0.9369, 0.8292, 0.7862 & 0.977 respectively) with Barthel Index and p-value less than level of significance (0.01). From results mentioned above infers a directly proportional association with functional independence and quality of life.

Hojjat Allah Haghgoo et al. (2013) and Kyung Kim et al. (2014) stated that there is a significant positive correlation between activities of daily living and quality of life in stroke patients because mobility and social cognition were the most influential of the functional independence measure (FIM) items affecting QOL.[14,18]

Graph 2 represents the most affected parameters of various domains in Stroke Impact Scale 3.0 in stroke survivors. Mean and difference were calculated. Out of eight domains, Emotion and ADL/IADL domains were affected the most in stroke survivors with difference of 16.65 and 16.26 from total score of 45 & 50 respectively. This table also shows Social participation, Mobility and Hand function were also affected (difference of 13.09, 12.63 and 12.55 from total score of 40, 45 and 25 respectively). Memory & thinking and communication were affected least in stroke survivors. Graphical representation of table 7 is shown in graph 6 with least mean in hand function (12.44) and highest in ADL/IADL (33.73). Supporting these results is a study by Soniya Shetty et al. (2016) concluded that about 55 % of stroke survivors had fair physical domain and majority of participants said that psychological and social domains were poor because depression, anxiety and mood shifts was major problems post stroke.[30]

Table 7 illustrates different patterns of abnormal lung function. Abnormal lung function is basically classified into 3 categories based on criteria being obstructive defect is when percentage of $FEV_1/FVC\%$ is < 70% including FVC ≥ 70% of predicted value. Restrictive defect is when FEV_1/FVC % ≥ 70% and FVC < 70% of predicted value. Mixed defect is when $FEV_1/FVC\%$ < 70% and FVC < 70% predicted value. Tabulated results based on criteria showed out of 52 test subjects, 36 participants (27 males, 9 females) had restrictive lung defect, 1 male stroke survivor had obstructive while 4 individuals precisely male had mixed lung defect. Remaining 11 participants (7 males, 4 females) who does not fit into any category are termed as having normal lung function. Graph 7 and 8 illustrates abnormality according to gender, as in male percentage of restrictive (69%) with obstructive (3%) being least. In female percentage of restrictive (69%) occupying more area in pie chart and least being both obstructive and mixed at zero percentage.

Xiao Y et al. (2012) and J.M. Annoni et al. (1990) stated that in central nervous system diseases, respiratory functions usually show restrictive defects, which are caused mainly by the changes in the chest wall or the abdomen.[31,6]

Graph 3 represents comparison of lung function variables (FVC, FEV1, FEV1/FVC and PEF) with duration of stroke using Kruskal – Wallis one-way analysis of variance test. Duration of stroke is classified into acute, subacute and chronic stroke. There was no statistically significant difference in lung function indices between acute, subacute and chronic stroke survivors for p-values of FVC, FEV1, FEV_1/FVC and PEF (0.8041, 0.9001, 0.7913 & 0.2554) respectively are less than level of significance 0.05. Graph 17 visually implication of duration of stroke in accordance with lung function variables. In all subplot, median value for FVC, $FEV_{1,}$ and PEF duration of stroke, this implies 50% of the time, acute stroke participants have more FVC, FEV_1 and PEF. This may be due to unequal number of samples in each group (acute, subacute and chronic).

CONCLUSION

The present study evaluated the lung function performance of stroke survivors and its correlation with perceived dyspnea, functional activities of daily living and quality of life in 72 participants who were recruited for this study. It was concluded by accepting the alternate hypothesis that there was a statistically significant reduction in lung volumes and capacities as compared to predicted values in stroke survivors and lung function showed statistical negative correlation with perceived dyspnea where as positive correlation with ADL and QOL. So, improvement in impairments related to respiratory function may have a potential to reduce activity-related symptoms such as dyspnea and the benefits could be carried over to everyday activities and QOL due to more efficient use of respiratory muscles in stroke survivors. These findings suggest the inclusion of pulmonary assessment and interventions to improve lung function in rehabilitation programs might be beneficial for stroke patients.

LIMITATIONS

- We could not measure respiratory muscle strength.
- There are many variables that affect the lung function like chest excursion, physical activity, altitude, exposure to air pollution, etc. was not considered.
- Purposive sampling was used.
- Control group was not included due to short time period for data collection.
- The socio-economic and education status are major factors which may affect quality of life but have not taken into consideration in this study.

FURTHER SCOPE OF THE STUDY

- There may be need for further studies to consider severity of stroke at onset, site of stroke using neuroimaging and sequential stage of recovery in light of potential natural recovery or further deterioration following stroke.

- Comparison of lung function between ischemic and hemorrhagic stroke can be carried out.
- More valid scales and recent invention in instruments can be utilized.

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