



IMMEDIATE EFFECTS OF BACKPACK
ON VENTILATION AMONG SCHOOL GOING CHILDREN AGED
FROM 7 TO 15 YEARS IN NAVSARI, GUJARAT, INDIA

Hetvi Shukla¹,
Anand Vaghasiya²ⁱ,
Shirin Shaikh³,
Khevana Naik⁴

¹Dr., MPT,

¹S. S. Agrawal Institute of Physiotherapy
and Medical care Education, Navsari,
Gujarat, India

²Dr., BPT,

²S. S. Agrawal Institute of Physiotherapy
and Medical care Education, Navsari,
Gujarat, India

³Dr., BPT,

³S. S. Agrawal Institute of Physiotherapy
and Medical care Education, Navsari,
Gujarat, India

⁴Dr., BPT,

⁴S. S. Agrawal Institute of Physiotherapy
and Medical care Education, Navsari,
Gujarat, India

Abstract:

Background: Backpacks are used popularly by students to carry their school belongings in many countries. Therefore, serious concerns are being raised about the effect of the backpack on children. There is ongoing concern regarding the weight of children's schoolbags and the negative consequences of such heavy loads on the developing spine and cardio-respiratory systems. There are various other factors which are affecting cardiorespiratory fitness in adult as well as children. A significant reduction was reported for most of the ventilatory function parameters while carrying the backpack. **Purpose:** To check the immediate effect of the backpack on the ventilation of school-going children aged from 7-15 years in Navsari. **Method:** 210 subjects were taken in this study to check respiratory parameters. All included children were tested in standing position with the head straight after taking written consent from parents. They were further

ⁱ Correspondence: email anandsvaghasiya@gmail.com

divided into three age groups ranging from 7-9 years, 10-12 years, and 13-15 years. Spirometry was done using the spirometer of clarity medical Pvt. Ltd. Spirometer used in the study facilitates the total valuation of lung function including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and peak expiratory flow rate (PEFR). **Results:** With the help of SPSS software paired sample t-test was done. The parameters of FVC, FEV1, and PEFR showed a significant reduction in the data with a backpack, without a backpack and with one shoulder strap. The result of parameters was $p < 0.005$ except for the value of PEFR with one shoulder strap in the third age group which was $p = 0.108$. **Conclusion:** There is a significant reduction in respiratory function (FVC, FEV1, and PEFR) in correlation with age, weight, and height and bag weight of subjects.

Keywords: age, weight, height, backpack, school going children, forced vital capacity, force expiratory volume in one second, subjects, peak expiratory flow rate

1. Introduction

There is ongoing concern regarding the weight of children's schoolbags and the negative consequences of such heavy loads on the developing spine and cardio-respiratory systems. There are various other factors which is affecting cardiorespiratory fitness in adult as well as children. A significant reduction was reported for most of the ventilatory function parameters while carrying the backpack.^[3] Musculoskeletal symptoms are believed to be multifactorial and its effect on body systems varies with each and every systems of the body, carriage of heavy schoolbags is a suspected 'contributory factor', and therefore represents an 'overlooked daily physical stress' for school going children with respiratory system more affected which is mentioned by Whittfield et al. ^[5] Normal respiration is a very Complex mechanism. ^[6] It's function is comprised of mechanical as well as non-mechanical components. Respiration can be affected by various factors, including age, disease, lifestyle, and even change in posture.

The lungs can be extended and compressed in two ways:

- 1) Downward and upward movement of the diaphragm is responsible for lengthening or shortening of chest cavity.
- 2) Elevation and depression of the ribs is responsible for increase and decrease in the anteroposterior diameter of the chest cavity. These two methods are shown in figure below.

During inspiration, all respiratory muscle contracts whereas during expiration almost entirely passive process occur which is caused by elastic recoil of the lungs and chest cage. In some conditions, the respiratory muscles normally perform "work" to cause inspiration and not to cause expiration. ^[6]

The work of inspiration can be further divided into three fractions:

- 1) **Compliance work or elastic work** - required to expand the lungs against the lung and chest elastic forces. ^[6]

- 2) **Tissue resistance work** - required to overcome the viscosity of the lung and chest wall structures. ^[6]
- 3) **Airway resistance work** - required to overcome airway resistance to movement of air into the lungs. ^[6]

Among the available investigation, pulmonary function test (PFT) is a valuable tool for the assessment of lung function. PFT for lungs can be compared to the ECG for heart. gender and height are the most important predictors of lung function while height linearly correlates with lung size. ^[8] Adverse effect of this can be seen in ventilatory function which can be harmful in upcoming years. Recently the published studies shows that in Saudi, there was 13.8% of body weight, which is greater than recommended limit which is 10% body weight. ^[18]

2. Methodology

Study design: Observational Design

Sample size: 210

Sampling method: Convenient Sampling

Study population: School Going children Aged from 7-15, various school of Navsari.

Study duration: from September 2019 to March 2020.

A. Inclusion Criteria

- school going children aged from 7-15 years;
- primary school children;
- children who can stand;
- children who carry bag to school.

B. Exclusion Criteria

- subjects who are not able to understand simple commands.
- any other acute or chronic cardio-respiratory disease. ^[3]
- any neurological disease.
- any musculoskeletal disorders including chest and trunk muscles.
- visual or auditory loss as it affects in outcomes. ^[3]
- upper respiratory tract infections (URTI) like symptoms in past 2 weeks. ^[24]
- h/o any allergy, children with bone deformity of chest or spine. ^[24]
- family history of atopy, asthma or other chronic lung diseases. ^[24]

2.1 Tools and Materials

- spirometer (hardware and software),
- table,
- computer,
- electronic weighing scale,
- wall mounted height scale,
- cotton,

- mouthpiece,
- isopropyl (for hygiene- solvent for cleaning mouthpiece),
- pen, pencil, eraser, paper (for data notation).



Figure 1: Table setup for data collection



Figure 1: Tools required in procedure: a) cotton b) spirometer c) nose clips
d) pen, pencil, eraser d) disposable mouthpiece e) sterillium & isopropyl



Figure 2: Wall mounted height scale

2.2 Procedure

- After the approval of research guide and coordinator the examiner visited the chosen schools to take the permission of higher authorities, the study aims to check immediate effects of backpacks on respiratory system amongst school going children from age 7-15 years in Navsari.
- The procedure was explained to each principal.



Figure 4: Electronic digital weight scale

- In the same visit the Gujarati consent form were given to the students to take permission of parents.
- At a specified day, the examiner meets the subject and explained them the procedure in simple and understandable manner.
- After the subjects willingly participated, subjects from each class was called individually with their backpack in order to measure the weight of backpack.
- Subjects were taken according to the inclusion criteria of research which is School Going Children aged from 7-15 year, primary school children, children who can stand and children who carry bag to School.
- Screening was done according to the age and standard of subjects.
- First height and weight were measured by the digital weighing scale, it was taken after removing shoes.
- The whole procedure was explained, in standing position the subject first carried out the manure for 30 second without any backpack.
- Subject was explained PFT basic manure about how to put the spirometer mouthpiece in mouth, inhale through nose, take a deep and slow breath in, place your lips around the mouthpiece, exhale fully and with as much as force as possible.
- After 2 minutes again the data was taken with backpack (on shoulder with both straps on).
- Third data was taken after 2 minutes with backpack on one shoulder (single strap).



Figure 5: Examiner collecting data of weight



Figure 6: Examiner collecting data of height



Figure 7: Bag weight measured with weighing scale

- After completion of all successful data the highest value of the 3 trials was noted down.
- The same procedure was repeated in all 210 subjects.
- The mouth piece was cleaned by smearing isopropyl on cotton and cleaning the mouth piece with cotton after every manure to maintain the hygiene.
- After the data was collected it was further taken forward for statistical analysis.



Figure 8: Examiner explaining the procedure of PFT to subject



Figure 9: Examiner collecting data of PFT on computer

2.3 Data and Analysis

The statistical analysis was done. The subjects were approached by the researcher for data collection of PFT which was later used for effective analysis. Descriptive statistics

including mean, standard deviation was measured. After analysis of data, paired t-test was used to compare the difference between FVC, FEV1 and PEFR without backpack, FVC, FEV1 and PEFR value with backpack and FVC, FEV1 and PEFR value while carrying backpack on one shoulder for all the subjects and among three age groups. Results were considered to be significant at $p < 0.05$ and confidence interval was set at 95%. All statistical analysis was performed using SPSS version 20.

Table 1: Demographic data

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
Age (years)	210	7	15	11.24	2.159
Height (meter)	210	1.07	1.78	1.4258	.15634
Weight (kg)	210	14.00	76.20	33.9881	13.97914
Bag weight (kg)	210	2.10	10.80	5.4933	1.84140

Table 1 shows the demographic data of age, height, weight, bag weight, FVC, FVC with backpack, FVC with one shoulder strap, FEV1, FEV1 with backpack, FEV1 with one shoulder strap, PEFR, PEFR with backpack and PEFR with one shoulder strap among 210 subjects. The mean age of 210 subjects is 11.24 and SD is 2.159. The mean characteristic as per height for subjects is 1.425 and SD is 0.156. For weight the mean is 33.9881 and SD is 13.979, for bag weight the mean is 5.4933 and SD is 1.8414.

Table 2: Age group

Group No.	Age (range in year)	Number of students
Group 1	7-9 Year	53
Group 2	10-12 year	89
Group 3	13-15 year	68

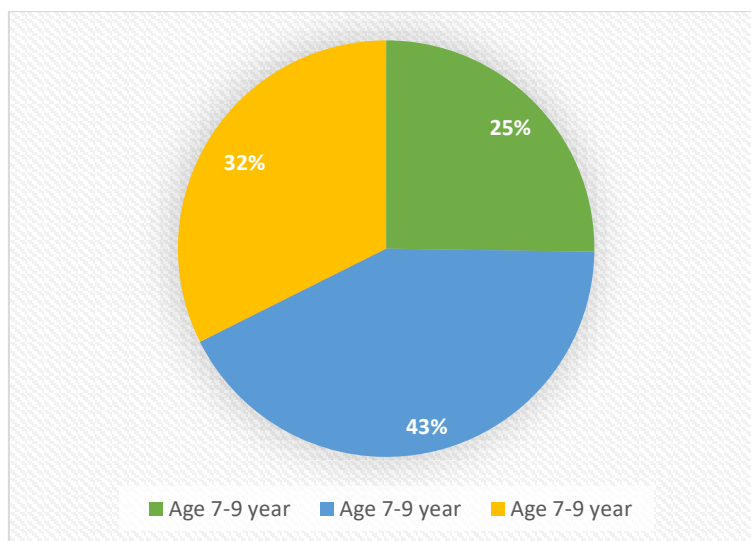


Chart 1: Frequency of Age

Table 2 and Chart 1 pie chart demonstrates the range of age and the number of students included in it. Group 1 demonstrate the Age range 7-9 years and it consist of 53 students, Group 2 demonstrate the Age range 10-12 years and it consist of 89 students and Group 3 shows Age range 13-15 years and it consist of 68 students.

Table 3: Comparison of values of FVC, Fev1 And PEFR with three different condition

Serial Number	Variables	Mean	SD	t-value	P value
1.	FVC- FVC with Bag	0.5129	0.41105	18.06	0.000
2.	FVC- FVC with one strap	0.27267	0.3291	12.007	0.000
3.	FEV1- FEV1 with bag	0.44876	0.37085	17.536	0.00
4.	FEV1- FEV1 with one strap	0.25243	0.31149	11.743	0.00
5.	PEFR- PEFR with bag	0.77086	0.96122	11.621	0.00
6.	PEFR- PEFR with one strap	0.42171	1.09856	5.563	0.00

Confidence interval is 95% and p value is <0.05.

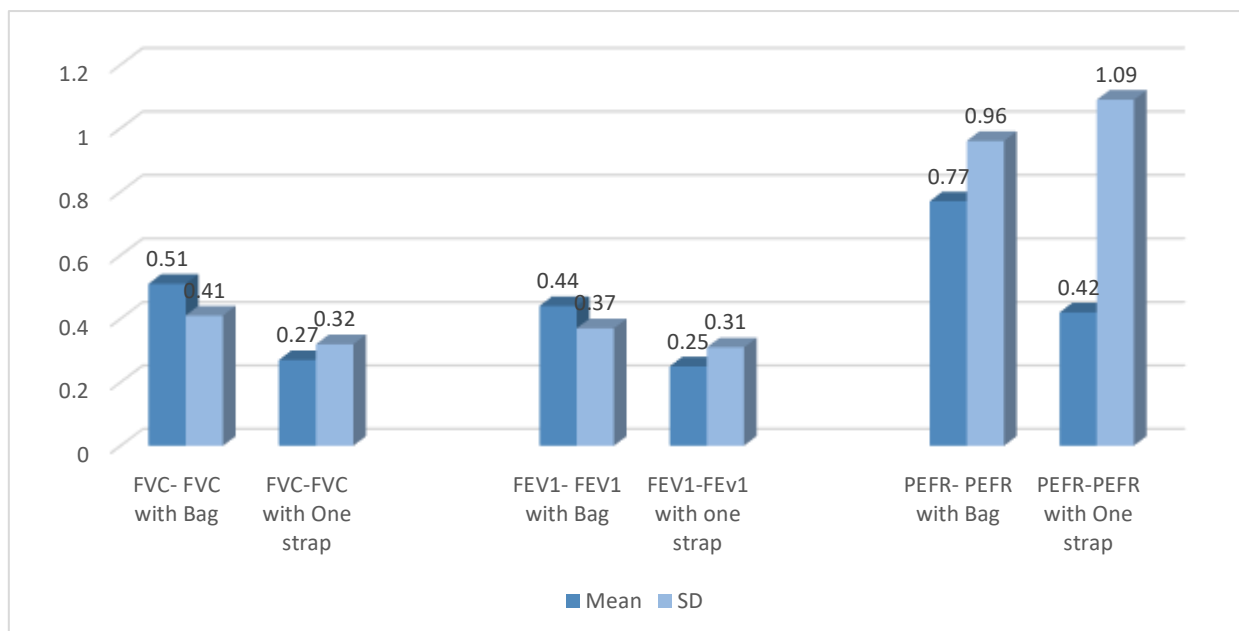


Chart 2: Comparison of values of FVC, FEV1 and PEFR with three different condition

Table 3 and Chart 2 shows result of analysis done by using paired t-test to determine the comparison of values FVC, FEV1 and PEFR with three different condition. The mean for FVC-FVC with backpack is 0.5129, SD is 0.41105 and t-value is 18.06. The mean for FVC-FVC with one strap is 0.27267, SD is 0.3291 and t-value is 12.007. The mean for FEV1-FEV1 with backpack is 0.44876, SD is 0.37085 and t-value is 17.536. The mean for FEV1-FEV1 with one strap is 0.25243, SD is 0.31149 and t-value is 11.743. The mean for PEFR-PEFR with backpack is 0.77086, SD is 0.96122 and t-value is 11.621. The mean for PEFR-PEFR with one strap is 0.42171, SD is 1.09856 and t-value is 5.563. The p value for all the above-mentioned data is $p < 0.05$.

Table 4: Comparison among the age group (FVC)
 Paired sample t test among three age group

Age group	Variables	Mean	SD	T	P
1	FVC-FVC with Bag	0.466	0.367	9.233	0.000
	FVC- FVC with one strap	0.238	0.292	5.94	0.000
2	FVC-FVC with Bag	0.504	0.440	10.81	0.000
	FVC- FVC with one strap	0.275	0.359	7.21	0.000
3	FVC-FVC with Bag	0.557	0.404	11.37	0.000
	FVC- FVC with one strap	0.295	0.315	7.71	0.000

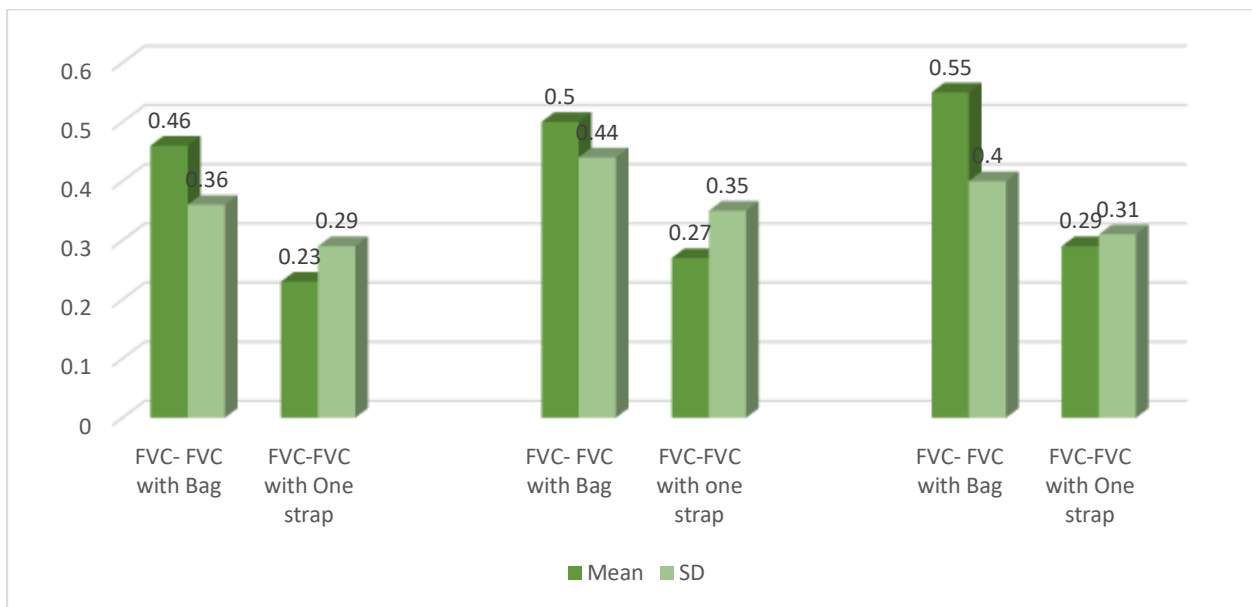


Chart 3: Comparison among the Age group (FVC)

Table 4 and Chart 3 illustrates the comparison of FVC among the three Age groups. For group 1 the mean for FVC-FVC with backpack is 0.466, SD is 0.367 and t-value is 9.233 and the mean for FVC-FVC with one shoulder strap is 0.238, SD is 0.292 and t-value is 5.94. For group 2 the mean for FVC-FVC with backpack is 0.504, SD is 0.440 and t-value is 10.81 and the mean for FVC-FVC with one shoulder strap is 0.275, SD is 0.359 and t-value is 7.21. For group 3 the mean for FVC-FVC with bag is 0.557, SD is 0.404 and t-value is 11.37 and the mean for FVC-FVC with one shoulder strap is 0.295, SD is 0.315 and t-value is 7.71. The p value for all the three group is $p < 0.05$.

Table 5: Comparison among the Age Group (Fev1)

Age group	Variables	Mean	SD	T	P
1	FEV1- FEV1 with Bag	0.44075	0.44146	7.268	0.000
	FEV1- FEV1 with one strap	0.25057	0.35542	5.132	0.000
2	FEV1- FEV1 with Bag	0.49281	0.37191	12.501	0.000
	FEV1- FEV1 with one strap	0.29416	0.33251	8.346	0.000
3	FEV1- FEV1 with Bag	0.39735	0.30130	10.875	0.000
	FEV1- FEV1 with one strap	0.19926	0.23286	7.056	0.000

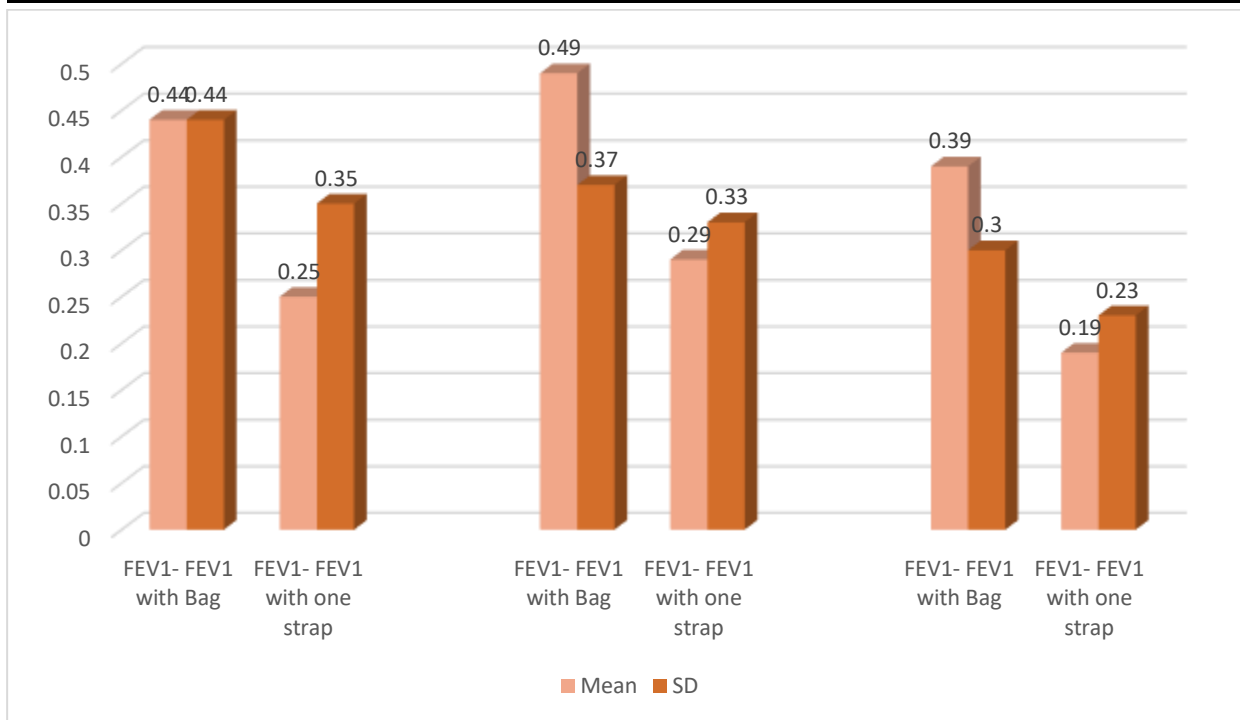


Chart 3: Comparison among the Age Group (FEV1)

Table 5 and Chart 4 shows the comparison of FEV1 among the three Age groups. For group 1 the mean for FEV1-FEV1 with backpack is 0.44075, SD is 0.44146 and t-value is 7.268 and FEV1-FEV1 with one shoulder strap the mean is 0.25057, SD is 0.35542 and t-value is 5.132. For group 2 the mean for FEV1-FEV1 with backpack is 0.49281, SD is 0.37191 and t-value is 12.501 and the mean for FEV1-FEV1 with one shoulder strap is 0.29416, SD is 0.33251 and t-value is 8.346. For group 3 the mean for FEV1-FEV1 with backpack is 0.39735, SD is 0.30130 and t-value is 10.875 and the mean for FEV1-FEV1 with one shoulder strap is 0.19926, SD is 0.23286 and t-value is 7.065. The p value for all the above data is $p < 0.05$.

Table 6: Comparison among the group (PEFR)

Age group	Variables	Mean	SD	T	P
1	PEFR- PEFR with Bag	0.91906	0.95643	6.996	0.00
	PEFR- PEFR with one strap	0.54755	0.8266	4.822	0.000
2	PEFR- PEFR with Bag	0.88831	1.13849	7.361	0.000
	PEFR- PEFR with one strap	0.53157	1.32822	3.776	0.000
3	PEFR- PEFR with Bag	0.50162	0.60042	6.889	0.000
	PEFR- PEFR with one strap	0.17985	0.91064	1.629	0.108

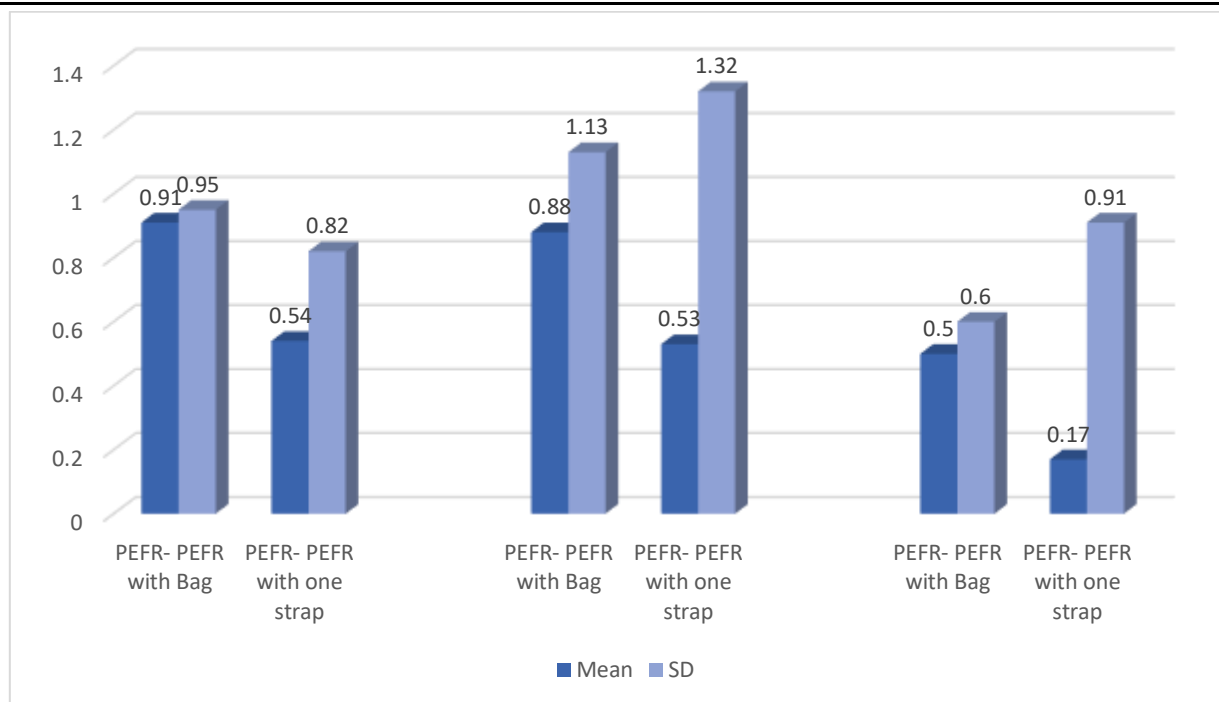


Chart 4: Comparison among the group (PEFR)

Table 6 and Chart 5 shows the comparison of PEFR among the three age groups. For group 1 the mean for PEFR-PEFR with backpack is 0.91906, SD is 0.95643, t-value is 6.996 and p value is 0.000 and the mean for PEFR-PEFR with one shoulder strap is 0.54755, SD is 0.8266, t-value is 4.822 and p value is 0.000. For group 2 the mean for PEFR-PEFR with backpack is 0.88831, SD is 1.13849, t-value is 7.361 and p value is 0.000 and the mean for PEFR-PEFR with one shoulder strap is 0.53157, SD is 1.32822, t-value is 3.776 and p value is 0.000. For group 3 the mean for PEFR-PEFR with backpack is 0.50162, SD is 0.60042, t-value is 6.889 and p value is 0.000 and the mean for PEFR-PEFR with one shoulder strap is 0.17985, SD is 0.91064, t-value is 1.629 and p value is 0.108.

3. Discussion

Respiratory functions are most vital in the entire human body. Understanding the relationship between respiratory mechanism and how it reacts to the stress coming from postural deviation is the key to the exclusive. The aim of the study is to check immediate effect of backpack on Ventilation amongst school going children aged from 7-15 years in Navsari. It was conducted in various schools of Navsari region. Total 210 subjects willingly participated in this research. It cannot be denied that there are no changes in Ventilation amongst subjects. During the research, demonstration of manoeuvre was given to the subject and after that the procedure was started. The study was done on 210 subjects with mean age 11.24 ± 2.159 ranging from 7-15 years, the outcome measure was determined by PFT which consist of FVC, FEV1 and PEFR components. In previous study, Abeer E. Al-Katheri has conducted study on the impact of backpack load on ventilatory function among 9-12year old Saudi girls having mean 10.5 ± 0.8 . He concluded

a significant reduction for most of the ventilatory function parameters while carrying the backpack. Similar changes were found in parameters of our research. The present study was carried out with the concept of strong correlation between effect of backpack weight and Ventilation amongst 210 subjects who were divided into three group according to their age. For group 1 the age range was 7-9 years, for group 2 age range was 10-12 years and for group 3 age range was 13-15 years, to investigate the Ventilation including FVC, FEV1 and PEFR. In present study the data found for FVC, FEV1 and PEFR was $p < 0.005$ which shows positive correlation with age, height, weight. It can be summarised from above discussion that there was a significant reduction in most of the parameters after using backpack. These findings are in agreement with the findings of Abeer E. Al Katheri who found that there is reduction in most of the ventilatory function without and with carrying a backpack.

The important aspect of this study is to focus on the effect of backpack on Ventilation of children and how it can affect their musculoskeletal system and breathing mechanism. Our study showed reduction in parameters which shows future complications for the children.

4. Conclusion

The result of the present study on 210 subjects have rejected the null hypothesis. Hence it is concluded that there is a significant reduction in the Ventilation parameter which is FVC, FEV1 and PEFR without backpack, with backpack and with one shoulder strap. Further the subjects were divided into three groups. Group 1 (7-9 years), Group 2 (10-12 years) and Group 3(13-15 years). All the same parameters were measured in this three group and it also rejected the null hypothesis which indicates that there is significant reduction in Ventilatory parameters.

4.1 Limitation of the Study

- 1) The duration of study was short.
- 2) Environmental and personal factors are not so stringent.
- 3) The understanding of the manoeuvre can be perceived differently by each individual.

4.2 Future Recommendation

- 1) The study was done on a small sample size, so to generalize the effect of the intervention large sample size is needed.
- 2) The study should have a follow up in order to evaluate the effectiveness that is maintained or not and for what period of time.
- 3) Future study can be done for correlation between BMI and Ventilation with backpack.

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Appendix 1



**S. S. AGRAWAL INSTITUTE OF PHYSIOTHERAPY AND
MEDICAL CARE EDUCATION**

સંમતિ પત્ર

Form Number: -

હું.....નાર,
વિદ્યાર્થી.....ના વાલી (માતા/ પિતા/ વાલી)
તરીકે સંમતિ આપું છું અને નીચે દર્શાવેલ વિગતો અને અભ્યાસમાં સહભાગી થવા સંમતિ પ્રદાન કરું
છું. મે નીચે જણાવેલા નિયમો પોતે વાંચેલા/ વંચાવેલા છે અને હું તેનાથી સહમત છું. નીચે જણાવેલ
પ્રક્રિયા એ એસ. એસ. અગ્રવાલ ફીઝિઓથેરાપી કોલેજના ઇન્ટર્ન દ્વારા કરવામાં આવેલ Research
નો ભાગ છે. દફતર નો ભાર ઉઠાવ્યા પેહલા અને ભાર ઉઠાવ્યા બાદ બાળકો ના શ્વાસોચ્છવાસ ની
પ્રક્રિયા માં તેમજ ફેફસા ની ક્ષમતા માં કોઈ પણ પ્રકારનો ફેરફાર થાય છે કે નહી તે જોવા માટે એક
સાધન માં (PFT - Pulmonary Function Test - by clarity Pvt.Ltd) બાળકે દફતર નું વજન
ઉઠાવ્યા વગર અને વજન ઉઠાવ્યા બાદ ફૂક મારવાની રહે છે. જેનું માપન કરવામાં આવશે. આ
પ્રક્રિયા માં વધુમાં વધુ ૧૦ મિનિટ નો સમય લાગશે કે જે બાળક ને કોઈ પણ પ્રકારે હાનિકર્તા નથી
અને માત્ર નિદાન નો ભાગ છે.

- (૧) મેં આ સંમતી ફોર્મ વાંચી છે અને સમજી છે અને માહિતી મને પ્રદાન કરવામાં આવેલ છે.
 - (૨) આ સંમતી પત્ર મને સમજવામાં આવી છે.
 - (૩) મારા અધિકારો અને જવાબદારીઓ મને તપાસ કરનાર દ્વારા સમજવામાં આવી છે.
 - (૪) મને આ અભ્યાસ માં ભાગ લેવા સાથે સંકળાયેલા જોખમો અંગે સલાહ આપેલ છે.
 - (૫) હું એ હકીકત થી પરિચિત છું કે હું કોઈ પણ સમયે કોઈ પણ કારણો આપ્યા વિના આ અભ્યાસ
માંથી બહાર જઈ શકું છું અને તે આ હોસ્પિટલ માં મારી ભવિષ્ય માં સારવાર પર અસર કરશે નહિ.
 - (૬) હું અહી તપાસકર્તા ઓ ને પરવાનગી આપું છું કે તેઓ આ અભ્યાસ માં ભાગ લેવા પરિણામે જે
જાણકારી મેળવી છે તે નિયમનકારી સત્તાવાળાઓ, સરકારી એજન્સીઓ અને નીતિશાસ્ત્ર સમિતિ
સામે પ્રકાશિત કરી શકે છે.
 - (૭) જો મારી માહિતી જાહેર માં રજુ કરવામાં આવે તો મારી ઓળખ ગુપ્ત રાખવામાં આવશે.
- આ સંમતી પત્ર સાઈન કરીને, હું પ્રમાણિત કરું છું કે આ પત્ર માં આપેલ માહિતી મને સ્પષ્ટ કરવામાં
આવેલ છે અને મને સમજ પડી છે.

વાલી નુ નામ અને સહી: -

વિદ્યાર્થી નુ નામ:-

જન્મ તારીખ:-

ઉંમર: - ધોરણ: -
શાળા નુ નામ: -

વાલીનો કોન્ટેક્ટ નંબર: -

Appendix 2: Assessment Format for Subjects

- Demographic data:
 - Name:
 - Age:
 - Gender:
 - Height(m):
 - Weight(kg):
 - Standard/division:
 - Name of school:
- Cough:
 - Present/ absent:
- Duration:
- Sputum:
- Personal History:
- Diet:
- Sleep:
- Appetite:
- Vitals:

Blood Pressure:

Respiratory rate:

Pulse Rate:

SpO₂:

- Any respiratory condition:
- Chest pain:
 - Type:
 - Duration
 - Area:
- History of asthma or any other lung disease:
- Any recent upper respiratory tract infection:
- Any neurological deficit:
- Any musculoskeletal disorder:
- Any deformity:
- Any allergy:

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Data collection sheet no. 1

Id No.	Name	Age (in year)	Height (in meter)	Weight (in Kg)	Bag weight (in kg)
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					

Data collection sheet no. 2

Id No.	Name	Class	FVC without backpack	FVC with backpack on both strap	FVC with backpack on single strap
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

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Data collection sheet no. 3

Id No.	Name	Class	FEV1 without backpack	FEV1 with backpack on both strap	FEV1 with backpack on single strap
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					

Data collection sheet no. 4

Id No.	Name	Class	PEFR without backpack	PEFR with backpack on both strap	PEFR with backpack on single strap
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					

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