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Effect of Frontpack and Backpack Weight on Respiratory Function in School Going Children in Age Group of 10-15 Years

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Abstract
Aim: To Study the effect of front-pack and backpack weight on respiratory function in school going children in age group of 10-15 years.
Relevance of Study: There is ongoing concern regarding the weight of children's Schoolbags and negative consequences of such heavy load On developing spine and cardio-respiratory Systems. Increasing the mass of the load, thus increasing overall workload, consistently results in increased energy expenditure. So this study will help in carring out impact of Whether frontpack and backpack is more in school going children.
Methodology: In this observational study, 48 school going children were taken who carried school bags. Subjects were choosen according to inclusion and exclusion criteria. subjects willingly participated from age of 10-12 yrs with avg wt. of 5.50 and age of 13-15 yrs with avg wt. 10.80 kg has been kept in the bag. The subject first performed the procedure of PFT maneavre by without bag and rest was given for 3 min, then frontpack and rest was given for 3 min and then backpack. Thereafter the PFT parameters like FVC, FEV1 and PEFR been checked, The same procedure was repeated in all subjects.
Result: The Statistical data Analysis was done. After analysis of data using the GraphPad Instat was done and paired t-test is used to compare the difference between FVC, FEV1 and PEFR with frontpack and FVC, FEV1 and PEFR with backpack for all subjects among the 2 age groups. FVC in age 10-12 group.i.e group 1 the mean for Frontpack is [68.833] and for Backpack is [70.250] and age group 13-15,i.e group 2 the mean for frontpack is [73.73] and for backpack is [78.735]. FEV1 in age group 10-12, i.e group 1 the mean for frontpack is [75.417] and for backpack is [78.5] and age group 13-15, i.e group 2 the mean for frontpack is [78.382]and for backpack is [81.382] PEFR in age group 10-12 i.e group 1 the mean value frontpack is [60.883] and Backpack is [78.75] and age group 13-15 i.e group 2,the mean for frontpack is [75.618] and for Backpack is [82.471]. The p- value <0.0001 considered extremely significant.
Conclusion' It is concluded that while carrying the backpack is better than carrying the frontpack, So Backpack has the advantage over the Frontpack in terms of ventilatory parameters.

Keywords: School going children; Forced vital capacity; Forced Expiratory Volume in one sec; Peak Expiratory Flow Rate

Introduction

There is ongoing concern regarding the weight of children's Schoolbags and negative consequences of such heavy load On developing spine and cardio-respiratory Systems. There are various other factors, which is affecting cardio-respiratory fitness in adult as well as Children [1]. Nowadays, use of backpack for carrying school supplies Is a routine duty of school children and associated With many symptoms of musculoskeletal disorders in children using a backpack, therefore it is a considerable problem that should be regarded by education authorities and health experts [2]. When walking with a backpack load, energy consumption is influenced by a proportional increase in metabolic costs to load [3].

However daily carriage of a school backpack imposes a substantial load on the spine and is a frequent cause of discomfort in children. Reported mean weights of school backpacks in children over the age of 10 years old range from approximately 10% of body weight (BW) to over 20% BW [4].

There is change in kinematics when the placement of load was altered. The front pack show a significant change in hip flexion/However daily carriage of a school backpack imposes a substantial load on the spine and is a frequent cause of discomfort extension values, along with significant reduction in Forward head position. The upright position seen with the use of front pack may reduce shearing forces acting on the spine, which has been identified as a risk factor for back injuries [5]. Bilateral front carriage as supported by previous literature produce a symmetrical swift away from load. Unilateral carriage however produces an asymmetrical deviation away from load which results in significant Postural deviation and adaptations [6].

The impact of backpack carriage on physical performance has been investigated to establish guidelines for safe load limits, and the effect of backpack carriage on pulmonary function has been one of the main areas of interest. Backpack load carriage loads the spine symmetrically while maintaining stability [7]. According to scientific researches, More than 60 percent of students who was carrying backpacks for school, Exposed to the structure-stature problems and early fatigue [8]. Wearing a weighted backpack could have the dual negative effect of mass loading and restricting the chest-wall. Both loading and restricting of the chest-wall could cause an increase in inspiratory muscle work and lead to respiratory muscular then lead to reduction of lung capacity and lung volume [9].

Among the available investigation, pulmonary function test (PFT) is a valuable tool for the assessment of lung function [10]. PFT is used to identify the underlying cause of respiratory symptoms in children and adolescents and to monitor the status of those with chronic lung disease [11]. Predicted normal values are essential for meaningful clinical interpretation of those test. Studies carried out in children had projected the equations for predicting different lung function using height, age and weight as independent variables in India [12].

Forced vital capacity (FVC)- The maximum volume of air which can be exhaled after a maximal inspiration.

Forced expired volume in one sec (FEV1)- The volume expired in first second of maximal e expiration after a maximal inspiration.

Peak expiratory flow rate (PEFR)-The maximal expiratory flow rate achieved during a forced expiratory maneuver.

PEFR is determined by

1. The size of lungs and lung elasticity.
2. The dimensions and compliance of the central intra Thoracic airways.
3. The strength and speed of the contraction of the respiratory muscle [13].

Recent studies have shown that wearing a backpack reduces forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1) in healthy children [14].

Methodology

Material

1. Pulmonary Function Test Software
2. Spirometry
3. Table
4. Laptop
5. Electronic weighing scale
6. Height measuring inch tape
7. Cotton, pen, pencil, eraser, paper
8. Isopropyl (for hygiene solvent for cleaning mouth piece)
9. Bag with 5.50-10.80 kg weight of books by weighing it.

Study design: observational study.

Study population: School going children aged from 10-15 years and children's of residential area.

Sampling technique: convenient sampling.

Sample size: $n = z^2s^2/d^2$

Where,

$n = (1.96)^2(7.05)^2/(\pm 2)^2$

n = 48. Therefore minimum sample size for the study will be 48

Study duration: 6 months

Place of study: Dr. Ulhas Patil College of Physiotherapy, Jalgaon.

Outcome Measure

Pulmonary function test

Among the available investigation, pulmonary function test (PFT) is a valuable tool for the assessment of lung function. Studies carried out in children with parameters as follows.

Forced vital capacity (FVC)- The maximumm volume of air which can be exhaled after a maximal inspiration.

Forced volume in one sec (FEV1)-The volume expired in first second of maximal expiration after a maximal inspiration.

Peak expiratory flow rate (PEFR)-The maximal expiratory flow rate achieved during a forced expiratory maneuver.

PEFR is determined by

1. The size of lungs and lung elasticity.
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3. The strength and speed of the contraction of the respiratory muscle.

Procedure

- After the Approval of institutional Ethical Committee, the examiner takes the permission of the school by writing the letter to the principal.
- The Procedure was explained to the principal in short format in letter, then examiner meets the subjects and explained them the procedure in simple and understandable manner.

  Subjects were taken according to the inclusion criteria of research, subjects willingly participated from age of 10-12 yrs with avg wt. of 5.50 and age of 13-15 yrs with avg wt. 10.80 kg has been kept in the bag.

  First height and weight were measured; it was taken after removing shoes. The whole procedure was explained, about How to inhale through the nose and take deep breath and put the mouthpiece in mouth and place your lips around the mouthpiece, exhale fully with much force as possible and again inhale.

The subject first performed the procedure of PFT maneavre by without bag and rest was given for 3 min, then frontpack and rest was given for 3 min and then backpack

Thereafter the PFT parameters like FVC, FEV1and PEFR

been checked The same procedure was repeated in all subjects.
The mouthpiece was cleaned by spirit and with cotton after every maneuver to maintain hygiene.

Statistical Analysis
The Statistical data Analysis was done. The Subjects were approached by the examiner for the data collection of PFT which is used for data Analysis. Descriptive statistics including the mean, standard deviation was measured. After analysis of data using the Graph Pad Instat was done and paired t-test is used to compare the difference between FVC, FEV1 and PEFR without backpack, FVC, FEV1 and PEFR with backpack and FVC, FEV1 and PEFR with front pack for all subjects among the 2 age groups.

Table 1: Demographic Data

Descriptive Statistics	Minimum	Maximum	Mean
Age [years]	10	15	12.5
Height [m]	1.34	1.52	1.43
Weight [kg]	32	54	43.00
BMI [kg/m2]	17.1	24	20.5
Bag Weight [kg]	5.50	10.80	8.15

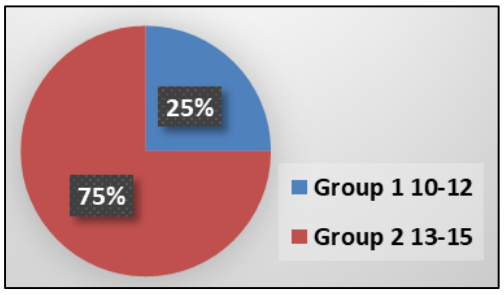
Result

Table 2: Age Group

Group no	Age [years]	No of Students
Group 1	10-12	12
Group 2	13-15	36

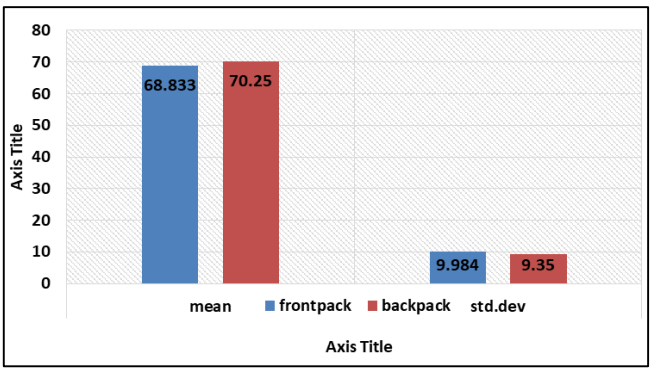
Table no 2 and pie chart demonstrates the range of AGE and no of students participated in it.

Group 1: Demonstrate the AGE range 10-12 years and it consists of 12 students with frequency of 25%.
Group 2: demonstrate the AGE range 13-15 years and it consists of 36 students with frequency of 75%.



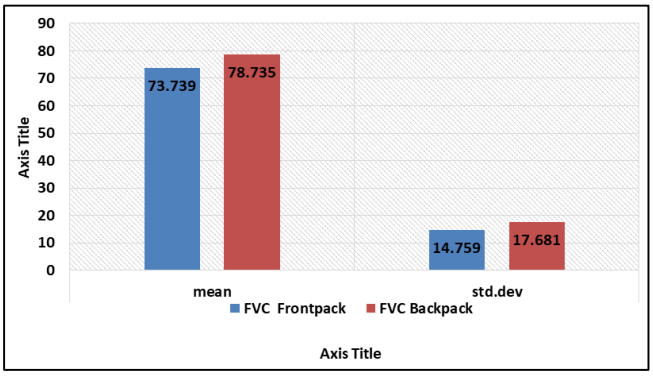
Graph 1: No. of students

FVC
Graph no 1 shows the comparison of FVC in age 10-12 group. For group 1 the mean and SD for Frontpack is [68.833± 9.984 and for Backpack is [70.250±9.35] with p- value< 0.0152, considered significant.



Graph 2: Comparison among AGE group 10-12 [FVC]

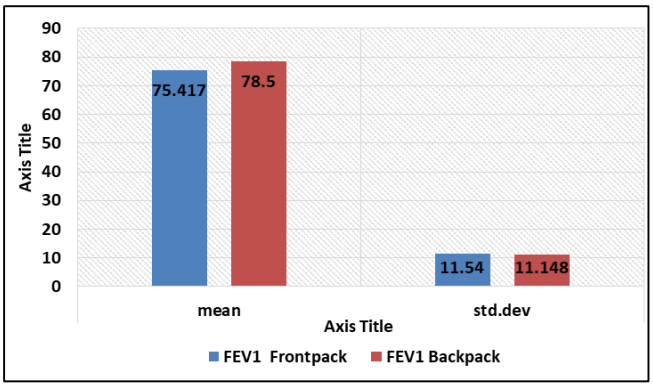
Graph no 2 shows comparison of FVC in age group 13-15, for group 2 the mean and SD for frontpack is [73.739±14.739] and for backpack is [78.735±17.681] with p- value <0.0054 considered significant.



Graph 3: Comparison among AGE group 13-15[FVC]

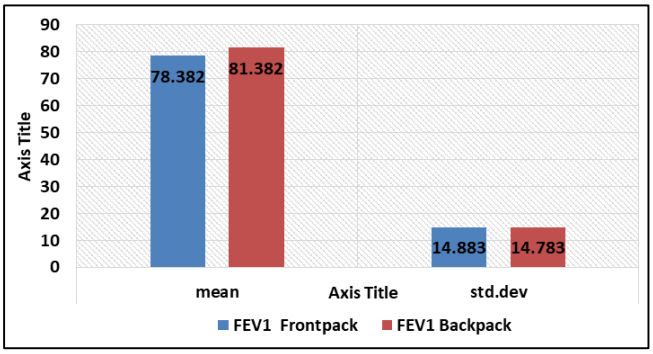
FEV1

Graph no. 3 shows comparison of FEV1 in age group 10-12, for group 1 the mean and SD for front pack is [75.417 ± 11.54] and for backpack is [78.5± 11.148] with p- value < considered significant.



Graph 4: Comparison among AGE group 10-12[FEV1]

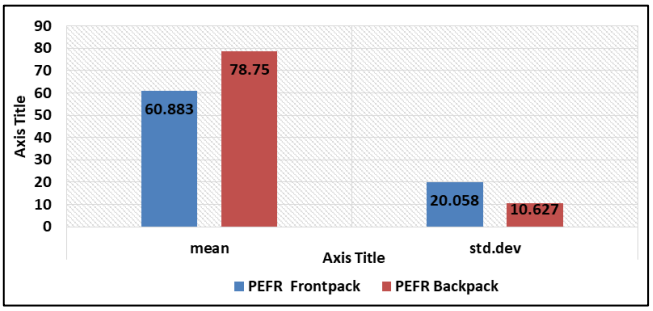
Graph no 4 shows comparison of FEV1 in age group 13-15, for group 2 the mean and SD for frontpack is [78.382±14.883] and for backpack is [81.382±14.783] with p- value <0.0001 considered extremely significant.



Graph 5: Comparison among AGE group 13-15[FEV1]

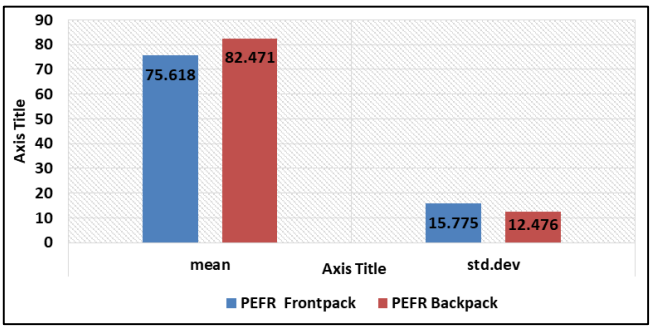
PEFR

Graph no 5 illutrates the comparision of PEFR in age group 10-12 for group 1 the mean and SD value frontpack is [60.883±20.058] and Backpack is [78.75±10.627] with p-value< 0.0010 considered significant.



Graph 6: Comparison among AGE group 10-12 [PEFR]

Graph no 6 shows the comparison of PEFR in age group 13-15 for group 2, the mean and SD values for front pack is [75.618±15.775] and for Backpack is [82.471±12.476] with p-value < 0.0007 considered significant.



Graph 7: Comparison among AGE group 13-15 [PEFR]

Discussion

Respiratory functions are most vital in the entire human body. The effect of both front pack and backpack on the respiratory function in school going children is the aim of the study.

Understanding the relationship between respiratory mechanism and how it reacts to the stress coming from postural deviation is the key to exclusive.

Total 48 subjects participated in the study, age range from 10-15 years and outcome measure is determined by PFT, which consists of FVC, FEV1, PEFR components.

In the present study we conclude that backpack has advantage over front pack in terms of ventilatory parameters. with p value <0.005 considered significant On the basis of literature review, little information was available regarding the effect of front pack on ventilatory function in children, But most of literature presented the role of posterior load carriage on the physiological and perceptual parameters [19].

This can be explained by understanding the mechanics of breathing, In normal breathing the chest expand in 3 diameters; vertical diameter by downward movement of diaphragm, transverse diameter by external intercostal muscle contraction and antero-posterior diameter by sternomastoid ‘s action [19].

The author Chow D, Ting J M and Pope A, explained about carrying backpack, chest wall kinematics and breathing pattern will be changed so, The first mechanism is the forward leaning of trunk results in kyphosis posture, which restricts downward movement of the diaphragm [20].

Second mechanism, which influences chest wall kinematics that is side to side movement of the ribcage may be restricted by compression of both sides of backpack [15].
Third mechanism, as tight fitting shoulder straps of the backpack were associated with decreased FVC and FEV1 parameters as they oppose the expansion of the ribcage [21].
The extra cost associated with carrying a front load may be attributed to increased work of breathing due to decreased ventilation and decreased the dorso ventral movement of sternum and ribcage during respiration as a result of anterior load [23].
A study conducted by Abeer Mahmoud Yousef, Shaimaa Elghareb Ali and Samah Alsaid Ahmed *et al* in (2019). He concluded that carrying a front pack load is higher than when carrying a Backpack, So Backpack has advantage over frontpack which coincides with present Study. Because lungs can be extended and compressed and leads to Elevation and Depression of the ribs responsible for increase and decrease in the antero-posterior of the chest cavity, so during Inspiration respiratory muscles contract and expiration is caused by elastic recoil of the lungs and chest cage [6].
A study conducted by Hetvi Shukla, Anand Vaghasiya, Shirin Shaikh and Khevna Naik studied the immediate effect of Backpack on ventilation among school going children Aged from 7-15 years *et al* (2020) concluded that data found for FVC, FEV1 and PEFR was <0.005 which shows positive correlation with Age, Height and Weight and there is significant reduction in FVC, FEV1 and PEFR with backpack and one Shoulder strap. This results in work of inspiration as compliance work required to expand the lungs against the lungs and chest wall forces. The tissue resistance work required to overcome the viscosity of the lungs and chest wall structure. The airway resistance work required to overcome airway resistance to movement of air into lungs [6].
A research study conducted by Jagdish Hundekari, Meena Agrawal, Vrushali Kahapre on topic Effect of single and double strap backpack load carriage on vital capacity in school going children *et al* (2017) conclude that carrying the backpack load by school going children reduces the breathing volume and provide similar levels of protection without pulmonary restriction.

Conclusion

Based on findings of this study, the following conclusion appeared

- This study conclude that both frontpack and backpack significantly decreased forced vital capacity [FVC], Forced expiratory volume in one second [FEV1] and peak expiratory flow rate[PEFR].
- The result of study have rejected the Null Hypothesis and all the same parameters were measured in 2 group.
- Comparing both groups, this decreased in the ventilatory parameters was significant.
- Thus, it is concluded that while carrying the backpack is better than carrying the frontpack, So Backpack has the advantage over the Frontpack in terms of ventilatory parameters.

Future Scope

Future study can be done for correlation between BMI and ventilatory parameters with backpack and frontpack.
Study can be done in college going students too. Studies also should be carried out with different types of backpacks, choosing from best type and must be considered ergonomically design.

Clinical Implication

Study Shows that there is a reduction in ventilatory parameters like FVC, FEV1 and PEFR and Backpack has advantage over Frontpack, So we need to increase ventilatory parameters in children by giving them.
Physiotherapy management like Breathing Exercises and Energy Conservative Techniques.

Limitation of Study

The understanding of the maneuver can be perceived differently by each individual. Standardized position of the backpack carriage is advocated for better level of evidence.

Acknowledgement

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