Medical Journal of Babylon
Vol. 12- No. 4:1101 -1108 , 2015
http://www.medicaljb.com
ISSN 2312-6760©2015 University of Babylon

Original Research Article

Impact of School Bag on Pulmonary Functions among Elementary School Children in Al-Hilla City-Iraq

Saraa Alaa Hasan Alwan Baiee*
College of Medicine, University of Babylon, Hilla, IRAQ

*E-mail:hassanbaey@yahoo.com

Accepted 29 September, 2015

Abstract

Backpacks are used by school children to carry their materials. Heavy backpacks associated with several adverse effects on the health of children and may interfere with their school achievement.
The objective to assess the effect of school bags on pulmonary functions of school children in Al- Hilla city.
This is a descriptive school based cross sectional study which was carried out on a convenient sample of 220 healthy pupils, from the fifth and sixth grades, from four randomly selected primary schools during the period from February through May, 2015.
Written and verbal consents were obtained from the pupils and their parents .
Data were collected through interviewing the participants by using a structured questionnaire contained sociodemographic and school bag related information. Pulmonary function test was performed using an electronic portable spirometer (discovery-2 USA), after measuring the weight and height of the participants.
Pulmonary function parameters were significantly reduced after carrying backpack (p value < 0.001) except the FEV1/FVC was increased after carrying the backpack .
The results indicate that there was a significant reduction of the ventilatory functions of primary school children after carrying the backpack. Preventive measures are needed to protect school children.

Key words: Backpack, pulmonary function, elementary school children, Hilla, Iraq.

أثر الحقيبة المدرسية على وظائف الرئة عند تلاميذ المدارس الابتدائية في مدينة الحله – العراق

الخلاصة

تستعمل الحقيبة المدرسية من قبل اطفال المدارس محمله اللوازم المدرسية, للحقيبة المدرسية الثقيلة آثار صحية سلبيه على الاطفال وقد تؤدي الى ضعف انجازهم المدرسي.هدف الدراسة لتقييم أثر حمل الحقيبة المدرسية على وظائف الرئة عند أطفال المدارس الابتدائية.
الدراسة مقطعيه وصفيه مدرسيه شملت عينه قصريه من ٢٢٠ تلميذ من تلاميذ الصف الخامس والسادس في أربع مدارس ابتدائية اختيرت عشوائيا من مركز مدينة الحلة للمده من بداية شباط الى أيار عام ٢٠١٥. بعد اخذ الموافقة الشفهية للأطفال والمكتوبة الواعية لأولياء امورهم تم مقابلة الاطفال وفحصهم من خلال ورقة استبيان تضمنت معلومات ديموغرافية واخرى متعلقة بحمل الحقيبة المدرسية وتم قياس وظائف الرئة بعد قياس اوزان الاطفال و أطوالهم باستعمال جهاز قياس وظائف الرئة الالكتروني (دسكوفري-٢ الولايات المتحدة الامريكية).
اظهرت النتائج قلت حجم الزفير القسري في الثانية الاولى وقلت حجم الرئة الحيوي القسري وبمعدلات احصائية مهمة معنويا (اقل من ٠.٠٠١) بعد حمل الحقيبة المدرسية. ولم يظهر تأثير على تناسب الزفير القسري في الثانية الاولى الى حجم الرئة الحيوي القسري بل قلت نسبته.اظهرت الدراسةنقص وظيفة الرئة وقلت سعتها بعد حمل الحقيبة المدرسية من قبل الاطفال عن وظيفتها قبل حمل الحقيبة.

الكلمات المفتاحية: الحقيبة المدرسية, اطفال مدارس ابتدائية, وظائف الرئة, مدينة الحلة, العراق.

Introduction

All over the world there is an outcry by children, parents, school officials, and health professionals about the carrying of backpack loads more than the recommended safe limits[1]. Backpacks are commonly used nowadays by students of various educational levels to carry their books and other equipment from home to school during the school years[2,3]. Therefore serious concerns are growing in developed as well as in developing countries about the impacts of heavy school bags on children wellbeing and general health[4].

Regular use of heavy school bags in inappropriate carrying way can affect the quality of life of children, decrease motivation and absence from the school[5,6,7]. The American Physical Therapy Association recommends that the weight of the school bag should be less than 15% of the total body weight of the child, while the American Academic Orthopedic Surgeons and the International Chiropractic Pediatric Association recommended that the school bag weight limits should not be more than 10% of the child's body weight[8,9].

Many studies suggested that carrying heavy school bags on shoulders affects the chest expansion and causes changes in lung functions that are typical restrictive ventilatory impairment[10,11]. Other studies showed that improper use of heavy school bags by children can cause forward leaning of the head and the trunk in order to compensate the heavy weight of the bag[12], this abnormal posture can stress the muscles of the neck and back which may lead to chronic musculoskeletal pain that interfere with daily activities and can affect their ventilatory functions[3,8,13,14]. Going through literature there are limited studies about the effects of backpack load placement on pulmonary functions of schoolchildren[15,16]. In Iraq no previous study addressed the effect of backpacks on the lung parameters of school children. This study was conducted to assess the impact of backpack on the lung capacity of elementary school children.

Materials and Methods

This is a cross sectional study which was conducted on 220 voluntary healthy primary school children aged 11 and 12 years old , which were selected in convenient way after obtaining the official approvals of ethical committee of Babylon health directorate and the permission from the school authorities involved.

Each pupil recruited in this study was given a written consent form to be approved and signed by his/her parents before participation in the study. The period of the study extended from the beginning of February through May, 2015. A structured questionnaire was prepared by researchers to gather the required data by interviewing the student. A questionnaire included information about the sociodemographic characteristics that include (age, sex, grade).

Electronic weight scale (QE-2003B,) was used to measure electronically the weight of the participants, weight of the student was measured without shoes and with light clothes as much as possible, first without school bag and then measuring the weight of the student after carrying the school bag and the difference between weights is the weight of the school bag[13]. The height was measured without shoes using height board with a horizontal head board that contact to the upper most point in the head, the child was standing upright on both feet on flat ground , heals together and the head is positioned vertical , so the line of vision perpendicular to the body of the child[17].

Body Mass Index (BMI) was calculated using the following equation[18]:

Weight (kilogram)/height^2 (meter^2)

The percent of the school bag weight to the body weight was calculated using the following equation[19]:

$$\frac{\text{School bag weight}}{BW} \times 100\ \%$$

Spirometer:

Lung function was measured by using an electronic portable spirometer (Discovery-2 USA). Spirometer measure the volume of air against time[20]. To optimize precise technique, the test for this study were based on the manual operation of the device according to ATS (American Thoracic Society)[21].The test was done at the same time from 8 a.m. to 2 p.m. to decrease any physiological variations[22].

The procedure was explained to the pupil before starting, then the test was performed in standing position with using of disposable bacterial/viral filter, mouth piece and nasal clips[15], the test was repeated three times without backpack and the procedure was repeated after five minutes after carrying a double strap shoulder backpack over the shoulders[15,23].All the spirometric measurements were done according to the American Thoracic Society (ATS) recommendations [21], the entire maneuver took approximately 30 minutes with every child.At the beginning, the following information should be entered to the spirometer:

Identification number for each participant, date of birth in month, day, year, gender, race, smoking habit,weight in kilogram and height in centimeters.The spirometer gives the results as printable graph which includes the following values:

1. The expected (predictive) values which depend on the entered information of the student .
2. The best (actual) one of three tests values which is based on performance of maximal inspiration and expiration of the child[22,24].

Statistical analysis was carried out usingStatistical Package of Social Sciences(SPSS) version 17, variables were presented as frequencies and percentages. Continuous variables were presented as (Means ± SD). Paired t-test was applied, p value was considered significant at $p < 0.05$.

Results

Table (1) shows the baseline characteristics (Means ±SD) of the study group. The means and the standard deviations of the age, weight, height of the study group were: (11.6±0.4) years, (39.87±6.66) kg, (143±7) cm respectively. While the means and standard deviations of BMI, weight of bag and weight of bag to body percent were: (19.29±1.95) kg/m2, (5.50±1.17) kg and (13±3) %, respectively.

Table 1: Baseline characteristics (means and standard deviations) of the study group

Variables	Mean ± SD
Age(years)	11.6±0.4
Height (cm)	143±7
weight (kg)	39.87±6.66
BMI (kg/m^2)	19.29±1.95
Weight of bag (kg)	5.50±1.17
Weight of bag to body percent(%)	13±3

Table (2) shows the mean differences of spirometric parameters without and with carrying backpack. There was a statistical significance between the means and standard deviations of actual FEV1, FVC, FEV1/FVC and percent predicted of FEV1, FVC and FEV1/FVC without and with carrying the backpack, (p value ≤ 0.001).

Table 2: Mean differences of spirometric parameters with and without carrying backpack

RFT	Mean± SD Without bag	Mean± SD With bag	Mean± SD Difference	t-test	P value
FEV1 (liter)	2.11±0.39	2.02±0.38	0.09± 0.19	7.106	<0.001
FEV1 (%pred.)	98.99±8.66	96.43±8.11	2.55±4.65	8.155	<0.001
FVC (liter)	2.55±0.52	2.37±0.50	0.18±0.25	10.555	<0.001
FVC (%pred.)	100.34±7.55	94.01±7.68	6.33±5.82	16.123	<0.001
FEV/FVC (%)	85.38±6.73	86.63±7.08	1.25±4.41	4.200	<0.001
FEV/FVC(%pred.)	100.96±8.49	102.19±8.49	1.22±5.48	3.321	<0.001

Figure (1) shows the distribution of pupils by the actual FEV1 and FVC with and without carrying backpack, the means and standard deviations of FEV1 without and with carrying the backpack were: (2.11±0.39) L and (2.02±0.38) L respectively, while the means and standard deviations of FVC without and with carrying the backpack were: (2.54±0.52) L and (2.36±0.50) L respectively. The differences in both tests were statistically significant (p value < 0.001).

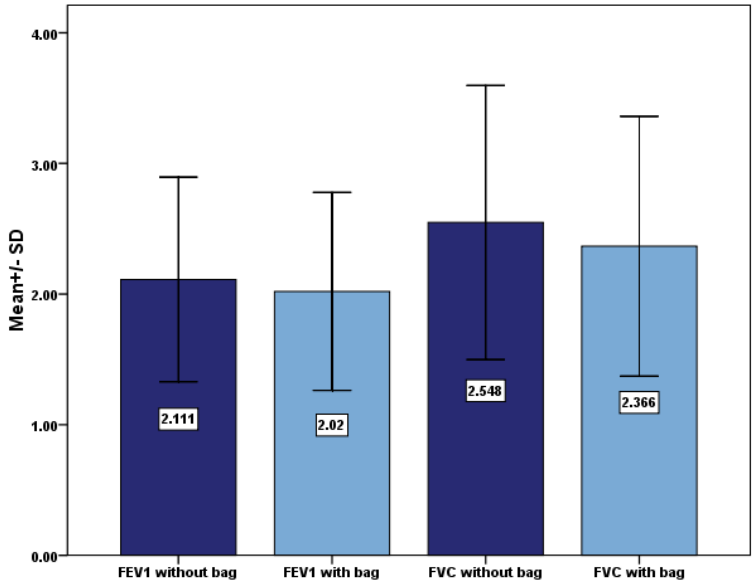

Figure 1: Distribution of pupils by the actual FEV1 and FVC with and without carrying the bag

Figure (2) shows the distribution of schoolchildren by the percent predicted of FEV1 and FVC with and without carrying the backpack, the means and standard deviations of FEV1 percent predicted without and with carrying the backpack were: (98.99±8.86) and (96.43±8.11) respectively, while the means and standard deviations of FVC percent predicted without and with carrying the backpack were: (100.34±7.55), (94.01±7.68), respectively. The differences were statistically significant (p value < 0.001).

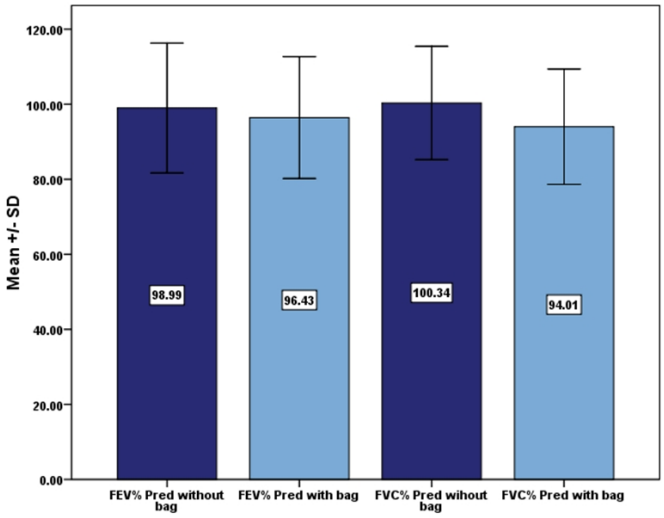

Figure 2: Distribution of pupils by the percent predicted of FEV1 and FVC with and without carrying the bag

Figure (3)shows the distribution of the participants by the actual and the percent predicted FEV1/FVC with and without carrying the backpack, the overall means were: (85.37±6.73), (86.63±7.08) and (100.96±8.49), (102.19±8.49), respectively. These differences reached the statistical difference (p value < 0.001).

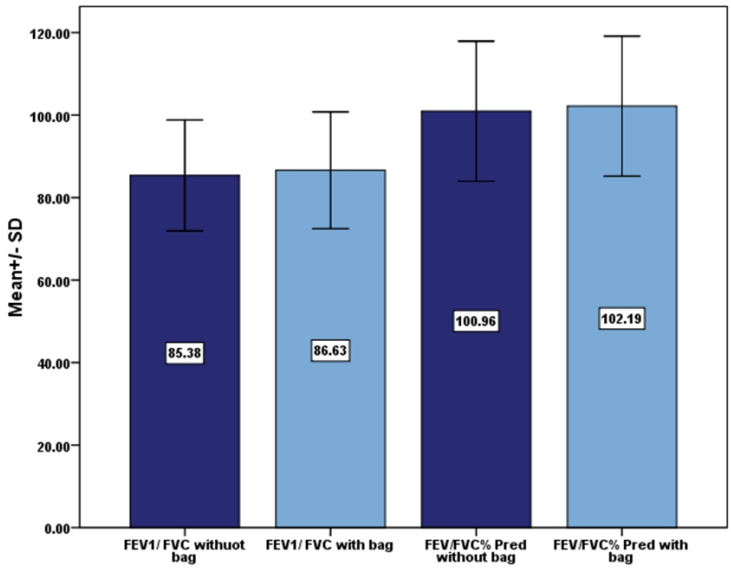

Figure 3: Distribution of pupils by the actual and the percent predicted FEV1/FVC with and without carrying backpack

Discussion

School is an important organized institution that gives the child's body and spirit ability to flourish by providing a healthy environment[25].This study showed that the average weight of the school bag was 5.5 kg, this weight is higher than the mean weight of school bag reported in other local study[26], in the neighboring countries the mean weight of the school bag range from 2.8 kg in Iran to 4.7 kg in Saudi Arabia[23,27,28].This heavy weight lead to increase in energy consumption, increase leaning forward of the trunk and decreased lung volume. These three factors cause reduction of the oxygen partial pressure leading to an aerobic respiration and cause fatigue[29,30].

The differences in both backpack weight among the studies may be due to the differences in age, gender, grades and schools[31], or differences in culture, school requirements, school curriculum, educational system, the type and the number of the books required, and quality of the backpacks in each country[32].Other reasons may also be due to the availability of facilities such as lockers which are little and not enough for all school children because of schools overcrowding especially in developing countries including Iraq[1].

The spirometric parameters in this study including; FVC, FEV1were significantly reduced during carrying the backpack with exception of FEV1/FVC. This result is in agreement with the findings of other studies. Al-Katheri found that there was a significant reduction in most of pulmonary function parameters when carrying a backpack with exception of FEV1/FVC[23]. Chow et al also found that carrying of 15% body weight backpacks resulted in a significant reduction in FEV1 and FVC without significant effect on FEV1/FVC[15].

These findings can be explained by understanding the mechanics of breathing in which the main power of ventilatory function is pressure differences and thoracic cage movement so any change of this mechanism by carrying backpack load will affect breathing and decrease the pulmonary function. In normal breathing the chest is expanded in three diameters; vertical diameter by downward movement of the diaphragm, transverse diameter by external intercostal muscles' contractions and antero-posterior diameter by the sternomastoid muscle's action[23].

During carrying backpack, the chest wall kinematics and breathing pattern will be changed in different mechanisms. The first mechanism is the forward leaning of trunk results in kyphotic posture while carrying a backpack, this will affect the respiratory muscles lead to restriction of the downward movement of the diaphragm, as the weight of the backpack increases, the inspiratory and expiratory volumes will be decreased[15].

Brackley et al stated that increase leaning forward of the trunk may affect the movement of the respiratory muscles of the chest and abdomen[33]. The second mechanism that influences chest wall kinematics during the carrying of backpack is that the side to side movement of the rib cage may be restricted by compression of both sides of the backpack on sides of the rib cage and opposition of its movement which decreases the transverse diameter and limits the antero-posterior diameter of the chest[23]. The third mechanism was discussed by Bygrave et al. they showed that tight-fitting shoulder/chest straps of the backpack were associated with decreased FVC and FEV1 values as they oppose the expansion of the rib cage[34].

In this study, the only parameter that didn't reduce was FEV1/FVC where it increased with carrying a backpack. This can be explained by the fact that FEV1/FVC is reduced as a result of the narrowing of the bronchial lumen size due to several causes which therefore would increase the resistance to the airflow as what would happen in obstructive dysfunctions, and this might not be produced by carrying a backpack[15]. Also, FEV1/FVC which was increased

because the decline in FVC was more than that of FEV1 in this study.

It was concluded that tightening the fit of a backpack significantly affects lung function in a manner that is typical of a restrictive change in lung function and is very similar in pattern to that of wearing a loosely fitted loaded backpack[35]. Vieira et al found that carrying double straps backpack produce a restrictive effect on pulmonary function but in less degree than when carrying single strap backpack, and he suggested that the double straps backpack is preferable to the single strap backpack[16].

Conclusions

The school children in Al-Hilla\Iraq carry backpack load more than the recommended limits andthere was a significant reduction in the pulmonary function parameters including: FEV1, FVC with exception of FEV1/FVC which was increased after carrying a backpack**.**

Acknowledgement

We would like to thank Ass. Prof Hatem Abd Latif, Babylon University, for his assistance in statistical analysis. Thanks are due to all parents and children who agreed to participate in this study, special thanks are due to school staff for their help during conducting this study.

References

1. Mwaka ES, Munabi IG, Buwembo W, Kukkiriza J, Ochieng J. Musculoskeletal pain and school bag use: a cross-sectional study among Ugandan pupils. BMC Research Notes, 2014; 7: 222-229.
2. Lasota A. Schoolbag weight carriage by primary school pupils. Work, 2014; 48(1): 21-26.
3. Lavigne VDC. Weight limit recommendation in backpack use for school-aged children. Journal of Clinical Chiropractic Pediatrics, 2014; 14(2): 1156-1159.
4. Talbotta NR, Bhattacharyab A, Davisb KG, Shuklab R, Levin L. School backpacks: It's more than just a weight problem. Work, 2009; 34: 481–494.
5. Moore MJ, White GL, Moore DL. Association of relative backpack weight with reported pain, pain sites, medical utilization, and lost school time in children and adolescents. Journal of School Health, 2007; 77(5): 232-239.
6. Ko J, Kim M. Reliability and responsiveness of the gross motor function measure-88 in children with cerebral palsy. Phys Ther, 2013; 93(3): 393-400.
7. Turk Z, Vauhnik R, Micetić-Turk D. Prevalence of nonspecific low back pain in schoolchildren in north-eastern Slovenia. CollAntropol, 2011; 35: 1031-1035.
8. Rai A, Agarwal SH. Back problems due to heavy backpacks in school children. Journal of Humanities and Social Science, 2013; 10(6): 22-26.
9. Vidal J, Borràs PA, Ponseti FJ, Cantallops J, Ortega FB, Palou P. Effects of a postural education program on school backpack habits related to low back pain in children. Eur Spine J, 2013; 22(4): 782–787.
10. Hundekari J, Agarwal MJ, Jadhav DB, Bondade AK. Effect of load carriage on pulmonary mechanics in school children. International Journal of Basic and Applied Medical Sciences, 2013; 3(2): 16-21.
11. Pal MS, Majumdar D, Bhattacharyya M, Kumar R, Majumdar D. Optimum load for carriage by soldiers at two walking speeds on level ground. International Journal of Industrial Ergonomics, 2009; 39: 68–72.
12. Singh T, Koh M. Lower limb dynamics change for children while walking with backpack loads to modulate shock transmission to the head. Journal of Biomechanics, 2009; 42(6): 736-742.
13. Haselgrove C, Straker L, Smith A, O'Sullivan P, Perry M, Sloan N. Perceived school bag load, duration of carriage, and method of transport to school are associated with spinal pain in adolescents: an observational study. Australian Journal of Physiotherapy, 2008; 54: 193- 200.

14. Kordi R, Rostami M. Low back pain in children and adolescents: an algorithmic clinical approach. Iran J Pediatr, 2011; 21: 259–270.
15. Chow D, Ting j M, Pope A. Effects of backpack load placement on pulmonary capacities of normal schoolchildren during upright stance. International Journal of Industrial Ergonomics, 2009; 39: 703–707.
16. Vieira AC, Ribeiro F. Impact of backpack type on respiratory muscle strength and lung function in children. Ergonomics, 2015; 58(6): 1005-1011.
17. Candotti CT, Noll M, Roth E. Assessment of weight and mode of transport of school material in high school students. Rev Paul Pediatr, 2012; 30(1): 100-106.
18. Kliegman RM, Behrman RE, Jenson HB. Stanton Nelson's textbook of pediatrics 19th Edition. Overweight and obesity, 2011: 179.
19. Barkhordari A, Ehrampoush MH, Barkhordari M, Derakhshi F, Barkhoradri M, Mirzaii M. Assessment of school backpack weight and other characteristics in elementary schools, Yazd, Iran. Journal of Community Health Research, 2013; 2(1): 2-7.
20. Ranu H, Wilde M, Madden B. Pulmonary function tests. Ulster Med J, 2011; 80(2): 84-90.
21. Miller MR, Hankinson J, Brusasco V. Standardization of spirometry. EurRespir J, 2005; 26: 319–338.
22. Malo JL, Chan-Yeung M. Agent causing occupational asthma. J Allergy ClinImmunol, 2009; 123: 545-550.
23. Al-Katheri A E. Impact of backpack load on ventilatory function among Saudi girls 9-12 years old. Saudi Med J, 2013; 34(12): 1255-1261.
24. Baiee HA, Mahmoud RI. Pulmonary function test for water pipe smokers and cigarette smokers in males in Al-Hilla city during the year 2014. Medical Journal of Babylon, 2014; 11(4): 1029-1036.
25. Matlabi H, Behtash HH, Rasouli A, Osmani N. Carrying heavy backpacks and handbags amongst elementary students: Causes and solutions. Science Journal of Public Health, 2014; 2(4): 305-308.
26. Farhood HF. Low back pain in school children: the role of school bag weight and carrying way. Journal of Natural Sciences Research, 2013; 3(8): 156-164.
27. Lucas GN. Backpacks in children. Sri Lanka Journal of Child Health, 2011; 40: 1-3.
28. Amro A, Al-Faqeeh A. The effect of school bag weight on pain, posture, and vital capacity of the lungs of three elementary schools in Bethlehem district in Palestine. Middle East Journal of Family Medicine, 2009; 7(7): 7-14.
29. Ramprasad M, Alias J, Raghuveer AK. Effect of backpack weight on postural angles in preadolescent children. Indian Pediatr, 2010; 47(7): 575-580.
30. Orloff HA, Rapp CM. The effects of load carriage on spinal curvature and posture. Spine, 2004; 29(12): 1325-1329.
31. Ibrahim A. Incidence of back pain in Egyptian school girls effect of school bag weight and carrying way. World Applied Sciences Journal, 2012; 11: 1526-1534.
32. Sharan D, Ajeesh PS, Jose AJ, Debnath S, Manjula M. Back pack injuries in Indian school children: risk factors and clinical presentations. Work, 2012; 41: 929-932.
33. Brackley HM, Stevenson JM. Are children's backpack weight limits enough? A critical review of the relevant literature. Spine, 2004; 29: 2184-2190.
34. Bygrave S, Legg SJ, Myers S, Llewellyn M. Effect of backpack fit on lung function. Ergonomics, 2004; 47: 324-329.
35. Hamzat TK, Abdulkareem TA, Akinyinka OO, Fatoye FA. Backpack-related musculoskeletal symptoms among Nigerian secondary school students. RheumatolInt J, 2014; 34(9): 1267-73.