

Electromyographic Analysis of Upper Trapezius Muscle and Development of MSD in Collegiate Students Carrying Laptop Bag

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Abstract: Introduction: laptop bag may be a contributing factor for musculoskeletal complaints in schoolchildren. Several studies have reported an association between carrying heavily loaded schoolbags and musculoskeletal pain or discomfort. Methods: 105 collegiate students were conveniently recruited in this study. Electromyography (EMG) signals were recorded during the treadmill walking at a speed of 4-5km /hour for 20 minutes with the load. The data were recorded in back pack, right side pack and left side pack with both right & left upper trapezius. Results: Paired sample t test was used to find out the significance level of EMG activity and result showed significant differences in right side pack and left side pack. Conclusions: EMG activity of right trapezius exhibited increased in subjects with right side pack, left trapezius was increased in subjects with left side pack, but in back packs the increment of right & left trapezius EMG is almost equal.

Keywords: Side Pack, EMG, Musculoskeletal Discomfort

1. Introduction

Backpack carriage is common among adults, schoolchildren and adolescents for daily transferring of personal belongings, laptops, books and stationeries to and from offices, colleges or schools. As the load of backpack is directly applied to the spine via the shoulder straps and external loading has been demonstrated to be associated with spinal disorders [1]. De Paula et al. (2012) found that a significant number of students carry backpacks weighing more than 10% of their BWs most of the time [2]. This heavy stress puts the student at an increased risk of injury [3].

Total weight carried, duration and frequency of carriage and the manner in which the weight is carried all affect the demands on the musculoskeletal system and may affect the incidence of musculoskeletal pain or discomfort. The improper use of backpacks can lead to muscle imbalance that could turn into chronic pain and neck problems later on during the lifetime (The American Academy of Orthopaedic Surgeons (AAOS), 2008). In a study conducted by Grimmer et al. (1999) of 1269 high school students in Adelaide, Australia, found gender and age specific associations

between recent low back pain, the amount of time spent sitting, the backpack load and the time spent carrying it [4].

There is evidence that schoolbags may be a contributing factor for musculoskeletal complaints in schoolchildren. Several studies have reported an association between carrying heavily loaded schoolbags and musculoskeletal pain or discomfort [5-7]. Load carriage has been associated with an increased risk of musculoskeletal disorders in the back and upper and lower limbs in recreational hikers (Twombly and Schussman, 1995) [8] with females suffering significantly higher injury rates than males when participating in the same hiking activities in outdoor education [8-9].

Backpack carried by collegiate students and their role in the development of musculoskeletal pain has been the subject of recent attention [3, 10] and reducing backpack weight has been suggested as one prevention strategy to reduce hiking-related injury [11] with previous research recommending 30% body weight (BW) as the maximum load for healthy adult males [12]. If it is necessary to carry loads more than 10% of body weight, the modified backpack helps the integrity of the back and neck. Also, it helps to reduce

muscular stresses on the back when the backpack exceeds the lifted weight of 10% of student's BW. Therefore, the use of the modified backpack is better than to use the commercial one [13].

At present however community based therapists are reporting an increase in the number of students requiring treatment for musculoskeletal injuries and discomfort [14]. This increase in the number of students as patients has been suggested to be related to students' increased use of computers.

When reviewing the literature there is minimal research reported on the use of laptop computers and the physical implications of their use, both within school and general environments. At the time of this research only four published studies were found that discussed the physical implications of using laptop computers [15].

It is evident that a lot of research work has been done related to back pack and scapular kinematics but there is a paucity of research linking the involvement with side pack with Electromyographic activity, thus there is a need to do a work on that specific aspect. The purpose of the study is found out the changes in Electromyography in upper trapezius in collegiate student with backpack and side pack.

2. Methodology

2.1. Articipants

105 collegiate student form Sardar Bhagwan Singh (PG) Institute of Biomedical Sciences & Research, Balawala, Dehradun were conveniently recruited in this study (Table-1). The detailed protocol of the research was explained and consent of every subject was taken prior to their inclusion in the study. The whole research was approved by the human subjects ethics review committee at the Punjabi University, Patiala, India.

Table 1. Demographic Statistics of the populations.

| | Minimum | Maximum | Mean | SD |
|--------|---------|---------|--------|------|
| Age | 18.00 | 28 | 22.15 | 1.94 |
| Height | 150.00 | 188 | 164.54 | 7.73 |
| Weight | 40.00 | 78 | 65.23 | 7.53 |

A Custom made double-strap backpack was used in this study. An internal aluminum frame covered with rigid plastic material was used and position the center of gravity of the backpack approximately at the participant's T12 level [16]. Weights were symmetrically attached to the custom made back pack about the midline of the backpack until the overall weight of the backpack was 10% of the participant's body weight [17]. The lengths of the backpack straps were

adjusted according to the participant's comfort. All the participant was asked to walk with backpack carriage on a motor driven treadmill for 20 min [3].

EMG signals were recorded during the treadmill walking at a speed of 4-5km /hour with the back pack and side pack. Subject has to walk for 20 minutes after that the signals were saved in the computer through neuroperfect software. The data were recorded in back pack, right side pack and left side pack with both right & left upper trapezius.

2.2. Measurement of EMG Activity in Upper Trapezius

Before placing the electrodes, the skin preparation was done in which the skin of each individual was wiped with the alcohol to reduce the skin impedance [18]. Two Ag/AgCl surface electrode filled with electrode paste were placed unilaterally. The inter electrode distance was 20mm from centre to centre of the electrode and each electrode was of 1.0 cm diameter. Electrodes were oriented in the direction of the muscle fibers.

Two electrodes were placed so that they ran parallel to the muscle fibers and positioned in such a way that one electrode was superomedial and other inferomedial to a point 2 cm lateral to one-half the distance between the C7 spinous process and the lateral tip of the acromion. The ground electrode was placed over C7 spinous process. Palpation of C7 spinous process was done by moving the head in flexion and extension. The electrodes were secured to the skin by means of adhesive tapes. Surface electrodes were chosen because they were simple to handle and they pick up signal from a comparatively large volume of muscle and do not discomfort the subject. It was necessary to have electrode attached for long period and at the same time retain comfort and relaxation [19].

The parameters used in EMG data were sensitivity of $\pm 100 \mu V$, bandwidth of 10 to 2000 Hz. The input impedance of the EMG amplifier was less than 10 Megaohms, common mode rejection ratio of 85 db and Gain of 1000. [20].

2.3. Data Analysis & Result

Paired sample t test was used to find out the significance level of EMG activity with back pack and side pack position. The acceptable probability level was set at $p < .05$.

The results of the present study showed significant differences in right side pack and left side pack but non-significant differences with back pack when comparison was done within the group between right side & left side upper trapezius (Table 2 and Figure 1).

Table 2. Comparison of EMG Readings of right trapezius & left trapezius with different packs.

| | Mean \pm SD | | SEM | t-value | p-value | Significant |
|-----------------|------------------|------------------|--------|---------|---------|-------------|
| | Rt Trap | Lt Trap | | | | |
| Right Side Pack | 1.61 \pm 0.28 | 1.47 \pm 0.26 | 0.0230 | 6.041 | 0.0001 | S |
| Left Side Pack | 1.47 \pm 0.37 | 1.73 \pm 0.40 | 0.0262 | 10.038 | 0.0001 | S |
| Back Pack | 1.506 \pm 0.30 | 1.501 \pm 0.30 | 0.0226 | 0.0217 | 0.829 | NS |

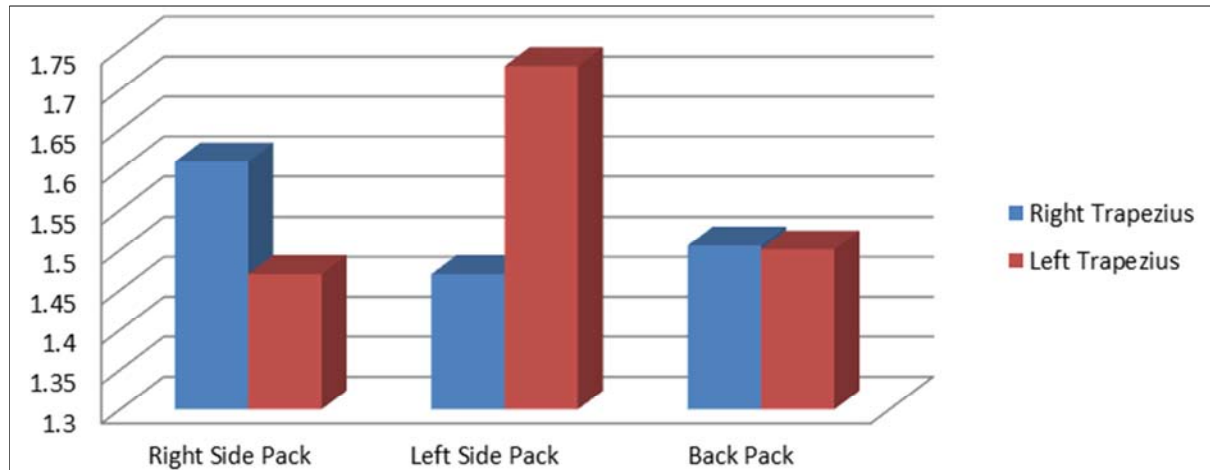


Figure 1. Mean comparisons of EMG Readings between Rt & Lt Trapezius.

When comparison was done between different pack of right upper trapezius, the result showed significant differences between right side pack & left side pack, and right side pack & back pack and showed non-significant differences between left side pack & back pack of right upper

trapezius. In left upper trapezius, the result showed significant differences between right side pack & left side pack, and left side pack & back pack and showed non-significant differences in right side pack & back pack (Table 3 and Figure 2).

Table 3. Comparison of EMG readings between individuals with Different Pack in right trapezius.

| | | SEM | t-value | p-value | Significant |
|-----------------|-------------------------|--------|---------|---------|-------------|
| Right Trapezius | Right Side Vs Left side | 0.0453 | 3.007 | 0.003 | S |
| | Right side Vs Back Pack | 0.0370 | 2.830 | 0.006 | S |
| | Left side Vs Back Pack | 0.0455 | 0.694 | 0.489 | NS |
| Left Trapezius | Right Side Vs Left side | 0.0460 | 5.776 | 0.0001 | S |
| | Right side Vs Back Pack | 0.0378 | 0.782 | 0.436 | NS |
| | Left side Vs Back Pack | 0.0462 | 5.108 | 0.0001 | S |

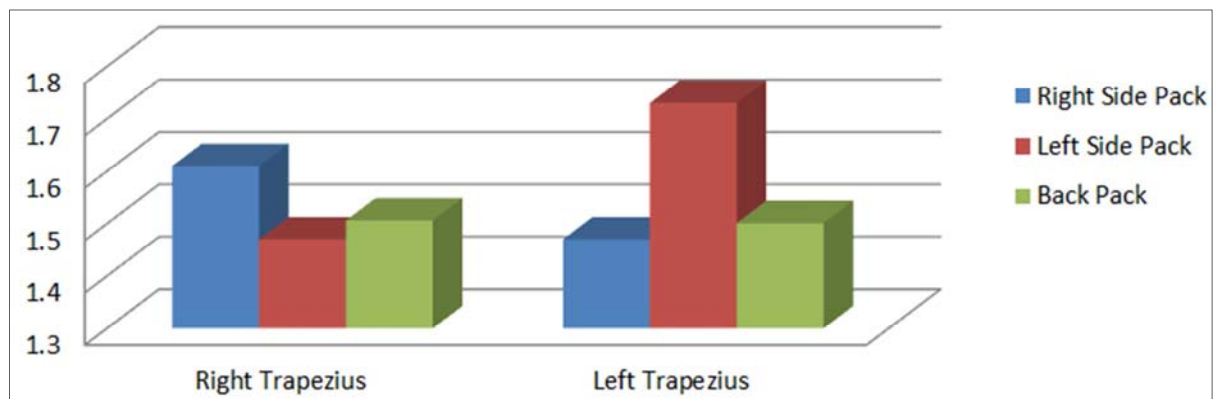


Figure 2. Comparison of EMG readings between individuals with Different Pack in Rt & Lt Trapezius.

3. Discussion

Electromyographic activity of upper trapezius was varied in load carrying with different pack. The results of the present study showed significant differences when comparison was done within the group between right side & left side upper trapezius with wearing right side pack and left side pack but non-significant differences with back pack. That means right trapezius EMG activity was increased in subjects with right side pack, and left trapezius EMG was increased in subjects with left side pack, but in back packs

the increment of right & left trapezius EMG is almost equal. Our study was supported by Kim et al., 2008 when they tested the RMS of upper trapezius EMG activities in forward head position during carrying three types of school packs with 15% of body weight; they found that the RMS of EMG activity of the upper trapezius was significantly higher while carrying the backpack [21]. Bobet J, Norman RW, 1984 proved that the upper trapezius EMG activity was significantly higher double pack than without a backpack [22].

Holewijn, 1990 monitored the EMG signal of the trapezius muscle among four young male volunteers as they walked on

a treadmill carrying either 0, 5.4, or 10.4 kg in a backpack [23]. The load significantly increased the root mean square EMG value of the muscle, corresponding to an increase in force exerted by the muscle. However, with increased loading, increased activation of postural muscles providing spinal stability, and especially the back extensor muscles, is expected due to the increased thorax flexion [24].

Piscione & Gamet D, 2006 found that through increasing a load up to 15 percent of body weight, the upper fibre of EMG activities was increased Carrying loads bilaterally offers two specific advantages over unilateral load carrying [25]. First, the bilateral load carrying produced less EMG activity than unilateral load. Second, the forces on both sides would be nearly equivalent due to the symmetry of the muscles on both sides and across both sides of the spine [26]. This explains that side pack produces less EMG activity than the back pack. Basically the strap of the bag produces restriction to the movement of the scapula but the scapula produces an upward reaction force against the weight of the bag which ultimately force the muscle to contract isometrically, whereas the other shoulder is free from weight and the muscle of that shoulder is acts concentrically thus producing less EMG signals.

When comparison was done between different pack of right upper trapezius, the result showed significant differences between right side pack & left side pack, and right side pack & back pack and showed non-significant differences between left side pack & back pack, that means EMG activity is more in right side pack than back pack and then left side pack. This might be explained as the maximum subjects are right hand dominant so the right side upper trapezius will contract isometrically against strap under load. Aaras, 1994, showed that upper trapezius activity above 5% Maximum voluntary Contraction is associated with increased incidence of work-related neck and upper limb disorders, the import of seemingly small changes in neck postures maintained over long time periods is clear [27]. Furthermore, a significant increase in anterior-posterior swing of trunk when carrying higher loads would cause the abdomen, back and leg muscles to work harder to maintain dynamic balance. This would involve the semispinalis, erector spinae, trapezius, tibialis anterior, vastus lateralis and hamstring muscles [28]. Stokes et al. (1989) the pelvis rotates in the frontal plane opposite to the shoulder girdle during most of the stride cycle. The shoulder on the opposite side to the leg striking the ground is lifted and rotated forward [29]. When this movement of the shoulder is impeded due to a load supported by the shoulder, the trapezius muscle has to generate a higher force in order to overcome this. From this data on the force generated by the descending part of the trapezius muscle during load carrying will produce more EMG activity.

4. Conclusions

Electromyographic activity of upper trapezius was measured during treadmill walking with right side pack, left side pack and back pack. EMG activity of right trapezius

exhibited increased in subjects with right side pack. EMG activity of left trapezius was increased in subjects with left side pack, but in back packs the increment of right & left trapezius EMG is almost equal.

References

- [1] Korovessis P, Koureas G, Zacharatos S, Papazisis Z. Backpacks, back pain, sagittal spinal curves and trunk alignment in adolescents: a logistic and multinomial logistic analysis. *spine*. 2005; 30: 247-55.
- [2] De Paula A. J. F., Silva JCP, Paschoarelli LC, Fujii JB. Backpacks and school children's obesity: challenges for public health and ergonomics. *work*. 2012: 900-6.
- [3] Mackie HW, Legg SJ, Beadlea J, Hedderley D. Comparison of four different backpacks intended for school use. *Applied Ergonomics*. 2003; 34: 257-64.
- [4] Grimmer KA, Williams MT, Gill TK. The associations between adolescent head-on neck posture, backpack weight, and anthropometric features. *Spine*. 1999; 24 (21): 2262-7.
- [5] Negrini N. S., Carabalona R. Backpacks on! Schoolchildren's perceptions of load, associations with back pain and factors determining the load. *Spine*. 2002; 27: 187-95.
- [6] Sheir-Neiss GI, Kruse RW, Rahman T, Jacobson LP, Pelli JA. The association of backpack use and back pain in adolescents. *Spine*. 2003; 28: 922-33.
- [7] Dianat I, Javadivala Z, Asghari-Jafarabadi M, Asl Hashemi A, Haslegrave CM. The use of schoolbags and musculoskeletal symptoms among primary school children: are the recommended weight limits adequate? *Ergonomics*. 2013; 56: 79-89.
- [8] Twombly SE, Schussman LC. Gender differences in injury and illness rates on wilderness backpacking trips.. *Wilderness and Environmental Medicine*. 1995; 4: 363-76.
- [9] Leemon D, Schimelpfenig T. Wilderness injury, illness, and evacuation: National Outdoor Leadership School's Incident Profiles. *Wilderness & Environmental Medicine*. 2003; 14: 174-82.
- [10] Javadivala Z, Allahverdipour H, Dianat I, Bazargan M. Awareness of parents about characteristics of a healthy school backpack. *Health Promotion Perspectives*. 2012; 2: 166-72.
- [11] McIntosh SE, Leemon D, Visitation J, Schimelpfenig T, Fosnacht D. Medical incidents and evacuations on wilderness expeditions. *Wilderness & Environmental Medicine*. 2007; 18 (4): 298-304.
- [12] Haisman MF. Determinants of load carrying ability. *Applied Ergonomics*. 1988; 19 (2): 111-21.
- [13] Mohamed Z. Ramadan, Al-Shayea AM. A modified backpack design for male school children. *International Journal of Industrial Ergonomics*. 2013; 43: 462-71.
- [14] Wilson K. Laptops a pain in neck. Melbourne:.. Herald Sun. 1997 5 August 1997: 7.
- [15] Diederich J, Stewart M, editors. Laptop computers: Flexibility v's disability. In *Occupational Therapy Australia*., 19th National Conference; 1997; Perth, Western Australia.

- [16] Grimmer K, Dansie B, Milanese S, Pirunsan U, Trott P. Adolescent standing postural response to backpack loads: a randomised controlled experimental study. *BMC Musculoskeletal Disorders*. 2002; 3: 10.
- [17] Chow DH, Leung KT, Holmes AD. Changes in spinal curvature and proprioception of schoolboys carrying different weights of backpack.. *Ergonomics*. 2007; 50: 2 148-56.
- [18] Michael J. Decker, et. al. Serratus Anterior Muscle Activity During Selected rehabilitation Exercises. *The American Journal Of Sports Medicine*. 1999; 27 (6): 784-91.
- [19] Richard A. Ekstrom, Robert A. Donatelli, Gary L. Soderberg. Surface Electromyographic Analysis of Exercises for the Trapezius and Serratus Anterior Muscles. *JOSPT*. 2003; 33 (5): 247-58.
- [20] Ann M. Cools, Erik E. Witvrouw, Geert A. De Clercq, Lieven A. Danneels, Tine M. Willems, Dirk C. Cambier, et al. Scapular Muscle Recruitment Pattern: Electromyographic Response of the Trapezius Muscle to Sudden Shoulder Movement Before and After a Fatiguing Exercise. *J Orthop Sports Phys Ther*. 2002; 32: 221-9.
- [21] Kim M. H., Kwon O. Y., Cho S. H., Yoo W. G. Changes in neck muscle electromyography and forward head posture of children when carrying school bags. *Ergonomics*. 2008; 51 (6).
- [22] Bobet J, Norman RW. Effects of load placement on back muscle activity in load carriage.. *European Journal of Applied Physiology and Occupational Physiology*. 1984; 53: 71-5.
- [23] Holewijn M. Physiological strain due to load carrying. *Eur J Appl Physiol*. 1990; 61: 237-45.
- [24] Granata KP, Orishimo KF, Sanford AH. Trunk muscle coactivation in preparation for sudden load.. *Journal of Electromyography and Kinesiology*. 2001; 11: 247-54.
- [25] Piscione J., Gamet D. Effect of mechanical compression due to load carrying on shoulder muscle fatigue during sustained isometric arm abduction: An electromyographic study. *Eur J Appl Physio*. 2006; 197: 573-81.
- [26] Neuman D. A., Cook T. M. Effect of load carrying position on the electromyographic activity of the gluteus medius muscle during walking. *Physical Therapy*. 1985; 65 (3): 305-11.
- [27] Aaras A. The impact of ergonomic intervention on individual health and corporate prosperity in a telecommunications environment. *Ergonomics*. 1994; 37 (10): 1679-96.
- [28] Cook T, Neumann D. The effect of load placement on the EMG activity of the low back muscles during load carrying by men and women. *Ergonomics*. 1987; 30: 1413-23.
- [29] Stokes V. P., Andersson C., Forssberg H. Rotational and Translational movement features of the pelvis and thorax during adult locomotion. *Journal of Biomechanics*. 1989; 22 (1): 43-50.