

INFLUENCE OF SCHOOL BAG CARRIAGE ON GAIT AND POSTURE

By

DALIA MOHAMMED MOHAMMED MOSAAD

M.Sc. Physical Therapy (2004)

Basic Science Department

A Thesis Submitted to Basic Science Department in partial
fulfillment of the requirements for Doctoral degree in physical
therapy

Faculty of Physical Therapy
Cairo University
2009

SUPERVISORS

Prof. Dr. Mohsen M. El-Sayyad

Professor of Physical Therapy
Director of Motion Analysis Lab
Basic Science Department
Faculty of Physical Therapy
Cairo University

Dr. Samy Abd El Samad

Professor of Physical Therapy
Basic Science Department
Faculty of Physical Therapy
Cairo University

Dr. Sahar Adel

Lecturer of Physical Therapy
Basic Science Department
Faculty of Physical Therapy
Cairo University

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

رَبِّهِ هَبْ لِي حُكْمًا وَأَلْحِقْنِي
بِالصَّالِحِينَ * وَأَجْعَلْ لِي لِسَانَ
صِدْقٍ فِي الْآخِرِينَ * وَأَجْعَلْنِي
مِنْ وَرَثَةِ جَنَّةِ النَّعِيمِ .

صدق الله العظيم

سورة الشعراء

(83 - 85)

DEDICATION

To *My parents*, who gave every thing to me. To *My husband*, for his sacrifices and continuous help. To *My lovely girl, Raneem*, and my sweat boy, *Mohammed*, the best gift of **Allah**. For every one of my family and my friends who gave me support.

ACKNOWLEDGEMENTS

First and above all, I would like to kneel to thank *Allah*, the most compassionates, the most merciful, for the guidance, support and mercy.

First and foremost, I would like to thank Professor. **Dr. Mohsen M. El-Sayyad**. Professor of Physical Therapy and Director of Motion Analysis Lab., Basic Science Department, Faculty of Physical Therapy Cairo University. I would like to express my sincere gratitude for his advice, and for guiding me to finish this thesis. Without his constant encouragement and enthusiastic approach this work would not have ended fruitfully.

I would like to thank **Dr. Samy Abd El Samad**, Professor of Physical Therapy. Basic Science Department, Faculty of Physical Therapy, Cairo University for his great assistance especially at the early beginning of my thesis. His directions and guidance were always up to point.

I would like to thank **Dr. Sahar M. Adel**. Lecturer of Physical Therapy. Basic Science Department, Faculty of Physical Therapy. Cairo University, for her instructions and guidance to finish this thesis.

Thanks for every volunteer participated in this work, for the time and effort he spent.

Abstract

Background The carriage of backpacks has been shown to constitute a considerable daily "occupational" load on the spines of school children. **The purpose** of this study was to assess the neck posture angles and vertical and antero-posterior ground reaction forces in children while they were carrying two types of schoolbag (ordinary backpack and modified double-sided bag) and compare each with carrying no pack. **Subjects:** Thirty subjects, mean age was (10.06 ± 1.31). They were assigned in one group. **Materials and methods:** They passed through two tests. First, static test with child stand (without bag, with ordinary backpack, and with the modified double side bag) then take a capture of the neck posture angles for each. Second, the dynamic test, to take Ground Reaction Forces (vertical and anteroposterior forces) in the same three situations while the child walked in his normal gait passing over the Force plate. The recording includes, neck angles captured by Infrared cameras and force plate for GRF data. **Results:** There was a statistically significant increase in the cranio-horizontal angle (upper cervical) when carrying ordinary bag compared with no load and modified bag carriage. There was also significant decrease in the cranio-vertebral angle when using the ordinary bag compared with no load and modified bag. Shoulder sagittal angle showed significant decrease in ordinary bag carriage compared both to the modified bag and no load. There was significant increase in the examined GRF vertical and anteroposterior forces when carrying the ordinary bag in relation to no load. While only F2, F3 and F5 were significantly increased when using the modified bag in relation to no load. F1 was the only force had significant difference between the ordinary and modified condition. **Discussion and conclusion:** Modified double side bag significantly decreased the forward head posture compared with the ordinary backpack style, and led to less but not significant decrease in vertical and antero-posterior GRF in using the modified bag compared with ordinary style. **Keywords:** Backpack, Children, Neck posture, Ground reaction force.

TABLE OF CONTENTS

	<i>Page</i>
<i>Chapter (I) Introduction.....</i>	<i>1</i>
Statement of the problem	3
Purpose of the study	4
Specific objectives.....	4
Justification of the study.....	5
Delimitation of the study	6
Limitation of the study	6
Basic assumption.....	6
Hypothesis	7
Definition of terms.....	
 <i>Chapter (II) Literature Review.....</i>	 <i>9</i>
Head –Neck posture.....	10
Forward head posture.....	10
Load carriage in children	13
Load carriage and neck angles.....	25
Gait kinetics.....	30
Effect of load carriage on the ground reaction forces.....	37
 <i>Chapter (III) Methodology.....</i>	 <i>43</i>
Design of study.....	43
Selection of subjects.....	43
Inclusion criteria.....	44
Exclusion criteria.....	44
Instrumentation	44
Procedure.....	50
Data processing.....	57

<i>Chapter (IV) Analysis of Results.....</i>	<i>59</i>
<i>Chapter (V) Discussion</i>	<i>84</i>
Summary, conclusions and recommendations	98
<i>References</i>	<i>102</i>
<i>Appendices</i>	
<i>Arabic summary</i>	

LIST OF TABLES

Table 1	Effects of FHP on musculoskeletal system	12
Table 2	Anthropometric Characteristics of subjects	59
Table 3	Effect of different bag styles on CHA	62
Table 4	Post Hoc analysis for mean differences of craniohorizontal angle (CHA), in all conditions	63
Table 5	Effect of different bag styles on (CVA	65
Table 6	Post Hoc analysis for mean differences of cranio-Vertabral angle (CVA), in all conditions	66
Table 7	Effect of different bag styles on (SSP)	67
Table 8	Post Hoc analysis for mean differences of shoulder sagittal posture (CHA), in all conditions	69
Table 9	Effect of different bag styles on F_1	71
Table 10	Post Hoc analysis for mean differences of F_1 , in all conditions.	72
Table 11	Effect of different bag styles on F_2	73
Table 12	Post Hoc analysis for mean differences of F_2 , in all conditions.	74

Table 13	Effect of different bag styles on F_3	76
Table 14	Post Hoc analysis for mean differences of F_3 in all conditions.	77
Table 15	Effect of different bag styles on anterior force (braking) F_4	78
Table 16	Post Hoc analysis for mean differences of F_4 in all conditions.	79
Table 17	Effect of different bag styles on posterior force (propulsusion) F_5 .	81
Table 18	Post Hoc analysis for mean differences of F_5 in all conditions.	82

LIST OF FIGURES

Figure		page
Fig. (1)	Head angles	26
Fig. (2)	Ground reaction force vector	31
Fig. (3)	Ground reaction force components	34
Fig. (4)	Vertical GRF Vector	35
Fig. (5)	Antero-posterior GRF vector	37
Fig. (6)	pro-reflex camera	45
Fig. (7)	Wand kit	45
Fig. (8)	Markers at static test	47
Fig. (9)	Markers at dynamic test	47
Fig. (10)	Force platform unit	48
Fig. (11)	Ordinary backpack	49
Fig. (12)	Modified double bag style	49
Fig. (13)	Back view of the double bag	50
Fig. (14)	Anterior view of the double bag	50
Fig. (15)	Camera system calibration	52
Fig. (16)	Force platform calibration	52
Fig. (17)	Capture while child without bag in static condition	53
Fig. (18)	Capture while child with ordinary backpack in static condition	53
Fig. (19)	Capture while child with double bag style in static Condition	54
Fig. (20)	Representation of lines forming cervical angles	55

Fig. (21)	Dynamic without bag	56
Fig. (22)	Dynamic with ordinary bag	56
Fig. (23)	Dynamic with modified bag	56
Fig. (24)	Mean values of age for females and males subjects	60
Fig. (25)	Mean values of weight for females and males subjects	61
Fig. (26)	Mean values of height for females and males subjects	61
Fig. (27)	Mean values of BMI for females and males Subjects	61
Fig. (28)	Mean values of 7.5 % weight for females and males Subjects	62
Fig. (29)	The pattern of changes in mean value of cranio-horizontal angle in all conditions	63
Fig. (30)	Post Hoc analysis for mean differences of Cranio-horizontal angle (CHA), in all conditions	64
Fig. (31)	The pattern of changes in mean value of cranio-vertbral angle (CVA) in all conditions	65
Fig. (32)	Post Hoc analysis for mean differences of cranio-vertabral angle (CVA), in all conditions	67
Fig. (33)	The pattern of changes in mean value of shoulder sagittal posture (SSP) in all conditions	68
Fig. (34)	Post Hoc analysis for mean differences of shoulder Sagittal posture SSP)	70
Fig. (35)	Represents the mean and standard deviations of all cervical angles	70
Fig. (36)	The pattern of changes in mean value of F_1 in all Conditions	71

Fig. (37)	Post Hoc analysis for mean differences of F_1 , in all conditions.	73
Fig. (38)	The pattern of changes in mean value of F_2 in all Conditions	74
Fig. (39)	Post Hoc analysis for mean differences of F_2 , in all Conditions	75
Fig. (40)	The pattern of changes in mean value of F_3 in all Conditions	76
Fig. (41)	Post Hoc analysis for mean differences of F_3 in all Conditions	78
Fig. (42)	The pattern of changes in mean value of F_4 in all Conditions	79
Fig. (43)	Post Hoc analysis for mean differences of F_4 in all conditions.	80
Fig. (44)	The pattern of changes in mean value of F_5 in all Conditions	82
Fig. (45)	Post Hoc analysis for mean differences of F_5 in all Conditions	83

LIST OF ABBREVIATIONS

<i>Abbreviation</i>	<i>Name</i>
AIS	Adolescent idiopathic scoliosis
AP	Antero-Posterior
BW	Body Weight
CHA	Cranio Horizontal Angle
COM	Center of Mass
CPSC	Consumer Product Safety Commission
CVA	Craniovertebral Angle
FHP	Forward head posture
F1	First peak of the vertical ground reaction force
F2	The valley of the vertical ground reaction force
F3	Second peak of the vertical ground reaction force
F4	Anterior force of ground reaction force
F5	Posterior force of ground reaction force
GRF	Ground reaction force
GRFV	Ground Reaction Force Vector
HPSCI	Head Posture Spinal Curvature Instrument
LEMD	Linear Excursion measurement Device
LBP	low back pain
ML	Medial-Lateral
N	Newton
SSP	Sagittal Shoulder Posture

CHAPTER I

INTRODUCTION

The carriage of backpacks has been shown to constitute a considerable daily "occupational" load on the spines of school children. It is widely believed that the repeated carriage of heavy school backpacks places additional stress on the rapidly growing spine of school children, making them more prone to postural changes, and ultimately leading to lower back problems ^(1,2).

It is alarming that almost half of the school children reported complaints of muscle soreness of neck, shoulder and back. It was reported that gender-related factors including physical fitness (cardiovascular fitness, muscle performance, motor competence), activity patterns (information technology use, moderate and vigorous physical activity), psychological factors (depression/anxiety, life stresses) and the perceived weight of the bag were the main factors associated with these complaints, which lead to alternation in the posture and gait of the students ^(1,3,4).

Neck and back pain are among the major problems associated with school bag carriage. When the backpack weighs more than 10 to 15 percent of the student's bodyweight (BW), postural changes, particularly, the forward leaning of the head and trunk is a major problem that may result in spinal deformities. Studies have shown that reports of back pain occur early