



UNIVERSITI PUTRA MALAYSIA

**RISK OF MUSCULO-SKELETAL DISORDERS AND THE DEVELOPMENT
OF ERGONOMIC FURNITURE FOR PRIMARY SCHOOL CHILDREN IN
MALAYSIA**

NURUL ASYIQIN BINTI MOHD ALI

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By

NURUL ASYIQIN BINTI MOHD ALI

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March 2010

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Chair: Dr Shamsul Bahri Bin Hj Md Tamrin, PhD

Faculty: Faculty of Medicine and Health Sciences

Musculoskeletal problems (MSD) among children are increasing worldwide from year to year. The school environment had been identified as one of the contributing factors in the increase of MSD complaints among children. The 2 main objectives of this study are: first, to determine the prevalence and risk factors of MSD among Malaysian primary school children; and second, to develop and evaluate new ergonomics furniture for primary schools in Malaysia.

A cross-sectional study was carried out in 10 randomly selected primary schools from 4 regions in Peninsular Malaysia, with a total of 843 children participating in the study. A translated Nordic Questionnaire (TNQ) was used to determine the prevalence of MSD (life time complaints as well as complaints within 7 days of the interview). The schoolbags were weighed to determine the average weight carried by the school children. The ergonomics hazard and MSD risk factors were determined

using Logistic Regression analysis and ergonomics Hazard Identification, Risk Assessment and Risk Control (HIRARC). From the risks identified, ergonomics furniture were designed with the color and material preferences as chosen by the children through a simplified questionnaire. Anthropometric data was collected using a Martyn's type anthropometer and a customized chair to determine the specifications of the furniture based on the anthropometry of level 1 (standard 1 to standard 3) and level 2 (standard 4 to standard 6) children. Using all the important information, several sketches were produced and only one final design was selected. Two-dimensional (2D) and 3-dimensional (3D) mock-ups were produced based on the selected sketches. The specifications of the furniture were finally intergrated with the anthropometric data for the final design prior to prototype fabrication. Finally, Rapid Upper Limb Assessment modelling analysis was done using CATIA[®] software to evaluate the effectiveness of the proposed prototypes.

From the total respondents, 52% were females, most of them Malay (92%). The results showed that the overall prevalence of MSD (life time) was very high (66.5% for level 1 and 73% for level 2). From the assessment, the study revealed that 4 ergonomics parameters were found to be hazardous to school children, namely: 1) un-ergonomically designed furniture; 2) awkward posture; 3) prolong sitting; and 4) excessive loading. Among the children's activities, classroom learning indicated the highest risk level of 15 (high risk) compared to others. Binary Logistic Regression analysis shows a significant relationship for NP with relative bag weight ($X^2=4.015$, $p<0.05$, $R^2=0.084$), EP with relative bag weight ($X^2=7.667$, $p<0.05$, $R^2=0.585$), and KLP with existing furniture ($X^2=4.934$, $p<0.05$, $R^2=0.23$), among level 2 children.

Among level 1 children, the results showed a significant relationship between EP and relative bag weight ($X^2=5.740$, $p<0.05$, $R^2=0.177$), UBP with existing furniture ($X^2=5.265$, $p<0.05$, $R^2=0.377$), THP with the trolley-type bag ($X^2=15.348$, $p<0.05$, $R^2=0.393$), KLP with the trolley-type bag ($X^2=8.278$, $p<0.05$, $R^2=0.112$) and SP with existing furniture ($X^2=9.577$, $p<0.001$) and the trolley-type schoolbag ($X^2=6.343$, $p<0.05$). The existing furniture contributed 14.1% to SP complaints while the trolley-type schoolbag contribute only 7.4%, with the combination of both factors contributing 21.5% ($X^2=15.921$, $p<0.05$) to the dependent variable for Level 1 children. A majority of the school children (76%) preferred light colors to be used as furniture colors and 6 anthropometric parameter had been used in determining the dimensions of the new furniture. Using all the information, 2 primary school furniture prototypes had been developed. The RULA analysis showed the reduction of a grand score of 4 for the current furniture to 2 for the newly-proposed furniture design (levels 1 and 2).

In conclusion, this study proposes a new design of school furniture, with the combination of medical science research and industrial design processes to promote safety and health among Malaysian school children.

Keywords: *Primary school children, MSD, HIRARC, Anthropometrics data, Furniture Development, RULA.*

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**RISIKO MASALAH OTOT RANGKA DAN PEMBANGUNAN PERABUT
ERGONOMIK UNTUK KEGUNAAN MURID SEKOLAH RENDAH DI
MALAYSIA**

Oleh

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Masalah otot rangka (MSD) di kalangan kanak-kanak di seluruh dunia sedang meningkat dari setahun ke setahun. Persekitaran sekolah telah dikenalpasti sebagai salah satu faktor penyumbang kepada peningkatan aduan MSD di kalangan kanak-kanak. Dua objektif utama kajian ini adalah: pertama, untuk mengenalpasti prevalen dan faktor-faktor risiko MSD di kalangan murid sekolah rendah di Malaysia; dan kedua, untuk membangun dan menilai perabut ergonomik baru untuk sekolah-sekolah rendah di Malaysia.

Satu kajian keratan rentas telah dijalankan di 10 buah sekolah yang dipilih secara rawak daripada 4 bahagian di Semenanjung Malaysia, di mana sejumlah 843 orang kanak-kanak telah menyertai kajian ini. Borang soal selidik Nordic yang telah diterjemah ke Bahasa Melayu telah digunakan untuk menentukan prevalens MSD (aduan sepanjang hayat serta aduan dalam tempoh 7 hari dari temuduga). Berat beg

sekolah telah ditimbang untuk menentukan berat purata beg yang digalas oleh kanak-kanak tersebut. Bahaya ergonomik serta faktor-faktor risiko MSD telah ditentukan menggunakan analisis Logistik Regresi dan Pengenalpastian Bahaya Ergonomik, Penilaian Risiko dan Pengawalan Risiko (HIRARC). Daripada risiko yang telah dikenalpasti, perabut ergonomik telah direkabentuk dengan menggunakan warna serta bahan kesukaan para murid seperti yang telah dipilih melalui satu borang soal selidik yang ringkas. Data anthropometri diukur dengan menggunakan “Martin’s type anthropometer” serta satu kerusi khas yang direka untuk menentukan spesifikasi perabut berdasarkan anthropometri murid tahap 1 (darjah 1-3) dan tahap 2 (darjah 4-6). Dengan menggunakan maklumat yang di perolehi, beberapa lakaran perabut telah dihasilkan, di mana hanya satu rekabentuk akhir dipilih. Spesifikasi perabut ini akhirnya telah diintegrasikan bersama data anthropometri untuk sebelum proses fabrikasi prototaip. Akhirnya, analisis model RULA telah dijalankan menggunakan perisian CATIA® untuk menilai keberkesanan prototaip yang telah dicadangkan itu.

Sebanyak 52% daripada jumlah responden kajian adalah perempuan, dengan kebanyakannya berbangsa Melayu (92%). Hasil kajian mendapati bahawa prevalen MSD (sepanjang hayat) keseluruhan adalah sangat tinggi (66.5% untuk tahap 1 dan 73% untuk tahap 2). Daripada penilaian yang telah dijalankan, kajian ini mendapati bahawa 4 parameter ergonomik yang didapati berbahaya kepada murid sekolah, iaitu: 1) rekabentuk perabut yang tidak ergonomik; 2) postur kekok; 3) duduk terlalu lama; dan 4) bebanan berlebihan. Daripada aktiviti-aktiviti kanak-kanak yang dijalankan, pembelajaran di dalam kelas menunjukkan tahap risiko yang tertinggi iaitu 15 (risiko tinggi) berbanding dengan aktiviti lain. Hasil analisis Regresi Logistik Binari dengan

mengawal tahap aktiviti sukan, sejarah kamalangan terdahulu dan indeks jisim tubuh menunjukkan bahawa terdapat hubungan signifikan di antara sakit leher dengan berat beg relatif ($X^2=4.015$, $p<0.05$, $R^2=0.084$), sakit siku dengan berat beg relatif ($X^2=7.667$, $p<0.05$, $R^2=0.585$), dan sakit kaki serta lutut dengan perabot sekarang ($X^2=4.934$, $p<0.05$, $R^2=0.23$), di kalangan kanak-kanak tahap 2. Di kalangan murid-murid tahap 1, hasil analisis mendapati bahawa terdapat hubungan signifikan di antara aduan sakit siku dengan berat beg relatif ($X^2=5.740$, $p<0.05$, $R^2=0.177$), sakit belakang atas dengan perabot sekarang ($X^2=5.265$, $p<0.05$, $R^2=0.377$), sakit peha serta betis dengan beg beroda ($X^2=15.348$, $p<0.05$, $R^2=0.393$) dan sakit lutut serta peha dengan beg beroda ($X^2=8.278$, $p<0.05$, $R^2=0.112$). Dua faktor mempunyai hubungan signifikan dengan aduan kesakitan di bahagian bahu, iaitu perabot sekarang ($X^2=9.577$, $p<0.001$) dan beg sekolah beroda ($X^2=6.343$, $p<0.05$). Majoriti murid sekolah (76%) lebih menyukai warna lembut digunakan sebagai warna perabot. Hasil analisis keberkesanan perabot menunjukkan penurunan markah RULA dari 4 untuk perabot rekaan baru yang telah dicadangkan berbanding 2 untuk perabot sekarang (bagi tahap 1 dan 2).

Kesimpulannya, kajian ini telah mencadangkan satu rekabentuk baru untuk perabot sekolah, dengan mengaplikasikan kajian sains perubatan dan proses rekabentuk industri untuk mempromosi keselamatan dan kesihatan di kalangan murid-murid sekolah di Malaysia.

Kata Kunci: *Murid sekolah rendah, MSD, HIRARC, data antropometri, Pembangunan perabot, RULA.*

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Not to forget, to all my colleagues and friends who assisted in completing this thesis. Finally, to my family, who give full support and encouragement during completing this study.

I certify that an Examination Committee has met on **31 March 2010** of **viva voce** to conduct the final examination of **Nurul Asyiqin Binti Mohd Ali** on her **Master of Science** thesis entitled “**Risk Of Musculo-Skeletal Disorders And The Development of Ergonomics Furniture for Primary School Children in Malaysia**” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the student be awarded the degree of Master of Science (Environmental Health).

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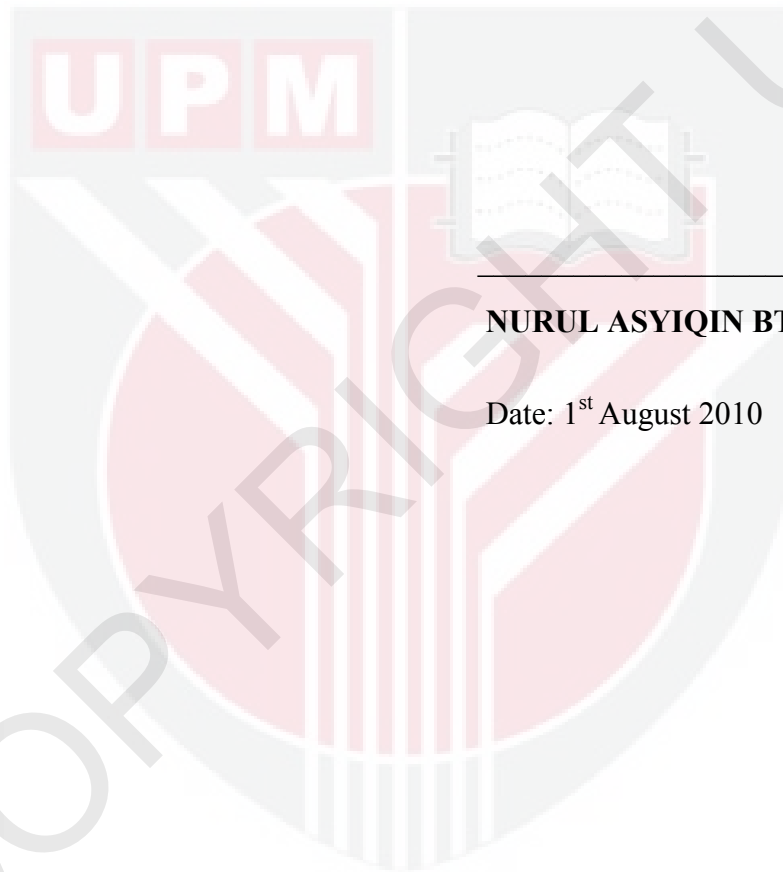
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Date: 16 August 2010

DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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Date: 1st August 2010



TABLE OF CONTENTS

	Page
ABSTRACT	ii
ABSTRAK	v
ACKNOWLEDGEMENTS	viii
APPROVAL	ix
DECLARATION	xi
LIST OF TABLES	xv
LIST OF FIGURES	xvi
LIST OF APPENDIXES	xvii
LIST OF ABBREVIATIONS	xviii
CHAPTER	
1 INTRODUCTION	1
2 LITERATURE REVIEW	
2.1 Human Musculoskeletal System	14
2.1.1 Human Skeleton	14
2.1.2 Skeletal Muscle	16
2.1.3 Musculoskeletal Disorders (MSD)	18
2.2 Prevalence of MSD among School Children	20
2.2.1 Prevalence of MSD: Perspective from International Studies	20
2.2.2 Prevalence of MSD: Perspective from Local and Regional Studies	22
2.3 Risk Factors of Non-Specific MSD among Children	23
2.3.1 Overall Risk Factors of MSD among School Children	23
2.3.2 Methods of Determine Risk Factors	26
2.4 Ergonomics in School	
2.4.1 Ergonomics Definition	27
2.4.2 Ergonomics Application in School	28
2.5 School Furniture Studies	31
2.5.1 Concept of Developing Ergonomics School Furniture	32
2.5.2 Developing Ergonomics Furniture: Malaysia Perspective	33
2.6 Anthropometry	35
2.6.1 Parameter for Anthropometrics Measurements	35
2.6.2 Anthropometrics Data of Western and Asian Children	37
2.6.3 Differences in Reported Anthropometrics Data	39
2.6.4 Method of Anthropometric Calculation from Normal Distribution	40
2.6.5 Estimation of Non Available Anthropometric Data using Ratio Scaling	45
2.6.6 Furniture Dimension	46
2.7 Rapid Upper Limb Assessment (RULA)	48
2.7.1 Real Time Observation of RULA: Calculation Method	50
2.7.2 RULA Modeling	53

3	METHODOLOGY	
3.1	Study Background	56
3.2	Study Location	56
3.3	Study Design	58
3.4	Sampling Size	58
3.5	Study Population	60
3.6	Sampling	
	3.6.1 Sampling Framework	61
	3.6.2 Sampling Unit	61
	3.6.3 Sampling Method	61
3.7	Methodology	66
3.8	Instrumentations	
	3.8.1 Questionnaire	69
	3.8.2 Ergonomics Assessment	72
	3.8.3 Body Dimension	77
	3.8.4 Furniture Parameter	81
	3.8.5 Furniture Development	82
	3.8.6 Evaluation of Furniture Performance	86
3.9	Quality Assurance	
	3.9.1 Questionnaire	89
	3.9.2 Anthropometrics Measurement	89
	3.9.3 Weighing Scale	90
3.10	Data Analysis	90
3.11	Ethics	92
4	NECK, SHOULDER, UPPER BACK & LOW BACK PAIN AND ASSOCIATED RISK FACTORS AMONG PRIMARY SCHOOL CHILDREN IN MALAYSIA: A PRELIMINARY RESULT	93
4.1	Abstract	94
4.2	Introduction	95
4.3	Material & Method	97
4.4	Result	101
	4.4.1 Socio-demographic Characteristic	101
	4.4.2 Sports & Physical Activities	103
	4.4.3 Load Carrying by School Children	103
	4.4.4 Prevalence of neck (NP), Shoulder (SP), Upper Back (UBP) and Low Back (LBP)	104
	4.4.5 Anthropometrics & Current School's Furniture Measurement	105
	4.4.6 Risk Factors of Upper MSD among the Year 5 children	106
4.5	Discussion	113
4.6	Conclusion	117
4.7	Acknowledgement	117
4.8	Acceptance Letter	118

5	DEVELOPMENT OF ERGONOMICS FURNITURE FOR PRIMARY SCHOOL IN MALAYSIA	119
5.1	Abstract	120
5.2	Introduction	121
5.3	Literature Review	122
5.4	Material & Method	124
5.4.1	Questionnaire	124
5.4.2	Risk Assessment	126
5.4.3	Anthropometrics Measurements	127
5.4.4	Furniture Design & Development	129
5.4.5	Quality Control & Data Analysis	131
5.5	Result	
5.5.1	Background Information	131
5.5.2	Prevalence of MSD	134
5.5.3	Risk Assessment	135
5.5.4	Risk Factors	137
5.5.5	Design Material based on Children Preferences	138
5.5.6	Furniture Dimensions	139
5.5.7	Furniture Development	140
5.6	Discussion	143
5.7	Conclusion	147
5.8	Acknowledgement	147
5.9	Acceptance Letter	148
6	SUMMARY, CONCLUSION AND RECOMMENDATION	
6.1	Summary	
6.1.1	Study Background	149
6.1.2	Socio-demography & Prevalence of MSD	150
6.1.3	MSD Risk Factors	152
6.1.4	Furniture Development	157
6.2	Study Limitation	159
6.3	Conclusion	160
6.4	Recommendation	166
	REFERENCES	168
	APPENDIX	176
	BIODATA	232
	LIST OF PUBLICATIONS	235