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

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Chair: Dr Shamsul Bahri Bin Hj Md Tamrin, PhD

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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 integrated 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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Mac 2010

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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 rikiso 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 sigifikan 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 perabut 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 ($X^2=8.278$, $p<0.05$, $R2=0.112$). 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 perabut. Hasil analisis keberkesanan perabut menunjukkan penurunan markah RULA dari 4 untuk perabut rekaan baru yang telah dicadangkan berbanding 2 untuk perabot sekarang ( bagi tahap 1 dan 2).

Kesimpulannya, kajian ini telah mencadangkan satu rekabentuk baru untuk perabut 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 voice 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).

Members of the Examination Committee were as follows:

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Date: 1 May 2010

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Master of Science. The members of the Supervisory Committee were as follows:

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Date: 16 August 2010

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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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NURUL ASYIQIN BT MOHD ALI

Date: 1st August 2010
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