



**UNIVERSITI PUTRA MALAYSIA**

***BIOMECHANICAL EFFECTS OF BACKPACKING WITH AND  
WITHOUT COUNTERBALANCED LOAD LEVEL WALKING ON A  
TREADMILL***

**HASSAN SAFIKHANI**

**FPP 2013 58**



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UNIVERSITI PUTRA MALAYSIA  
BERILMU BERBAKTI

**BIOMECHANICAL EFFECTS OF BACKPACKING WITH AND  
WITHOUT COUNTERBALANCED LOAD LEVEL WALKING ON A  
TREADMILL**

By

**HASSAN SAFIKHANI**

**Thesis Submitted to the School of Graduate Students, Universiti  
Putra Malaysia, in Fulfillment of Requirements for the Degree of  
Doctor of Philosophy**

**April 2013**

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## DEDICATION

I would like to dedicate my thesis to:

To my beloved wife Farzaneh and my cute son Pouya

To my parents



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfillment of the requirement for the degree of Doctor of Philosophy

**BIOMECHANICAL EFFECTS OF BACKPACKING WITH AND WITHOUT COUNTERBALANCED LOAD LEVEL WALKING ON A TREADMILL**

**By**

**HASSAN SAFIKHANI**

**April 2013**

**Chairperson: Tengku Fadilah Bt Tengku Kamalden, PhD**

**Faculty: Educational Studies**

Backpacks are used every day by students, young and old people to transport items from place to place, but as helpful as they are, if used improperly, they have also been implicated in causing injuries and back pain. When a backpack is overloaded, incorrectly worn, or improperly loaded it can cause a decrease in a person's performance. So the study intends to investigate the biomechanical effects of backpacking with and without counterbalanced load level walking on a treadmill. The participants of this study were twenty-six male students (Mean Age:  $22.41 \pm 1.75$  years). The walking protocol in this study was walking at 1.5 m/s speed under different conditions (unloaded walking, with normal, and counterbalance backpacks) on the treadmill. Trunk flexion angle, tibialis anterior and latissimus dorsi muscles activity, and ground reaction force, were measured during three conditions. To analyze the data for trunk forward lean angle and ground reaction force throughout a walking cycle with different conditions using a repeated measures ANOVA in SPSS. To analyze the data for tibialis anterior and latissimus dorsi muscles activity one way Analysis of Variance (ANOVA) was used. The results were shown that, there is significant difference among trunk flexion angle in six gait cycles: LR, MS, TS, PS, IS, and TSW, but there is no significant difference in MSW phase between walking with counterbalance backpack condition and unloaded walking. There is also no significant difference between walking with counterbalance backpack and unloaded walking on both muscles activity. There is significant difference among ground reaction force in IC, MS, and TS phases during unloading walking; walking with normal backpack and counterbalance backpack, but there is no significant difference among ground reaction force in LR phase between walking with counterbalance backpack condition and unloaded walking. Findings of this study clearly indicated that the advantage of a counterbalance backpack for carrying the loads.

The reduction of forward lean, muscles activity and ground reaction forces is a considerable ergonomic and kinematic benefit of carrying load in such backpacks. Notwithstanding carrying a load may still be considered the major cause of changes to walking patterns or increases in injury rates, the scientific testing of and development of future counterbalance studies can modify these risks. Using a counterbalance backpack may be one such method to reduce these risks.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN BIOMEKANIKAL BEG GALAS DENGAN MENGANGKUT BEBAN  
PENGIMBANG SEWAKTU BERJALAN DI PERMUKAAN RATA DI ATAS  
MESIN PENGINJAK ANJAKAN**

Oleh

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**Fakulti: Pengajian Pendidikan**

Beg gelas adalah digunakan oleh pelajar, warga muda dan tua setiap hari bagi mengangkut barang dari suatu tempat ke suatu tempat. Walaupun ia sangat berguna, namun jika ianya salah digunakan ia boleh menjadi punca kepada sakit belakang dan kecederaan kepada pembawanya. Apabila suatu beg gelas terlebih muatan, disalah pakai ataupun diisi dengan beban yang tidak betul, ia boleh menyebabkan penyusutan kepada kesihatan seseorang itu. Oleh itu, tujuan kajian ini adalah untuk mengkaji kesan biomekanik pengangkutan beban kepada seseorang apabila menggunakan dan tidak menggunakan beg pengimbang gelas sewaktu berjalan di atas permukaan rata pada mesin pengisar anjakan. Seramai dua puluh enam pelajar lelaki (Min Umur:  $22.41 \pm 1.75$  tahun) telah mengambil bahagian di dalam kajian ini. Kajian ini terbahagi kepada tiga fasa. Pada setiap hari ujian, selepas setiap orang melakukan senaman ringan, mereka telah melakukan satu cubaan pada waktu pagi untuk berjalan pada satu daripada tiga keadaan berikut (dengan mengangkut beg gelas, dengan mengangkut beg gelas biasa dan juga dengan mengangkut beg gelas pengimbang). Aktiviti Sudut Fleksi Tubuh, Anterior Tibialis, dan Dorsi Latissimus otot bersama dengan Dasar Daya Tindak Balas, diukur semasa melakukan tiga keadaan tersebut. Bagi menganalisa data untuk sudut tubuh condong ke depan dan dasar daya tindak balas sepanjang satu pusingan berjalan dalam keadaan yang berbeza adalah dengan menggunakan langkah-langkah yang berulang ANOVA dalam SPSS. Satu cara Analisis Bertentangan (ANOVA) telah diguna pakai ke atas aktiviti EMG pada anterior tibialis dan otot dorsi latissimus. Keputusannya telah menunjukkan bahawa terdapat perbezaan yang nyata antara sudut TFL di dalam enam fasa berjalan termasuk: LR, MS, TS, PS, IS TSW. Namun begitu, tiada perbezaan yang ketara dapat dilihat pada MSW fasa berjalan di antara keadaan berjalan dengan beban dan berjalan dengan mengangkut beg gelas pengimbang. Malahan, terdapat tiada perbezaan penting di antara berjalan tanpa beban, berjalan seperti biasa dan juga dengan mengangkut beg gelas pengimbang sewaktu berjalan di atas permukaan rata pada aktiviti otot TA dan LD. Akan tetapi, terdapat

perbezaan ketara di kalangan GRF pada fasa-fasa IC, MS dan TS semasa berjalan tanpa beban, berjalan seperti biasa dan dengan mengangkut beg galas pengimbang di atas permukaan rata, tetapi tiada perbezaan ketara di antara GRF pada fasa berjalan LR di antara keadaan berjalan tanpa beban dan berjalan dengan mengangkut beg galas pengimbang. Penemuan daripada kajian ini secara jelasnya telah menunjukkan kelebihan menggunakan pengimbang galas bagi mengangkut beban. Mengurangkan condong ke depan, aktiviti otot dan dasar daya tindak balas adalah suatu kelebihan besar kepada kinematik dan ergonomik pengangkutan beban bagi beg galas tersebut. Namun tidak dilupakan bahawa mengangkut suatu beban masih lagi dianggap sebagai punca utama kepada perubahan pola gaya berjalan ataupun peningkatan kadar kecederaan seseorang. Walau bagaimanapun, ujian saintifik dan perkembangan kajian pengimbang galas di masa hadapan mampu mengubah risiko tersebut. Oleh itu, penggunaan beg galas pengimbang merupakan suatu cara bagi mengurangkan risiko tersebut.



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Finally, I would like to thank all my participants who volunteered their time to help me accomplish this thesis.

I certify that a Thesis Examination Committee has met on 5 April 2013 to conduct the final examination of Hassan Safikhani on his thesis entitle "Biomechanical effects of backpacking with and without counterbalanced load level walking on a treadmill" in accordance with the Universities and University College Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A)106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

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## DECLARATION

### Declaration by graduate student

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