ROLE OF LENGTH SPECIFICITY, VELOCITY SPECIFICITY AND NEURAL ADAPTATIONS IN STRENGTH TRAINING

By

AHMAD NAIM ISMAIL

Thesis submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

March 2012

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

ROLE OF LENGTH SPECIFICITY, VELOCITY SPECIFICITY AND NEURAL ADAPTATIONS IN STRENGTH TRAINING

By

AHMAD NAIM ISMAIL

March 2012

Chair: Tengku Fadilah Tengku Kamalden, PhD

Faculty: Faculty of Educational Studies

A very common finding among many training studies is that the increase in weight-lifting strength is greater than the increase seen in isometric strength. Most are in view that this is the result of training and testing specificity. However the exact underlying mechanism that is responsible for the discrepancy has yet to be explained. The three studies of this thesis examine the explanation behind the discrepancy between the increases seen in weight-lifting strength compared to isometric strength after resistance training.

The first study was to look into the role of learning. Thirty two students completed the training. The subjects underwent four weeks of unilateral leg extension training, three times per week,three sets of eight lifts. One leg was chosen arbitrarily for the training. The contralateral leg, which was not trained, acted as a control. Subjects performed at a steady pace. The result showed that the lesser experienced subjects showed a significant

improvement in training weights lifted which illustrated that weight-lifting is very much a skill based task.

The second study was to look into length specificity and velocity specificity. Eighteen subjects completed the study. Subjects completed eight weeks of leg extension training, three times per week,four sets of six to eight lifts. One leg was arbitrarily assigned to perform the dynamic training. Isometric strength measured in the strength-testing chair. Measurements of isometric strength at 15° intervals from 60° to 105° of knee flexion using isokinetic dynamometer. Isokinetic strength testing was also measured at velocities of 45° s^{-1}, 180° s^{-1} and 300° s^{-1}. A non-significant 6% increase of isometric maximum voluntary contraction (MVC) at 90° was found and between 13% and 19% .Increases of isometric torque were found at all angles measured. The training resulted in increases in the isokinetic torque at all velocities for the trained leg. The result has shown no evidence to any length or velocity specific adaptations.

The third study was to look into whether there is any increase in neural activity during dynamic contractions in explaining the discrepancy between the increase in training weights and MVC. Seven male subjects participated in this study. Subjects were trained three times per week for four weeks, 80 - 85% of 1RM for three sets. One leg was chosen randomly. Subjects performed dynamic leg extension on a leg extension machine. The electromyogram (EMG) activity of *vastus lateralis* and *biceps femoris* was recorded for the training and control leg during all testing. There were no significant differences in terms of MVC force produced between the training chair and

the strength testing chair. The EMG data showed there was no significant change in the EMG activity of the *vastus lateralis* of the trained leg after training. There was a reduction in EMG activity of the hamstring during the 1 RM post training but was not significant. The results of the study have shown that there is no increase in neural activity which would explain the difference between the increase in training weights and MVC. Nor were there any significant changes in co-activation of the hamstring.

The discrepancy seen in the large increase in the weight lifting strength as compared to isometric strength cannot be accounted for by the angle specificity and velocity specificity factors. There is also no increase in neural activity which would explain the difference between the increase in training weights and MVC. Nor were there any significant changes in co-activation of the hamstring, consequently the discrepancy remains unexplained.

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

PERANAN SPESIFISITI PANJANG, SPESIFISITI HALAJU DAN ADAPTASI NEURAL DALAM LATIHAN KEKUATAN

Oleh

AHMAD NAIM ISMAIL

Mac 2012

Pengerusi: Tengku Fadilah Tengku Kamalden, PhD

Fakulti: Fakulti Pengajian Pendidikan

Kebanyakan dapatan daripada kajian mengenai latihan kekuatan mendapati bahawa peningkatan kekuatan (selepas latihan kekuatan) untuk mengangkat bebanan adalah melebihi kekuatan isometrik. Di antara alasan yang dikemukakan ialah kerana spesifisiti latihan dan ujian. Tetapi, dari segi mekanisme yang sebenarnya terlibat masih belum diketahui dengan jelas. Tiga kajian dalam tesis ini meneliti penjelasan di sebalik percanggahan di antara peningkatan yang dilihat dalam kekuatan mengangkat bebanan berbanding kekuatan isometrik selepas latihan kekuatan.

Kajian pertama adalah untuk mengkaji peranan pembelajaran. Seramai 32 subjek menamatkan latihan setelah menjalani 4 minggu latihan ekstensi kaki unilateral, tiga kali seminggu, tiga set lapan ulangan. Sebelah kaki telah dipilih secara rawak untuk latihan. Kaki kontralateral, yang tidak terlatih, bertindak sebagai kawalan. Hasil kajian

menunjukkan bahawa subjek yang kurang berpengalaman mempamerkan peningkatan yang signifikan dalam mengangkat bebanan. Ini menunjukkan bahawa latihan kekuatan (angkat bebanan) adalah satu kemahiran yang tersendiri.

Kajian kedua adalah untuk melihat spesifisiti sudut-panjang dan spesifisiti halaju. Seramai 18 subjek terlibat dalam kajian ini. Subjek menyelesaikan lapan minggu latihan ekstensi kaki, tiga kali seminggu, empat set 6-8 ulangan. Satu kaki secara rawak ditugaskan untuk melaksanakan latihan. Kekuatan isometrik diukur di kerusi ujian kekuatan isometrik. Pengukuran kekuatan isometrik pada 15° 60° hingga 105° fleksi lutut juga diukur menggunakan dinamometer isokinetik. Ujian kekuatan isokinetik juga diukur pada halaju 45° $^{s-1}$, 180° $^{s-1}$ dan 300° $^{s-1}$. Satu peningkatan kekuatan isometrik didapati sebanyak 6% tetapi tidak signifikan pada 90° dan peningkatan di antara 13% dan 19% didapati pada semua sudut yang diukur menggunakan dinamometer isokinetik. Latihan menyebabkan peningkatan tork isokinetik pada semua halaju untuk kaki terlatih. Hasil kajian menunjukkan tiada bukti adaptasi spesifisiti sudut-panjang atau spesifisiti halaju berlaku.

Kajian terakhir meninjau sama ada terdapat sebarang peningkatan dalam aktiviti neural semasa kontraksi dinamik dalam menjelaskan percanggahan di antara peningkatan dalam berat latihan dan peningkatan kekuatan isometrik. Tujuh subjek lelaki mengambil bahagian dalam kajian ini. Subjek telah dilatih tiga kali seminggu selama empat minggu, 80 - 85% daripada 1RM sebanyak tiga set. Subjek melakukan ekstensi kaki dinamik menggunakan mesin extensi kaki. Aktiviti electromyogram (EMG) *vastus*

lateralis dan *biseps femoris* dicatatkan bagi kaki latihan dan kawalan dalam semua ujian. Terdapat tiada perbezaan yang signifikan dihasilkan antara kerusi latihan dan kerusi ujian kekuatan. Data EMG menunjukkan tiada perubahan signifikan dalam aktiviti EMG bagi *vastus lateralis* selepas latihan. Terdapat pengurangan dalam aktiviti EMG *biseps femoris* selepas latihan tetapi tidak signifikan. Kajian terakhir tesis ini menunjukkan dengan jelas bahawa tiada sebarang peningkatan aktiviti neural yang boleh menjelaskan perbezaan di antara peningkatan mengangkat bebanan dengan peningkatan kekuatan isometrik selepas sesuatu latihan dijalankan. Didapati juga bahawa tidak terdapat perubahan yang signifikan bagi koaktivasi otot *hamstring*. Dengan itu penjelasan tentang mengapa terdapat perbezaan yang ketara itu masih tidak dapat dijelaskan oleh kajian dalam tesis ini.