

RINGKASAN

**Pengaruh Latihan Renang Intensitas Ringan Dan Berat
terhadap Panjang Tulang, Tinggi, dan Jumlah
Sel Kondrosit Lempeng Epifise Tibia
Tikus Putih Jantan Usia Pertumbuhan**

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Pertumbuhan memanjang tulang terjadi pada lempeng epifise tulang panjang dan ditentukan oleh aktivitas kondrosit didalamnya. Pada tempat tersebut, kartilago dibentuk melalui proliferasi dan hipertrofi kondrosit serta sintesis matriks ekstraseluler, sehingga pertumbuhan memanjang tulang dan dalam hal ini tinggi tubuh, merupakan hasil dari proliferasi dan hipertrofi kondrosit pada lempeng epifise.

Aktivitas lempeng pertumbuhan dikendalikan oleh beberapa faktor diantaranya yaitu genetik, endokrin, parakrin atau autokrin. Beberapa hormon berperan penting untuk pertumbuhan memanjang tulang yang normal, namun telah diketahui secara umum bahwa *Growth Hormone* (GH) merupakan hormon utama dalam hal ini. Sekresi *Growth Hormone* dipengaruhi oleh banyak faktor dan latihan fisik dengan intensitas yang tepat

Penelitian ini bertujuan untuk mengetahui pengaruh perbedaan intensitas renang terhadap panjang tulang, jumlah dan tinggi sel kondrosit lempeng epifise, serta hubungan antara intensitas renang dengan peningkatan panjang tulang. Studi ini menggunakan desain *separate sample pretest-posttest control group* yang terdiri dari 28 ekor tikus putih jantan, umur 3 minggu. Hewan coba secara acak dibagi menjadi 4 kelompok yaitu 2 kelompok perlakuan, 1 kelompok kontrol *pretest*, dan 1 kelompok kontrol *posttest*. Kelompok perlakuan pertama adalah kelompok renang intensitas rendah dengan beban 3% BB, dan kelompok perlakuan kedua adalah kelompok renang intensitas berat dengan beban 9% BB. Latihan diberikan tiga kali seminggu selama 6 minggu.

Pengamatan secara histomorfometri dilakukan pada tulang tibia setelah dibersihkan, difiksasi, didekalsifikasi, direndam dalam paraffin, dipotong sejajar dengan sumbu panjang tulang setipis 6 μ , dan dicat dengan Haematoxylin-Eosin. Panjang tulang diukur menggunakan caliper sedangkan jumlah dan tinggi sel diukur berdasarkan foto menggunakan kamera digital yang dipasang pada mikroskop cahaya dengan pembesaran 400 kali, dan dianalisa dengan program *Adobe photoshop 7.0*. Data dianalisa menggunakan analisa *multivariate analysis of variance* (MANOVA) dengan tingkat kepercayaan 95%.

Hasil pengamatan menunjukkan bahwa renang intensitas ringan dan berat meningkatkan panjang tulang, jumlah dan tinggi sel kondrosit lempeng epifise pada kelompok perlakuan dibandingkan kelompok kontrol *posttest*, namun peningkatan lebih tinggi terjadi pada kelompok renang intensitas berat. Panjang tulang pada intensitas ringan 31,91 \pm 1,32 mm, intensitas berat 35,02 \pm 0,96 mm, sedangkan kontrol *posttest* 30,17 \pm 0,99 mm. Tinggi kondrosit pada intensitas ringan 70,14 \pm 2,21 μ m, intensitas berat 81,22 \pm 1,88 μ m, dan kontrol *posttest* 57,02 \pm 0,95 μ m. Jumlah kondrosit pada intensitas ringan 9,41 \pm 0,34 sel/10⁴ μ m², intensitas berat 10,67 \pm 0,32 sel/10⁴, dan pada kontrol *posttest* 8,39 \pm 0,24 cells/10⁴ μ m².

Analisa lebih lanjut dengan Manova menunjukkan perbedaan yang bermakna pada panjang tulang, jumlah dan tinggi sel kondrosit diantara kelompok perlakuan. Hasil uji diskriminan mengungkapkan bahwa tinggi dan jumlah kondrosit memberikan kontribusi yang bermakna terhadap perbedaan tersebut. Uji korelasi membuktikan bahwa terdapat korelasi positif antara jumlah dan tinggi sel kondrosit dengan panjang tulang, dan antara intensitas latihan renang dengan panjang tulang.

Penelitian ini telah membuktikan bahwa latihan renang dengan intensitas yang tepat dapat meningkatkan panjang tulang, jumlah dan tinggi sel kondrosit lempeng epifise tibia, dan terdapat korelasi positif antara jumlah dan tinggi sel kondrosit dengan panjang tulang, serta antara intensitas latihan renang dengan panjang tulang.



SUMMARY

The Effect of Low and High Swimming Intensity on Bone Length, Cell Height and Cell Numbers of Tibial Epiphyseal Plate Chondrocytes in Male White Rats during Growth Period

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Longitudinal bone growth occurs at the epiphyseal plate of the long bone and chondrocyte activities within growth plate cartilage are the principal determinant of it. At this site, cartilage is formed by the proliferation and hypertrophy of chondrocytes and synthesis of the extracellular matrix, so longitudinal bone growth, and hence stature, are functions of epiphyseal plate chondrocyte proliferation and hypertrophy.

The growth plate activity is in turn subject to regulation by a number of factors, which might be of genetic, endocrine, paracrine, or autocrine origin. Several hormones are important for normal longitudinal bone growth, but it is generally accepted that *Growth Hormone* (GH) is the most important hormone in this respect. *Growth Hormone* secretion can be altered by many factors and exercise in appropriate intensity has long been recognized as a potent physiological stimulus of GH secretion.

This research was conducted to evaluate the effects of different intensity of swimming on bone length, cell numbers, and cell height of tibial epiphyseal plate chondrocytes, and the correlations between chondrocyte numbers and height with bone length, and between the intensity of swimming and bone length. This study used separate sample pretest-posttest control group design, consisting of 28 males white rats, 3 weeks old. They were randomly divided into 4 groups which is 2 groups of treatment, 1 control pretest group and 1 control posttest group. The 1st treatment was low swimming intensity group loaded with weight 3% of body weight, and the 2nd treatment was high swimming intensity group loaded with weight 9% of body weight. Training was given three times a week for 6 weeks.

Histomorphometric study was taken on tibial bone after dissected, fixed, decalcified, embedded in paraffin, cut parallel with bone longitudinal axis into 6 μ sections, and stained with Haematoxylin-Eosin. Bone length was measured using a caliper while cell numbers and height were measured through photomicrographs sections using digital camera-light microscope, taken at 400 x magnification, and analyzed with software *Adobe photoshop 7.0*. Data were analyzed using multivariate analysis of variance (Manova) with significance level of 95%.

The results showed that low and high swimming intensity increased bone length, cell numbers, and cell height of tibial epiphyseal plate chondrocytes in treatment group, compared to posttest control group. However, high swimming intensity exhibited more bone length, cell height and cell numbers compared with low intensity. Bone length in low intensity was $31,91 \pm 1,32$ mm, in high intensity was $35,02 \pm 0,96$ mm, and in posttest control group was $30,17 \pm 0,99$ mm. Chondrocyte height in low intensity was $70,14 \pm 2,21$ μ m, in high intensity was $81,22 \pm 1,88$ μ m, and in posttest control group was $57,02 \pm 0,95$ μ m. Chondrocyte numbers in low intensity was $9,41 \pm 0,34$ cells/ 10^4 μ m², in high intensity was $10,67 \pm 0,32$ cells/ 10^4 μ m², while in posttest control group was $8,39 \pm 0,24$ cells/ 10^4 μ m².

Further analysis using Manova showed that there were significant differences in bone length, cell numbers, and cell height among the treatments. The discriminant test revealed that chondrocyte height and numbers given a significant contribution in making differences between the two groups. The correlation test had proved that there was a positive correlation between cell numbers and cell height with bone length, and between the intensity of swimming and bone length.

This study had proved that swimming in appropriate intensity might increased bone length, cell numbers, and cell height of tibial epiphyseal plate chondrocytes. Indeed, there was a positive correlation between chondrocyte numbers and height with bone length, and between the intensity of swimming and bone length.



ABSTRACT

The Effect of Low and High Swimming Intensity on Skeletal Length, Cell Height and Cell Numbers of Tibial Epiphyseal Plate Chondrocytes in Male White Rats during Growth Period

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Longitudinal bone growth, which is represented by bone length, chondrocyte height and its numbers is influenced by several factors and one of them is exercise. This study was conducted to evaluate the effects of low and high intensity swimming exercise on skeletal length, cell height, and cell numbers of tibial epiphyseal plate chondrocytes. This study used separate sample pretest-posttest control group design, consisting of 28 males white rats, 3 weeks old. They were randomly divided into 4 groups which is 2 groups of treatment, 1 control pretest group and 1 control posttest group. The 1st treatment was low intensity group, loaded with weight 3% of body weight, and the 2nd treatment was high intensity group, loaded with weight 9% of body weight. Treatments were given three times a week for 6 weeks.

Histomorphometric study was taken on tibial bone after dissected and stained with Haematoxylin-Eosin. Bone length was measured using a caliper while cell numbers and cell height were measured through photomicrographs sections using digital camera-light microscope, taken at 400 x magnification, and analyzed with software *Adobe photoshop 7.0*.

The results showed that low and high swimming intensity increased bone length, cell numbers, and cell height of tibial epiphyseal plate chondrocytes in treatment group, compared to posttest control group. Further analysis using Manova showed that there was a significant difference among independent variables between low and high swimming intensity groups. The correlation test proved that there was a positive correlation between cell numbers and cell height with bone length, and between the intensity of swimming and bone length.

This study had proved that swimming in appropriate intensity might increase bone length, chondrocyte numbers, and chondrocyte height of tibial epiphyseal plate. Indeed, there was a positive correlation between chondrocyte numbers and height with bone length, and between the intensity of swimming and bone length.

Keyword : *Swimming intensity, bone length, epiphyseal plate chondrocytes*