

High-Calorie Diet Reduces Neuroglia Count

by Lilik Herawati

Submission date: 27-Jul-2020 05:00PM (UTC+0800)

Submission ID: 1362760275

File name: Bukti_C.28.pdf (1.54M)

Word count: 15571

Character count: 87467

SIPS | SURABAYA 2017 | INTERNATIONAL PHYSIOLOGY SEMINAR

30

PROCEEDINGS OF THE SURABAYA INTERNATIONAL PHYSIOLOGY SEMINAR

Surabaya, October 12-14, 2017

Editors:

Soetjipto
Muhammad Miftahussurur
Ferry Efendi
Purwo Sri Rejeki
Bambang Purwanto



72

SIPS 2017

Proceedings of the
Surabaya International Physiology Seminar

Surabaya - Indonesia

October 12 - 14, 2017

Edited by Soetjipto, Muhammad Miftahussurrur, Ferry Efendi, Purwo Sri Rejeki and Bambang Purwanto

Printed in Portugal
ISSN: 2184-3678
ISBN: 978-989-758-340-7
Depósito Legal: 446682/18

<http://sipsfk.conference.unair.ac.id>
sipsiafi2017@gmail.com

BRIEF CONTENTS

INVITED SPEAKERS	IV
ORGANIZING COMMITTEES	V
FOREWORD	VII
CONTENTS	XI

INVITED SPEAKERS

Cheng Hwee Ming
University of Malaya
Malaysia

Daniel John Green
University of Western Australia
Australia

Fadzil Hamzah
Sport Center of Changi General Hospital
Singapore

Deanne Helena Skelly
Griffith University
Australia

ORGANIZING COMMITTEES

SCIENTIFIC COMMITTEE

71

Cheng Hwee Ming, Department of Physiology, Faculty of Medicine, University of Malaya, Malaysia

Daniel John Green, University of Western Australia, Australia

Fadzil Hamzah, Changi Sports Medicine Centre, Changi General Hospital, Singapore

Deanne Helena Skelly, University of Western Australia, Australia

R. Soedarso Djojonegoro, Universitas Airlangga, Indonesia

Paulus Liben, Universitas Airlangga, Indonesia

Elyana Asnar STP, Universitas Airlangga, Indonesia

Choesnan Effendi, Universitas Airlangga, Indonesia

Harlina, Universitas Airlangga, Indonesia

Tjitra Wardani, Universitas Airlangga, Indonesia

Gadis Meinar Sari, Universitas Airlangga, Indonesia

Purwo Sri Rejeki, Universitas Airlangga, Indonesia

Lilik Herawati, Universitas Airlangga, Indonesia

Bambang Purwanto, Universitas Airlangga, Indonesia

Kristanti Wanito Wigati, Universitas Airlangga, Indonesia

Hayuris Kinandita Setiawan, Universitas Airlangga, Indonesia

Irfiansyah Irwadi, Universitas Airlangga, Indonesia

Sundari Indah Wiyasihati, Universitas Airlangga, Indonesia

Eka Arum Cahyaning Putri, Universitas Airlangga, Indonesia

Misbakhul Munir, Universitas Airlangga, Indonesia

FOREWORD

Dean of Faculty of Medicine, Universitas Airlangga

Assalamu'alaikum Wr. Wb.

Distinguished Guests, all the Participants, Ladies and Gentlemen

On behalf of Faculty of Medicine, Universitas Airlangga, it is my great pleasure to welcome all the speakers, moderators, and participants on **Surabaya International Physiology Seminar 2017 (SIPS 2017)**, which will be held from today, October 12th until October 14th, 2017. I would like to express my hearty welcome to all the international speakers, **Prof. Cheng Hwee Ming**, from University of Malaya, Malaysia; **Prof. Daniel John Green**, from University of Western Australia; **Dr. Fadzil Hamzah**, from Sport Center of Changi General Hospital, Singapore and **Dr. Deanne Helena Skelly**, from Griffith University, Australia.

The aim of SIPS 2017 is to provide a platform for academicians, educators, researchers, practitioners, undergraduate and postgraduate students to share and discuss the knowledge of the recent issues, opinions, researchers about the development and innovation of physiology in medical science, dentistry, veterinary, plants and agriculture, sports and sciences.

I believe this event is a great purpose in order to develop knowledge, experiences and best practices that can be applied for the good, especially in the field of healthcare as a whole.

Finally, I would like to express my sincere acknowledgements to those who take part and especially for Department of Medical Physiology, Faculty of Medicine, Universitas Airlangga for their effort in holding this event and wishing all to have success.

Wassalamu'alaikum Wr. Wb.

Prof. Dr. Soetojo, MD.

Faculty of Medicine, Universitas Airlangga

Chair of Committee / Head of Physiology Department, Faculty of Medicine, Universitas Airlangga

Assalamu 'alaikum Wr. Wb

Greetings,

On behalf of SIPS committee and Physiology Department, Universitas Airlangga, we are welcoming to Surabaya, City of Heroes.

This year, the annual meeting of Indonesian Physiology Society (IAIFI) is hosted at Surabaya, entitled **"Surabaya International Physiology Seminar Workshop (SIPS)"**. We present some update workshop and lectures in order to bring physiology research from basic to clinical application on humanities, animal welfare and good environment. All participants have opportunities to publish their research in presentation, poster and ISBN proceeding. Selected papers will be submitted to SCOPUS indexed proceeding/ journal and awarded as Best Poster and Best Oral Presentation.

We hope that all participants will get some interesting experiences for next 3 days, 12-14 October 2017. Enjoy our lectures and workshops, taste the culinary and take your time to sightseeing around Surabaya.

Wassalamu 'alaikum wr. wb.

Dr. Bambang Purwanto

83

Chairman of Committee / Head of Physiology Department
Faculty of Medicine, Universitas Airlangga

Welcome Address - Surabaya International Physiology Seminar Workshop (SIPS)

Dear fellow Physiologists and Participants,

On Behalf of the Indonesian Physiological Society (IAIFI) and the Physiology Department Faculty of Medicine Universitas Airlangga, I would like to welcome you all to Surabaya International Physiology Seminar (SIPS), held on 12-14 of October 2017.

Finally after long-awaited Surabaya gets a turn again to host and organize the International Physiology Seminar. Hence the Steering- and Organizing Committee consisting of young energetic physiologists are determined to make the Seminar a successful one. The theme of the seminar is:

"The Role of Physiology in Translation Research: From Basic to Application"

This annual meeting covers a wide range of topics of Physiology on Medicine, Dentistry, Veterinary, Plants and Agriculture, Sports and Sciences. We sincerely hope that SIPS 2017 enable to provide a platform for academicians, educators, researchers, practitioners and postgraduate students to present and discuss researches, development and innovations in wide range of topics as mentioned above. It will provide all participants to share knowledge, exchange new ideas and their experiences in many research topics, for then it will enhance future collaborations.

With great interest and enthusiasm I look towards the success of this Seminar, and wish all of you every success and a pleasant stay in Surabaya.

May Allah Swt. bestow upon us His Blessings.

On Behalf of the Steering and Organizing Committee Senior Physiologist,
Prof. R. Soedarso Djojonegoro

CONTENTS

PAPERS

FULL PAPERS

- The Dominant Personality Type in Vertigo Patients 5
Nanda Rizky FS, Netty Herawati, Nyilo Purnami, Nining Febriyana and Abdurachman
- The Role of Osteocytes in Alveolar Bone During Tooth Movement 10
Agni Febrina Pargaputril and Noengki Prameswari
- Body Movement and Islamic Energy Psychology Acupressure to Improve the Future Orientation In A Person With HIV 15
Ambar Sulianti and Fenti Hikmawati
- White Matter Changes in Neurodegenerative and Global Cortical Atrophy Scale Correlation in Older Patients Using Magnetic Resonance Imaging 21
Anggraini Dwi Sensusiati
- 8
The Influence of Mass Basic Life Support Training on The Skills and Attitude in Undertaking Life Support Using the Method of the Faculty of Medicine, Universitas Airlangga 26
Arie Utariani, Teguh Sylvaranto, April Poerwanto Basoeki, Prananda Surya Airlangga, Windy Ari Wijaya, Soni Sunarso Sulistiawan, Bambang Pujo Semedi, Christrijogo Sumartono, Hamzah, Kohar Hari Santoso, Philia Setiawan and Eddy Rahardjo
- Reflections of a Physiology Teacher 30
Cheng Hwee Ming
- 18
Does Sequential Diabetes Dance Improve on Glucose Level and Glucose Tolerance? 33
Cynthia Wahyu Asrizal and Bambang Purwanto
- Antioxidant Effect of Dayak Onion Extract (*Eleutherine Americana* Merr.) on Serum MDA Levels in Mice (*Mus Musculus*) Exposed by Lead Acetate 37
Daeng Agus Vieya Putri, Gadis Meinar Sari and Tjitra Wardani
- Exercise as Cardiovascular Medicine: Early Detection and Optimal Prevention 40
Danny Green and Raden Argarini
- The Effect of Circadian Rhythm on Hematopoietic Stem Cell Mobilization in Peripheral Blood as a Result of Submaximal Physical Exercise 48
Dhoni Akbar Ghozali, Harjanto and Agung Dwi Wahyu Widodo
- 51
The Effect of Intermitten Fasting Vs Low Calorie Diet to Insuline Like Growth Factor-1 (IGF-1) Concentration, Fat Mass and Lean Mass of *Rattus Norvegicus* Obesity Model 53
Dian Wijayanti, Sunarjati Sudigdo Adi, Achadiyani, Gaga Irawan Nugraha, Reni Farenia and Adi Santosa Maliki
- Uphill 10° Inclination Angle of Treadmill Concentric Exercises Improves Blood Glucose Levels and Glut-4 Levels in Diabetes Mice Model 56
Dini Surya Noviyanti, Bambang Purwanto and Choesnan Effendi

Variability in The Response to Low Impact Aerobic Exercise in Women Abdominal Obese With the Polymorphism of Uncoupling Protein-1 Gene <i>D Mukhtar, Siagian M, N Ibrahim, Neng Tine, T Ahmad, M Suryaatmadja, SW Jusman, AS Sofro, M Abdullah, S Waspadji and S Sugondo</i>	62
The Effect of an Aluminium Foil Shield on Reducing The Strength of Electromagnetic Radiation of Mobile Phones Reaching the Oculi of Adult Male Rats <i>Dion K. Dharmawan, Viskasari P. Kalanjati and Abdurachman</i>	67
The Effect of Osteocyte Signalling on Osteocyte Apoptosis <i>Dwi Setiani Sumardiko, Purwo Sri Rejeki and Gadis Meinar Sari</i>	72
Intermittent Physical Training Decreases Peak of Blood Glucose Level after Meals in Rats <i>Eka Arum Cahyaning Putri, Raden Argarini, Bambang Purwanto and Lilik Herawati</i>	76
The Effect of Cantaloupe Extract on Sperm Quality of Adult White Rats (<i>Rattus Novergicus</i>) Strain Induced by Ciproteron Acetat <i>Elyna Mahruzza Putri, Achadiyahani, Sunarjati, Sudigdoadi, Oki Suwarsa and Adi Santosa Maliki</i>	80
Correlation Between Academic Stress, Sleep Quality, Circadian Misalignment, Cortisol Concentration and Heart Rate Value at the First Year Medical Student at the State Islamic University Maulana Malik Ibrahim of Malang <i>Ermin Rachmawati, Muhammad Farid Wafi and Ira Resmi Melani</i>	84
PIGF as Predictor of Preeclampsia Complication <i>Ernawati E, Manggala PS, Khanisyah Erza, Rozi Aditya, Cininta M, MI Aldika Akbar, Budi Wicaksono, Agus Sulistyono, Hermanto TJ, Nadir Abdulah, Erry Gumilar and Adityawarman A</i>	91
Aluminum Foil Shield Diminishes the Electromagnetic Radiation of Mobile Phones in the Cerebellum of Adult Male Rats <i>Etha Rambung, Viskasari P. Kalanjati and Abdurachman</i>	97
Sauropus Androgynus for Increasing Uterine Weight in Menopausal Women: An Experimental Study Using Animal Models <i>Exma Mu'tatal Hikmah and Retno Susilowati</i>	101
Exercise And Swimming in Pregnancy - Physiological Considerations <i>Fadzil Hamzah</i>	106
The Comparison Effect Between Bodyweight and Sprint Interval Exercises Using Tabata Method Towards Heart Rate Frequency, Lactate Blood and Physical Fatigue Perception <i>Fengki Aditiansyah, Elyana Asnar and Choesnan Effendi</i>	112
Detection of COMT ^{Val158Met} Gene Polymorphism in Chronic Schizophrenic Patients at Psychiatric Unit of DR. Soetomo Hospital Surabaya, East Java, Indonesia <i>Gwenny Ichan Prabowo, Margarita Maria Maramis, Erikavitri Yulianti, Afrina Zulaikah, Zain Budi Syulthoni, Citrawati Dyah Kencono Wungu, Hendy Muagiri Margono and Retno Handajani</i>	117
Hyperbaric Oxygen (HBO) Heals Cell Through Reactive Oxygen Species (ROS) <i>Handi Suyono and Gurimo Suryokusumo</i>	123
Correlation of Fat Free Mass and Skeletal Muscle Mass with Left Ventricular Mass in Indonesian Elite Wrestlers and Dragon Boat Rowers <i>Henny Tantonno, Mohammad Rizki Akbar, Badai B. Tiksnadi, Triwedya Indra Dewi, Sylvie Sakasmita, Maryam Jamilah, Daniel Womsiwor, Ambrosius Purba, Augustine Purnomowati and Toni Mustahsani Aprami</i>	128

Decrease of Homocysteine Plasma Degree in Smokers by Low Intensity Weight Training and Supplementation of Folic Acid and Cyanocobalamin <i>HS Muhammad Nurfatony, Damayanti Tinduh and Tjitra Wardhani</i>	133
The Role of Physiology in Ergonomics - Empowerment Human Resources for Nations Competitiveness <i>I Putu Gede Adiatmika</i>	137
¹⁸ Influence of Use of Insole on Blood Glucose Rate Diabetes Mellitus Type-2 <i>Ignatius Heri Dwianto, Bambang Purwanto and Sony Wibisono</i>	143
The Profile of Endothelin-1 (Et-1), Receptor ET _A , And Receptor ET _B in Young and Adult Obese Wistar Rat <i>Irfan Idris, Aryadi Arsyad, A. Wardihan Sinrang and Syarifuddin Alwi</i>	147
Characteristics of Glucose Tolerance, Energy Expenditure, Lactic Acid Level, and Oxygen Saturation in Indonesian Diabetes Dance Version 6 <i>Irfiansyah Irwadi and Bambang Purwanto</i>	151
The Effect of Aluminium Foil Shielding in Hampering Electromagnetic Radiation Emitted from A Mobile Phone as an Oxidative Stressor in The Cerebra of Adult Male Rats <i>Irmawan Farindra, Viskasari P. Kalanjati and Ni Wajan Tirthaningsih</i>	154
Effect of Exercise on Learning Capability and Memory of Mice (Mus Musculus) Exposed to Monosodium Glutamate (MSG) <i>Husnur Rofiqoh, Kristanti Wanito Wigati and Suhartati</i>	159
Low, Moderate, and High Intensity Swimming Exercise Has No Negative Effect on Semen Analysis Test in Male Wistar Rats <i>Kristanti Wanito Wigati, Sundari Indah Wiyasihati and Misbakhul Munir</i>	165
High-Calorie Diet Reduces Neuroglia Count <i>Nilam Anggraeni, Kristanti Wanito Wigati, I Lukitra Wardani and Lilik Herawati</i>	169
⁵⁷ Three Weeks of High-Intensity Interval Training (HIIT) Decreases Visfatin Level on Overweight Men <i>Amal A. Hidayat, Mohammad Budiarto and Lilik Herawati</i>	174
VO ₂ MAX of Ergocycle Astrand Test Differs from 12-Minutes Cooper Running Test on Medical Students' Physical Fitness Level <i>Bella Anggi Afisha, Atika and Lilik Herawati</i>	178
⁹ Non-Invasive Method on Slow-Twitch Quadriceps Muscle Fibers Dominate a High Level of Fitness <i>Yuannita Ika Putri, Andre Triadi Desnanyo and Lilik Herawati</i>	182
Genotype Hepatitis B Virus Among Intravenous Drug Users with Occult Hepatitis B Infection in Surabaya, Indonesia <i>Lina Lukitasari, Lilik Herawati, Edhi Rianto, Indri Safitri, Retno Handajani and Soetjpto</i>	186
Anopheles Vagus Larval Midgut Damage as an Effect of Areca Catechu L. Seed Extract <i>Majematang Mading, Yeni Puji Lestari, Etik Ainun Rohmah, Budi Utomo, Heny Arwati and Subagyo Yotopranoto</i>	192
The Effect of Mozart's Music on Mus Musculus Balb/C Spermatozoa's Quantity and Motility Exposed by Lead Acetate <i>Maria Selviana Joni, Paulus Liben and Hermanto Tri Joewono</i>	198

The Lactid Acid's Decrease After Submaximal Exercise Due to Zamzam Water Treatment Compared the Packed Water <i>Moh. Tomy Yusep, Elyana Asnar STP and Harlina</i>	201
The Correlation of Lung Vital Capacity, VO ₂ Max, and Heart Rate Recovery With Changes in Blood Lactate Levels in Young Male: Cross Sectional Study in Provoked By Repeated Sprint Sessional-3 <i>Mustofa, Susiana Candrawati, Khusnul Muflikhah, Tiara Dwivantari, Rahardita Alidris and Dessy Dwi Zahrina</i>	204
Fgf 21 Secretion as Acute Response to Exercise in High Fat Diet Fed Rats <i>Nafi'ah, Imelda Rosalyn Sianipar, Nurul Paramita, Rabia and Neng Tine Kartinah</i>	208
The Miracle of Stichopus Hermanii <i>Noengki Prameswari</i>	212
Effect of Chemical Exposure on Endocrine System Disorder (Article Review) <i>Nurul Mahmudati and Husamah</i>	220
The Effect of Acute Exercise of Basic Breathing Motion on Breathing Skills Retention in Swimming <i>Okky Sinta Dewanti and Choensan Effendi</i>	226
Correlation Between Body Mass Index and Medial Longitudinal Arch of The Foot in Children Aged 5–6 Years <i>Purwo Sri Rejeki, Irfiansyah Irwadi, Widiarti and Misbakhul Munir</i>	230
Correlation Between Agility and Flat Feet in Children 5–6 Years Old <i>Anita Faradilla Rahim, Miftahul Nur Amaliyah, Irfiansyah Irwadi and Purwo Sri Rejeki</i>	234
Correlation Between Hand Grip and Achievement in Indonesian Female Floorball Athletes <i>Loren Fibrilia Perangin-angin, Siti Maesaroh, Irfiansyah Irwadi and Purwo Sri Rejeki</i>	238
Maternal Anthropometrics as a Predictor of Preeclampsia Risk Factor <i>Putri Wulan Akbar, Florentina Sustini, Hermanto Tri Juwono and Handayani</i>	241
Correlation Between Activity Level and Circadian Rhythmicity of Medical Students (Class Of 2014) at the Faculty of Medicine, Airlangga University <i>Qurrotta Ayuni Novia Putri, Irfiansyah Irwadi, Agustina Salinding and Sundari Indah Wiyasihati</i>	244
Exercise Formula to Induce Beiging Process: A Study Based on Acute Response of Irisin <i>Rabia, Neng Tine Kartinah, Nurul Paramita, Nafi'ah and Imelda Rosalyn Sianipar</i>	248
Effects of the 6th Series of Senam Diabetes Indonesia on Energy Expenditure <i>Riza Pahlawi, Harjanto JM and Dwikora Novembri Utomo</i>	252
The Difference of B-Endorfin Level in Brain Tissue and Testicular Tissue on Wistar Rats Given Once a Week Aerobic and Anaerobic Exercise <i>Rostika Flora, Lisna Ferta Sari, Muhammad Zulkarnain and Sukirno</i>	256
The Effectiveness of Ultrasound-Guided Injection for Pain Management in Indonesia <i>Soni Sunarso Sulistiawan, Dedi Susila, Belindo Wirabuana, Herdiani Sulilstyo Putri, Yusufa Fil Ardy, Ferdian Rizaliansyah, Noryanto Ikhromi, Bambang Pujo Semedi, Arie Uariyani, Hamzah and Nancy Margarita Rehatta</i>	261
Effects of Moderate Intensity Aerobic Exercise on MMP-9 Level, NOx Plasma Level and Resting Blood Pressure in Sedentary Elderly Women With Overweight <i>Suhartini SM, Gusbakti R and Ilyas EI</i>	265

Correlation Between Oxidative Stress Level with Plasma Beta Endorphin Level of Male Laboratory Rats Given Aerobic and Anaerobic Exercise <i>Sukirno, Herlia Elvita, Mohammad Zulkarnain and Rostika Flora</i>	271
Bone Age Estimates the Onset of the Adolescent Growth Spurt Among Male Basketball Players <i>Sundari Indah Wiyasihati, Bambang Purwanto and Agus Hariyanto</i>	277
The Correlation Between Haemoglobine and Body Mass Index With The Changes of Blood Lactate Levels in University of Jenderal Soedirman's Medical Students - A Study at Repeated Sprint Sessional 3 <i>Susiana Candrawati, Wiwiek Fatchurohmah, Ahmad Agus Faisal and Hana Khairunnisa</i>	280
Laughter Therapy Lowers Blood Pressure and Heart Rate in Hypertensive Balinese Patients at Ambarashram Ubud Bali <i>Suyasning HI and Adi Pratama Putra P</i>	284
The Different Effects of Contrast Water Immersion and Warm Water Immersion on Blood Lactic Acid Levels After Submaximal Physical Activity Among Basketball Athletes <i>Taufan Reza Putra, Elyana Asnar STP and Dwikora Novembri</i>	288
Diabetes Sprague-Dawley Model Induced With Fat Diet And Streptozotocin <i>Thressia Hendrawan, Nurul Paramita, Dewi Irawati and Ani Retno Prijanti</i>	292
The Difference of Heart Rate and Blood Pressure in Aerobic and Anaerobic Predominant Athlete Koni West Java Year 2016 <i>Titing Nurhayati, Hafiz Aziz and Nova Sylviana</i>	294
Effect of Exhaustive Exercise on Blood Lymphocyte Count and Diameter of Splenic White Pulp in Rats <i>Tri Hartini Yuliawati, Dewi Ratna Sari, Rimbun, Atika, Iskantijah and Ari Gunawan</i>	298
The Use of Purple Sweet Potato (<i>Ipomoea Batatas L.</i>) to Decrease Levels of Mda and Recover Muscle Damage <i>Utami Sasmita Lestari, Elyana Asnar and Suhartati Soewono</i>	304
Risk Factors of Low Back Pain Among Tailors in Kramat Jati, East Jakarta <i>Vivi Anisa Putri, Leli Hesti and Nurfitri Bustamam</i>	310
The Correlation of Norovirus Infection to Severity Degree of Acute Diarrhea in Children Under Five Years Old in Mataram City, Lombok <i>Warda Elmaida, Juniastuti and Soetjipto</i>	316
Malaria Prevalence in Alor District, East Nusa Tenggara, Indonesia <i>Yeni Puji Lestari, Majematang Mading, Fitriah, Avia Putriati Martha, Didik Muhammad Muhdi, Juniarsih, Zainal Ilyas Nampira, Suknawati Basuki and Florentina Sustini</i>	321
The Potential Role of 25-Hydroxycholecalciferol on Calcium Regulation in Young Sedentary Women With Goat's Milk Intervention <i>Yusni</i>	326
Hemoglobin A1C as the Strongest Influencing Factor in relation to Vascular Stiffness in Type 2 Diabetes Mellitus - Metabolic Syndrome Patients <i>Deasy Ardiany, Soebagijo Adi, Ari Sutjahjo and Askandar Tjokroprawiro</i>	331
Thyroid Crisis and Hyperosmolar Hyperglycemic State in a Hyperthyroid Patient <i>Yudith Annisa Ayu Reskitha, Rio Wironegoro, Hermawan Susanto, Soebagijo Adi and Ari Sutjahjo</i>	336

Effect of Growth Hormone Deficiency on the Cardiovascular System <i>Irma Magfirah, Soebagijo Adi Soelistijo, Hermina Novida and Deasy Ardiany</i>	342
Metformin, Effects Beyond Glycemic Control <i>Soebagijo Adi Soelistijo and Askandar Tjokroprawiro</i>	349
The Correlation of Initial CD4 Cell Count with Increased Alanine Aminotransferase in Patients with Human Immunodeficiency Virus Who Have Received Nevirapine <i>Abdur Rokhim, Usman Hadi and Erwin Astha Triyono</i>	356
Profile of Bacteraemia and Fungemia in HIV/AIDS Patients with Sepsis <i>Sajuni Widjaja, Erwin Astha Triyono and Arthur Pohan Kawilarang</i>	363
The Association between Cryptococcal Antigenemia and CD4+ T Lymphocyte Count in HIV/AIDS Patients with Suspected Cryptococcus Infection <i>Sajuni Widjaja, Erwin Astha Triyono and Arthur Pohan Kawilarang</i>	370
Impact of Music on Sport Intensity (Allegro) and on Levels of Left Ventricular Myocardial Damage in Wistar Rats <i>Faris Pamungkas Wicaksono, Sugiharto, Rias Gesang Kinanti, Paulus Liben, Suhartono Taat Putra and Purwo Sri Rejeki</i>	378
Association of Topical Capsaicin Exposure Dosage and Its Influence on Macrophages and Neutrophils in Periodontal Tissue <i>Ratna Mustriana, Haryono Utomo and Purwo Sri Rejeki</i>	383
Pharmacological Therapy of Portal Hypertension <i>Mukhammad Burhanudin, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Muhammad Miftahussurur, Husin Thamrin and Amie Vidyani</i>	389
Chronic Constipation Management in Adults <i>Erliza Fatmawati, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Husin Thamrin, Amie Vidyani and Muhammad Miftahussurur</i>	397
Diagnosis and Management of Ulcerative Colitis <i>Rendy Revandana Bramantya, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Amie Vidyani, Muhammad Miftahussurur and Husin Thamrin</i>	405
The Diagnosis and Management of Achlorhydria <i>Dicky Febrianto, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Amie Vidyani, Muhammad Miftahussurur and Husin Thamrin</i>	413
Acute Liver Failure <i>Troy Fonda, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Husin Thamrin, Amie Vidyani and Muhammad Miftahussurur</i>	421
Transient Elastography as Non-Invasive Examination of Hepatic Fibrosis <i>Satyadi, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Amie Vidyani, Muhammad Miftahussurur and Husin Thamrin</i>	426

21	Termination of Antiviral Administration in Chronic Hepatitis B <i>Edward Muliawan Putera, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Husin Thamrin, Amie Vidyani and Muhammad Miftahussurur</i>	431
21	Management for a Patient with Barret's Esophagus: A Case Report <i>Muhammad Miftahussurur, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Husin Thamrin and Amie Vidyani</i>	438
	Thrombocytopenia in Chronic Hepatitis C <i>Arvi Dian Prasetya Nurwidda, Poernomo Boedi Setiawan, Iswan Abbas Nusi, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Amie Vidyani, Muhammad Miftahussurur and Husin Thamrin</i>	446
	Short Bowel Syndrome: Review of Treatment Options <i>Nina Oktavia Marfu'ah, Herry Purbayu, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Muhammad Miftahussurur, Husin Thamrin and Amie Vidyani</i>	453
21	Problematic Diagnosis of a Patient with Tuberculosis Peritonitis <i>Elieza L. Pramugaria, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Husin Thamrin, Amie Vidyani and Muhammad Miftahussurur</i>	462
	Pathophysiology of Irritable Bowel Syndrome <i>Rastita Widiasari, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Ulfa Kholili, Budi Widodo, Husin Thamrin, Amie Vidyani and Muhammad Miftahussurur</i>	470
21	Recent Pathophysiology and Therapy for Paralytic Ileus <i>I Putu Surya Pridanta, Ulfa Kholili, Iswan Abbas Nusi, Poernomo Boedi Setiawan, Herry Purbayu, Titong Sugihartono, Ummi Maimunah, Budi Widodo, Amie Vidyani, Muhammad Miftahussurur and Husin Thamrin</i>	477
	A Case Report of a Patient with a Rare and Aggressive Plasma Cell Leukemia <i>Ugrosono Yudho Bintoro, Putu Niken Amrita, Raharjo Budiono, Made Putra Sadana and Ami Ashariat</i>	482
	Decreased Triglyceride and Protein Levels in Diabetic Rat Muscle Following Physical Exercise <i>Susi Anggawati, Bambang Purwanto and Sutji Kuswarini</i>	487
	Abnormal Uterine Bleeding with Three Different Doses and Intervals of Hormonal Contraceptive Injection <i>Ananda Febina Kimresti A, Ashon Sa'adi, Lilik Djuari and Maftuhah Rochmanti</i>	491
	Hypertrophic Scars Cause Burn Injuries Assessed by the Vancouver Scar Scale <i>Ardea Ramadhanti Perlanakusuma, Iswinarno Doso Saputro and Diah Mira Indramaya</i>	497
	Description of Body Mass Index Changes in Emergency Patients at the Intensive Observation Room–Emergency Installation <i>Galang Damariski Lusandi, Prananda Surya Airlangga and Ariandi Setiawan</i>	501
	Laboratory Profile of Acute Diarrhea and Chronic Diarrhea in Children <i>Mochammad Nasrulloh, Alpha Fardah Athiyah and Arifoel Hajat</i>	505

Effect of Ethanol Extract of <i>Ruellia tuberosa</i> L. Leaves on Total Cholesterol Levels in Hypercholesterolemia Model of <i>Mus Musculus</i> L <i>Nurin Kusuma Dewi, Siti Khaerunnisa and Danti Nur Indriastuti</i>	512
Combination of Aerobic and Resistance Exercise in Lowering Blood Glucose Levels Compared to Aerobic or Resistance Exercises in a Male Wistar Rat Model with Diabetes Mellitus <i>Sahrul Latif, Dwikora Novembri Utomo and Purwo Sri Rejeki</i>	517
AUTHOR INDEX	523

Intermittent Physical Training Decreases Peak of Blood Glucose Level after Meals in Rats

Eka Arum Cahyaning Putri, Raden Argarini, Bambang Purwanto and Lilik Herawati

Department of Physiology, Faculty of Medicine Universitas Airlangga, Jalan Mayjen Prof. Dr. Moestopo no. 47, Surabaya, Indonesia

eka-arum-cp@fk.unair.ac.id

Keywords: Blood Glucose, Exercise Intensity, Physical Activity.

Abstract: Some people prefer doing exercise following the intermittent model while others prefer the continuous one. However, it is still unclear which is the best one for blood glucose regulation. This study was carried out to determine the difference between the changes in blood glucose levels after doing physical exercise for the intermittent and the continuous model. The subject was male adult rats divided into 3 groups: control, continuous, and intermittent, 5 rats in each group. The rats swam in moderate intensity every day for 8 weeks. The results showed that the control group had the highest results of the peak (30 minutes) blood glucose levels after meals followed by the other 2 groups. The results of the intermittent group had a significant peak in blood glucose levels 30 minutes after meals ($p < 0.05$). Also the differences in blood glucose 30 minutes and 60 minutes after meals in the intermittent and continuous groups were significantly different than the control group ($p < 0.05$). During the 8 weeks of moderate physical exercise every day, it can be assumed that there was more insulin secretion to reduce peak blood glucose levels after meals. The lower blood glucose difference at 30 minutes and 60 minutes after meals of both the continuous and intermittent groups compared with the control group indicates that glucose uptake by cells is better in those groups. In conclusion, our data support the benefit of intermittent and continuous exercise training for the optimal regulation of blood glucose levels. The intermittent model also has more effect on the peak phase of blood glucose level after meals.

1 INTRODUCTION

Physical exercise is one way to regulate blood glucose levels. This is known through the improvement of GLUT-4 translocation in skeletal muscle when exercise increases glucose uptake by cells. According to the exercise and rest phase, physical exercise can be done intermittently and continuously. Continuous physical exercise means the exercise is done continuously and rest taken at the end of the exercise, while intermittent physical exercise is done with periods of exercise alternating with periods of rest. When observed, people generally do physical exercise with intermittent models (Shepherd, 1999; Ganong, 2001).

It is known that increasing the GLUT-4 translocation in skeletal muscle is important because it can indirectly result in the balance of blood glucose levels. Previous research has discovered that physical exercise can affect blood glucose levels by a mechanism independent of insulin. Stimulating

this mechanism may be an alternative for example for people with diabetes mellitus, in regulating blood glucose levels.

It is also known that intermittent and continuous submaximal physical exercise decreases blood glucose levels (Herawati, 2004). It can be assumed that there has been an increase in glucose uptake by cells through enhancement of GLUT-4 translocation, but how much improvement in GLUT-4 translocation in physical exercise of intermittent and continuous submaximal models remains unknown (Ganong, 2001; Zierath, 2000)

From Herawati's (2004) study comparing acute physical exercise on an intermittent and continuous basis, there was a noticeable decrease in glucose levels during physical exercise, but during recovery, the control group experienced a decrease in glucose levels.

According to the description above, this research was designed to find out the effect of a training program of moderate intensity physical exercise

with an intermittent and a continuous model on the speed of glucose uptake in skeletal muscle.

2 METHODS

This research is true experimental laboratory with random control posttest-only design. The population in this study were male white rats aged 2-3 months. The sample size was 5 heads per group, divided into 3 groups: control, continuous, and intermittent. The division of groups was random sample using the lottery method. This research was conducted in the Biochemistry Laboratory of Faculty of Medicine Universitas Airlangga, Surabaya.

The independent variable of this study was a medium-intensity physical exercise program in an intermittent and a continuous model every day for 8 weeks. In the intermittent training program, the rats were moderated by physical exercise of moderate intensity, ie 5% Body Weight load for maximum time that could be achieved but performed alternately between swimming and rest with a 2:1 ratio. For example, the work time in the pool was 30 seconds then the rest period was 60 seconds. In the continuous intensity physical exercise program, the rats were reinforced with submaximal intensity exercise, ie 5% BB load for the maximum time that could be achieved.

Variables dependent on this study were serial blood glucose levels examined with an Accu-Chek glucometer from Roche. Serial blood glucose levels were examined by cutting the male white rat's tail to obtain the drops of blood. The first drop of blood was removed, then a drop of blood after it was absorbed into a test strip, waiting 15 seconds until the blood glucose level appeared on the screen while the blood drops were stopped by pressing the bleeding site. The number or value shown is in new units of mg/dl.

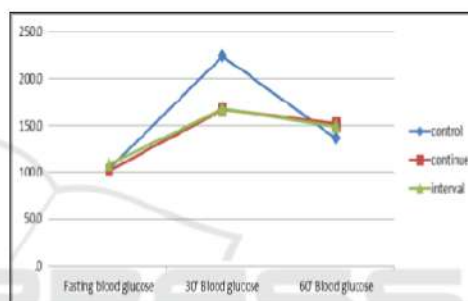
Blood glucose levels examined were fasting blood glucose levels, 30 minutes and 60 minutes after an intra-peritoneal glucose tolerance test. In addition, changes in blood glucose levels were also calculated by measuring the difference in fasting blood glucose levels and 30 minutes, the difference in blood glucose levels between 30 minutes and 60 minutes, and the difference in fasting blood glucose levels and 60 minutes.

At the end of the 8th week, there was a 2-day pause followed by statistical analysis and the production of descriptive statistics, a distribution normality test, a homogeneity test, and an ANOVA test if the data were normally distributed, or a

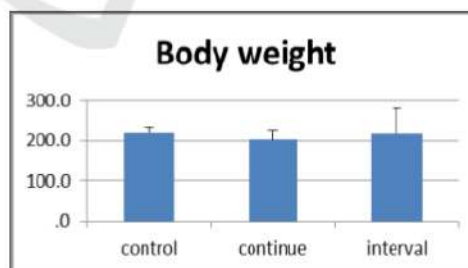
Kruskal-Wallis test if the data were not normally distributed.

3 RESULTS

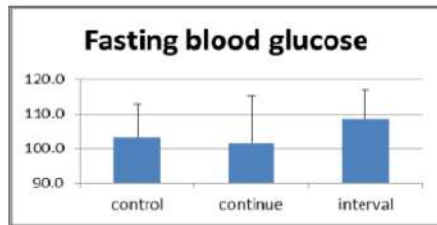
Overall, the 3 groups had nearly equal data of fasting blood glucose. The 3 groups also experienced elevated blood glucose 30 minutes after meals compared with fasting blood glucose. In the control group, blood glucose 30 minutes after meals was much higher in value compared to the other 2 groups. Then, in the blood glucose examination 60 minutes after meals, all 3 decreased with values that were not much different.



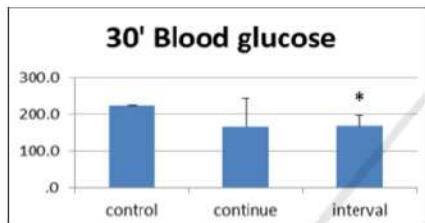
The number of white rats that were used in this study was 15 and these were divided into 3 groups (control, continue, and interval). Overall, the rats had an average body weight that did not differ between groups. This shows that body weight was not a confounding factor in this study. Likewise the type and age of animals used were not different.



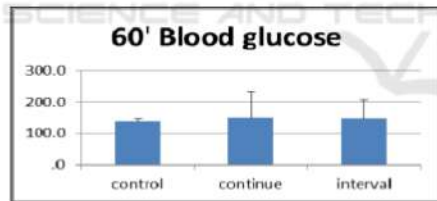
Fasting blood glucose examination is shown on the graph below. The intermittent group had the highest yield, and the continuous group had the lowest result. But the results of fasting blood glucose examination of the 3 groups were still in the range of values that were not different.



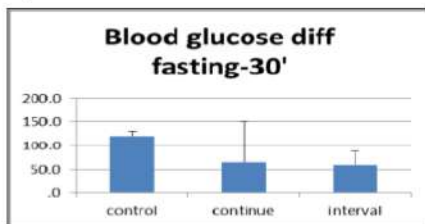
Thirty minutes after meals (using the peritoneal D40 glucose fluid), the control group had the highest yield. This was followed by the intermittent group, and the continuous group had the lowest yield. The result of the intermittent group showed a significantly different blood glucose level 30 minutes after meals ($p < 0.05$).



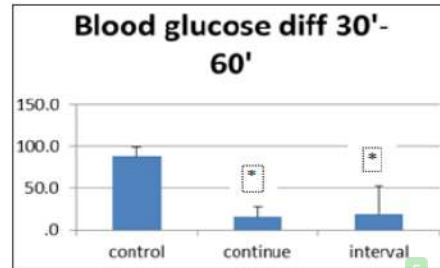
On examination of blood glucose 60 minutes after meals, the intermittent and continuous groups had similar results while the control group had slightly lower results.



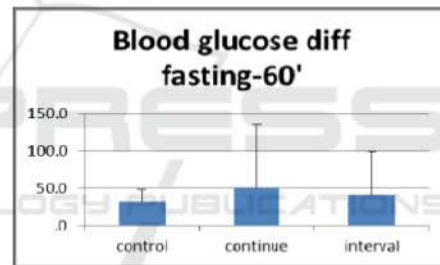
The graph below shows the difference between fasting blood glucose and blood glucose 30 minutes after meals. The control group had a difference in fasting blood glucose and blood glucose 30 minutes after meals, followed by the continuous group, these did not differ significantly with the intermittent group.



In the graph below, the largest difference between blood glucose 30 minutes and 60 minutes after meals of the 3 groups was the control group, followed by the intermittent and continuous groups. The results of the intermittent and continuous groups were significantly different from that of the control group.



The graph below shows the difference in fasting blood glucose and blood glucose 60 minutes after meals. In all 3 groups, there were no significantly different outcomes.



4 DISCUSSION

Guyton mentioned a glucose tolerance curve: when a normal person who is fasting then consumes 1 gram of glucose per kilogram of body weight, his blood glucose level will rise from about 90 mg/dl to 120-140 mg/dl, and within approximately 2 hours this level will go down again to its normal value (Guyton, 2008). However, with diabetic patients, Guyton also mentioned that fasting blood glucose concentration is almost always above 110mg/dl. This was consistent with significantly different results ($p < 0.05$) in the blood glucose levels obtained 30 minutes post-intermittent exercise by glucose tolerance test compared with the other 2 groups. Physical activity performed at intervals daily for 8 weeks stimulates better insulin secretion thereby reducing peak blood glucose levels after meals.

The result of decreasing peak blood glucose levels after a meal benefits the body because Guyton mentions that blood glucose levels need to be kept from rising too high even after eating. One of the dangers when blood glucose concentration rises too high is that glucose can cause large amounts of osmotic pressure in the extracellular fluid and may cause cell dehydration.

Herawati (2004) mentions that submaximal intermittent and continuous physical exercise decreases blood glucose levels. The blood glucose levels in question are those 30 minutes and 60 minutes after meals. In this study, blood glucose levels of 30 minutes and 60 minutes after meals also showed significant differences ($p < 0.05$) in the continuous and intermittent groups. This is when compared with control group who did not perform physical activity.

The lower blood glucose difference of 30 minutes and 60 minutes after meals in the continuous group indicates glucose entry into cells was slower. This is good for diabetic patients because it is expected that blood sugar levels after eating or drinking will be increased lightly but gradually. This can stimulate the pancreas to produce insulin so as to prevent the rise in blood sugar levels further and cause blood sugar levels to decline slowly.

56 5 CONCLUSIONS

Based on the results of the study and discussion it can be concluded that: (1) physical exercise at intervals with moderate intensity can decrease peak blood sugar level; and (2) there is a significant difference between the control group who did not do physical exercise and the intermittent and continuous groups who were doing physical exercise in keeping blood glucose levels lower after meals. There were decreased blood glucose levels between 30 minutes and 60 minutes after eating in both groups doing physical exercise (intermittent and continuous).

Although the results of this study have provided additional information about the physiological effect of physical exercise on blood glucose levels, further research is needed, both to extend theoretical explanations and their application.

REFERENCES

- Ganong WF, 2001. Review of Medical Physiology, 20th Edition. New York: Lange Medical Books/ McGraw-Hill: pp 278, 280-281, 333-336, 340.
- Guyton, A.C., dan Hall, J. E. 2008. Buku Ajar Fisiologi Kedokteran. Edisi 11. Jakarta: EGC.
- Herawati L, 2004. Penurunan Kadar Glukosa Darah Postprandial Pada Latihan Fisik Intensitas Sedang Secara Intermittent Dan Kontinyu. Surabaya: Tesis Program Magister Pascasarjana Universitas Airlangga, hal 40-62.
- Shepherd PR, Kahn BB, 1999. Glucose Transporters and Insulin Action. *The New England Journal of Medicine* 341 (4), P. 24.-255.
- Zierath JR, Krook A, Wallberg-Henriksson H, 2000. Insulin action and insulin resistance in human skeletal muscle. *Diabetologia* 43: 822-823.

Non-Invasive Method on Slow-Twitch Quadriceps Muscle Fibers Dominate a High Level of Fitness

Yuannita Ika Putri¹, Andre Triadi Desnantyo² and Lilik Herawati³

¹Medical Program, Faculty of Medicine, Universitas Airlangga, Jl. Mayjend Prof Dr Moestopo, Surabaya, Indonesia

²Department of Orthopedics, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

³Department of Physiology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

lilik_herawati@fk.unair.ac.id

Keywords: Fitness Level, Muscle Fiber Type, Non-Invasive Method, VO₂max.

Abstract: Previous studies have proved that there is a linear correlation between VO₂max and slow-twitch fibers in athletes. These studies were done using biopsy, the invasive method, to estimate the muscle fiber type. There is also a non-invasive method, which is convenient to use and not conflicted by ethical law in Indonesia. However, further study regarding muscle fiber shifting and its correlation with the level of fitness using a non-invasive method to estimate muscle fiber is still lacking. This research aims to determine the distribution and correlation between level of fitness and muscle fiber type in non-athletes estimated by a non-invasive method. Muscle fiber type in the quadriceps muscle group and level of fitness were determined in 33 untrained male students with an average age of 20.5 y.o. Muscle fiber type was determined by a non-invasive method by counting the maximal repetition with 80% 1RM weight. The level of fitness was determined a week later by the *Astrand ergocycle* method. The slow-twitch muscle fibers dominated a high fitness level ($p=0.002$). However, the correlation test between muscle fiber types and fitness level was not significant ($p=0.551$). This result showed that a high fitness level, which has a higher oxygen consumption, has numerous slow-twitch muscle fibers. It is rich in myoglobin delivering oxygen to maintain the aerobic activity. Yet there is no correlation between the level of fitness and muscle fiber type as estimated by a non-invasive method in quadriceps. Further studies are needed to analyze several factors that may contribute to it.

1 INTRODUCTION

Physical fitness has a direct relationship with the aerobic energy system, muscle ATP-PC capacities, and lactate metabolism (Robergs, 2003). Physical fitness can be determined by measuring VO₂max or maximal oxygen uptake (Ganong, 2010). VO₂max reflects the maximal amount of oxygen that has been consumed during intense physical activity.

Muscle fiber has been classified into slow-twitch (Type I) fiber and fast-twitch (Type II) fiber (Scott et al., 2001). The term mixed-twitch fiber has been used if there is an equal proportion of slow-twitch type and fast-twitch type in one muscle group. Slow-twitch fibers have a greater aerobic capacity, larger vascular and capillary, and are more resistant to fatigue than fast-twitch fibers (Ganong, 2010). Fast-twitch muscle was used for power and speed events due to its anaerobic capacity (Berning and Steen, 2005). Skeletal muscle consists of muscle tissues

which can easily adapt due to the environment that change its constituent protein (Magauffa et al., 2004).

Several studies show that shifts in muscle fiber from fast-twitch fiber to slow-twitch fiber is possible due to long periods of endurance type events (Wilson et al., 2012). Athletes who are involved in long periods of endurance training have very high levels of VO₂max (Skinner, 2005) and a high percentage of slow-twitch fibers (Plowman, 2007). A previous study has proved that there is a linear correlation between VO₂max and slow-twitch fibers in athletes (Bergh et al., 1978). However, most of the research was carried out on athletes or trained men. Further study regarding muscle fiber shifting and its correlation with level of fitness in non-athletes and untrained men is still lacking. Moreover, a non-invasive method to identify muscle fiber type is still clearly unknown. The purpose of this study was to determine the distribution and

correlation between level of fitness and muscle fiber type in non-athletes estimated by non-invasive method.

2 MATERIALS AND METHOD

Thirty-three untrained males aged 19–22 years participated in this study. Muscle fiber type in the quadriceps muscle group was determined by counting maximal repetition with 80% 1 RM weight during leg extension. This method is introduced and applied in muscle groups, not to an individual muscle (Kraps, 2001). Maximal repetition at a predetermined load and muscle fiber type have a fair to moderate relationship (Douris et al., 2006).

Level of fitness was determined using the Astrand method to measure predictive value of VO₂max while using the ergocycle. The Astrand method has been proven to be accurate in determining VO₂max in healthy young men and women (Hoehn et al., 2015). Then, the VO₂max was classified in low, average, high, and very high levels of fitness.

3 RESULTS

Frequency distribution of muscle fiber type of quadriceps muscle group among participants is presented at Fig. 1. Fifty-five percent participants have slow-twitch fibers, 39% mixed-twitch fibers, and 6% slow-twitch fibers.

The slow-twitch muscle fibers dominate low levels and high levels of fitness. There were five participants with slow-twitch and two participants with mixed-twitch muscle fibers at a low fitness level. In the high level of fitness, there were seven participants with slow-twitch and four participants with mixed-twitch muscle fibers. However, the significant difference between slow-twitch and mixed-twitch muscle fibers ($p=0.002$) was only in high level of fitness. The participants with average level fitness were dominated by mixed-twitch muscle fibers, yet there was no significant difference. The fast-twitch muscle fiber type was detected in a small proportion ($p \geq 0.05$) on average and a very high level of fitness. The frequency of distribution based on classification of fitness level

and muscle fiber type of participants is presented in Fig 3.

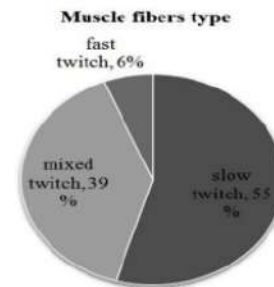


Figure 1: Frequency distribution of muscle fiber type of quadriceps muscle group (n=33).

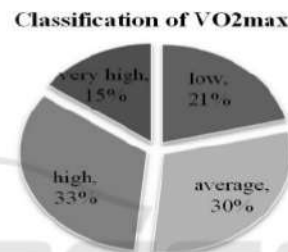


Figure 2: Frequency distribution of level of fitness (n=33).

P value was determined by the Spearman correlation test; $p = 0.551$ showed that there was no correlation between level of fitness and muscle fiber type (Table 1).

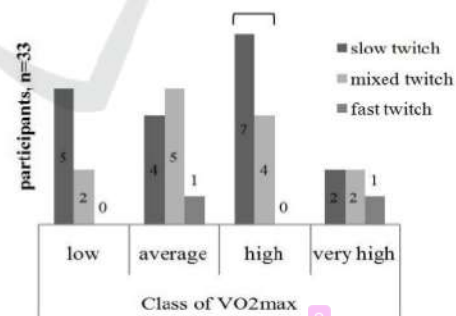


Figure 3: Frequency distribution of level of fitness on muscle fiber type.

*significant difference ($p < 0.05$) between slow and mixed-twitch muscle fibers.

Table 1. Correlation between level of fitness and muscle fiber type.

Spearman rho n=33	Classification of VO ₂ max	
Muscle fiber types	Correlation Coefficient	0.108
	Sig. (2-tailed)	0.551

4 DISCUSSION

The main finding in this study was that there is a significant difference between slow and mixed-twitch muscle fibers at a high level of fitness; however, there is no correlation between muscle fiber type and level of fitness in quadriceps of non-athletic young men. The domination of slow-twitch muscle fibers at a low and high fitness level is similar to the research by Barstow et al. (2000). Nine healthy participants were measured muscle fiber type recruitment based on the exercise intensity. The type I muscle (slow-twitch muscle fibers) was dominant in the low and/or high intensity of exercise (Barstow et al., 2000). Nevertheless, the correlation is contrary to the research from Barstow et al. (2000) and Bergh et al. (1978). One has to keep in mind that this study was done on untrained young men while their observation was done on athletes and trained men. Moreover, this study only uses quadriceps muscle to determine the muscle fiber type whereas the distribution between muscle fiber type varies in each muscle group.

There are some other factors that can influence level of fitness. Oxygen delivery is a primary factor in VO₂max limitation during exercises (Bassett and Howley, 2000). While athletes who have higher VO₂max also have a high percentage of slow-twitch fibers, VO₂max is not limited by the percentage of slow twitch muscle that someone is born with (Foss and Keteyian, 1998). Bergh's observation also found that VO₂max is higher in athletes than non-athletes in slow twitch fibers. This indicates that training and physical activities also influence VO₂max. Furthermore, studies regarding shift of muscle fiber from fast-twitch to slow twitch that was induced by training are still conflicted. It has already been cleared is muscle have the ability to alter its structural and functional properties to adapt to the environmental conditions imposed on it is known as muscle plasticity (Granssee et al., 2012). The mitogen-activated protein kinase signaling has been the possible pathway involved in exercise-induced adaptations in skeletal muscle (Hawley, 2002). Endurance exercise training can allegedly induce adaptive muscle fiber transformation and increase mitochondrial biogenesis (Wang et al., 2004).

However, the endurance training procedure and period that can actually change the fast-twitch fiber to slow-twitch fiber are still being debated. The majority of evidence still suggests that cross-innervation is the only way to effectively change the fast-twitch fiber into a slow-twitch fiber (Foss and Keteyian, 1998).

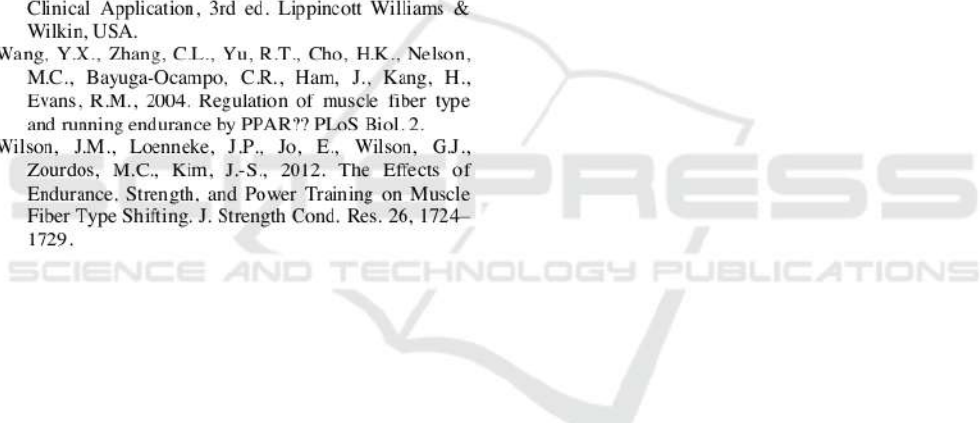
5 CONCLUSION

In summary, a high level of fitness has slow-twitch muscle fibers type domination with the invasive method; however, the correlation between the level of fitness and muscle fiber type in quadriceps of young men has not been found in this study. Many other factors can influence level of fitness and muscle fiber type distribution. Factors and metabolic change pathways as well as the training procedure and period that can actually change the muscle fiber type from fast-twitch to slow-twitch are suggested as potential for further studies.

REFERENCES

- Barstow, T.J., Jones, a M., Nguyen, P.H., Casaburi, R., 2000. Influence of muscle fibre type and fitness on the oxygen uptake/power output slope during incremental exercise in humans. *Exp. Physiol.* 85, 109–116.
- Bassett, D., Howley, E., 2000. Limiting Factors for Maximum Oxygen Uptake and Determinants of Endurance Performance. *Med. Sci. Sport. Exerc.* 32, 70–84.
- Bergh, U., Thorstensson, A., Sjodin, B., Hulten, B., Piehl, K., Karlsson, J., 1978. Maximal oxygen uptake and muscle fiber types in trained and untrained humans. *Med. Sci. Sport* 10, 151–4.
- Beming, J., Steen, S., 2005. *Nutrition for Sport and Exercise*, 2nd ed. Jones and Bartlett Publishers, Massachusetts.
- Douris, P.C., White, B.P., Cullen, R.R., Keltz, W.E., Meli, J., Mondiello, D.M., Wenger, D., 2006. The relationship between maximal repetition performance and muscle fiber type as estimated by noninvasive technique in the quadriceps of untrained women. *J. Strength Cond. Res.* 20, 699–703.
- Foss, M., Keteyian, S., 1998. *Fox's Physiological Basis for Exercise and Spor*, 6th ed. McGraw Hill, New York.
- Ganong, W., 2010. *Review of Medical Physiology*, 23th ed. The Mc Graw-Hill, California.
- Granssee, H.M., Mantilla, C.B., Sieck, G.C., 2012. Respiratory Muscle Plasticity. *Compr Physiol* 2, 1441–1462.
- Hawley, J.A., 2002. Adaptations of skeletal muscle to

- prolonged, intense endurance training. *Clin. Exp. Pharmacol. Physiol.* 29, 218–222.
- Hoehn, A.M., Mullenbach, M.J., Fontaine, C.J., 2015. Actual Versus Predicted Cardiovascular Demands in Submaximal Cycle Ergometer Testing. *Int. J. Exerc. Sci.* 8, 4–10.
- Kraps, J., 2001. Muscle Fiber Types and Training. *Track Coach* 155, 4943–4946.
- Magaudda, L., Mauro, D. Di, Trimarchi, F., Anastasi, G., Messina, G.M., 2004. Effects of Physical Exercise on Skeletal Muscle Fiber: Ultrastructural and Molecular Aspects. *J. Basic Appl Myol* 1, 17–21.
- Plowman, S., 2007. *Exercise Physiology for Health, Fitness, and Performance*. Lippincott Williams & Wilkins, USA.
- Robergs, R., 2003. *Fundamentals of Exercise Physiology*. McGraw Hill, New York.
- Scott, W., Stevens, J., Binder-macleod, S.A., 2001. Human Skeletal Muscle Fiber Type Classifications 81, 1810–1816.
- Skinner, J. 2005, 2005. *Exercise Testing and Exercise Prescription for Special Cases: Theoretical Basis and Clinical Application*, 3rd ed. Lippincott Williams & Wilkin, USA.
- Wang, Y.X., Zhang, C.L., Yu, R.T., Cho, H.K., Nelson, M.C., Bayuga-Ocampo, C.R., Ham, J., Kang, H., Evans, R.M., 2004. Regulation of muscle fiber type and running endurance by PPAR?? *PLoS Biol.* 2.
- Wilson, J.M., Loenneke, J.P., Jo, E., Wilson, G.J., Zourdos, M.C., Kim, J.-S., 2012. The Effects of Endurance, Strength, and Power Training on Muscle Fiber Type Shifting. *J. Strength Cond. Res.* 26, 1724–1729.

**PRESS**
SCIENCE AND TECHNOLOGY PUBLICATIONS

High-Calorie Diet Reduces Neuroglia Count

Nilam Anggraeni¹, Kristanti Wanito Wigati², I Lukitra Wardani³ and Lilik Herawati²

¹Medical Student Faculty of Medicine Universitas Airlangga, Jl. Mayjen. Prof. Dr. Moestopo, Surabaya, Indonesia

²Physiology Department Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia

³Physical Medicine and Rehabilitation Department Faculty of Medicine Universitas Airlangga, Surabaya, Indonesia
lilikeraw@gmail.com

Keywords: Astrocyte, Cerebral Cortex Diet, High Calorie, Hyperglycemia.

Abstract: Nowadays, high-calorie food consumption people can unwittingly affect health. Several studies have reported the effects of excess high-calorie food consumption can range from hyperglycaemia to neurodegenerative interference. In the brain, astrocytes function to respond to the modification of molecular brain structure. This study aimed to observe the effect of a high-calorie diet on the brain histology of male mice (*Mus musculus*). In this study, 28 mice were randomly divided into 4 groups: the control group pre (K0); the control group post with a standard diet (K1); the treatment group with 0.15g of glucose diet (K2); and the treatment group with 0.25g of glucose diet (K3). Treatment was given everyday for eight weeks. Brains were then histologically processed and stained with Haematoxylin-Eosin (HE) and observation made of quantitative changes of astrocytes in the cerebral cortex. Results: Data were analyzed with Post-Hoc ANOVA. From the study, significant differences were found between K0 and K2 ($\alpha < 0.05$). In addition, significant differences were obtained in the groups K0 and K3 ($\alpha < 0.05$). Meanwhile, no significant differences were found between groups ($\alpha > 0.05$). In conclusion, a high-calorie diet affects the brain histology of male mice.

1 INTRODUCTION

Nowadays, high-calorie foods are consumed in high quantities by people without them realizing that these types of food may result in bad habits. Eating excessive high-calorie foods can lead to metabolic diseases and cardiovascular disorders, even in the central nervous system (Auer *et al.*, 2015). When the body receives an excessive intake of high-calorie foods long term, this can lead to an increase in blood glucose levels. If this condition continues, it can cause hyperglycemia (Guyton & Hall, 2011). Hyperglycemia can lead to a decrease in the activity of insulin, which serves to increase glucose uptake in most tissue cells (CDC, 2011). In most cell tissues the body needs insulin for glucose uptake, but the insulin-free brain does not. At the time of hyperglycemia, where insulin insufficiency occurs, the brain will still obtain adequate nutrition, but with further consequences, the condition will eventually lead to brain dysfunction (Sherwood, 2014). Other

tissues can produce adenosine triphosphate (ATP) without oxygen; however, ATP cannot occur in the brain because the brain requires oxygen to produce it. Another unique aspect of the brain compared to other tissues is that the brain in normal circumstances can only use glucose as an energy source but cannot store it. Therefore, the brain depends entirely on adequate intake and a constant amount of glucose and oxygen. Brain damage might occur without sufficient intake of oxygen for more than four to five minutes or if its glucose discharge is cut off from 10 to 15 minutes (Sherwood, 2014). Hyperglycemia can lead to excess superoxide production of mitochondria in the endothelial cells of the blood vessels. Increased production of superoxide may lead to increased activation of advanced glycation end-products (AGEs/AGEP). This condition leads to the formation of intracellular reactive oxygen species (ROS) that can cause angiogenesis defects in response to ischemia; activate a number of pro-inflammatory pathways; and cause epigenetic long-lasting changes that

22

encourage persistent expression of pro inflammatory genes after hyperglycemic memory (Giacco & Brownlee, 2011). Changes in blood glucose levels affect the brain cells directly or indirectly because glucose is the main source of energy in addition to oxygen. A quarter of the body's oxygen is used for brain cells. This large energy-use brain cell is activated in the mitochondria, in order to maintain brain cell functional activity. In the brain, cells that play a major role in the neurotransmitter process and respond to biochemical changes are called astrocytes. Changes in blood glucose levels in the body can cause the intake of glucose and oxygen to the brain to be disrupted, meaning that the brain cannot run properly. Excessive consumption of a high-calorie diet can affect the body's metabolism, leading to hyperglycemia, which affects the brain tissue directly or indirectly, as described above. This has encouraged researchers to study the impact of a high-calorie diet on the histology of the brains of mice, and to increase public awareness of the impact of a high-calorie diet upon the body, especially brain tissue.

2 METHODS

The protocol used in this study has already been approved by Ethical Committee, Faculty of Veterinary Medicine, Universitas Airlangga.

The standard diet is mouse food obtained from the Faculty of Veterinary Medicine, Universitas Airlangga, and provided with mineral water which can be accessed freely (ad libitum) and 0.5cc of mineral water by oral gavage per day. A high-glucose diet is a standard diet, and 0.15g and or 0.25g of glucose in 0.5cc solution by oral administration without considering the weight and ad libitum glucose solution with a concentration of 0.05g/ml.

Twenty-eight mice were randomly divided into four groups. The first group (K0) is the pre-treatment control group. The second group (K1) is the standard dietary treatment group. The third group (K2) is a group with a high-glucose dietary treatment of 0.15g. The fourth group (K3) is a group with a high-glucose dietary treatment of 0.25g. The mice were adapted in a cage for 1 week prior to treatment. During the adaptation, they were fed with the standard food and drink ad libitum. The first group (K0) was sacrificed after a 1-week adaptation as pre group data. The other group received treatment for 8 weeks. Mice were treated as above, where glucose is administered by oral gavage once

per day for 8 weeks. After being treated for 8 weeks, the mice were all sacrificed. Prior to being sacrificed, the mice were given anesthesia by intraperitoneal injection. The head of the mice was dissected and the brain was taken out and then fixed with formalin buffer. The tissue was then stained using HE (Hematoxylin-Eosin) in the Histotechnic Laboratory of Anatomical Pathology Department of the Faculty of Veterinary Medicine Universitas Airlangga. Microscopic examination of brain tissue was conducted afterward. The astrocytes were then counted from 5 areas, which was at the top, right center, center, left center and bottom, and 400x magnification. Microscope mounted graticulae with 5x5 count chamber. Changes in the amount of astrocyte was counted and the result was analyzed statistically using SPSS.

3 RESULTS

Among 28 mice, there were 9 mice died during the study, 1 mouse in the post control group (K1), 3 mice in the glucose diet treatment group of 0.15g (K2) and 5 mice in the 0.25g glucose diet treatment group (K3). As of this, the amount of mice that performed histology of the brain is from 19 mice.

Table 1: Result of astrocyte count.

Group	N	Astrocytes (%) (Mean ± SD)
K0	7	18.43 ± 5.56
K1	6	16.00 ± 1.89
K2	4	12.75 ± 1.70
K3	2	10.00 ± 1.41

The least amount of astrocytes was obtained in the 0.25 gram (K3) glucose diet treatment group, which was smaller than the other groups. The largest amount of astrocytes was found in the pre control group (K0). The result of normality test shows that the data of astrocytes amount is normal ($\alpha > 0.05$), so the next data is analyzed by parametric statistic test that is one-way ANOVA. One-way ANOVA test results obtained significant results that is 0.040 ($\alpha < 0.05$) which means there are significant differences between groups.

Table 2: Post Hoc anova test result.

GROUP	K0	K1	K2	K3
K0		0.266	0.030*	0.014*
K1	0.266		0.203	0.071

K2	0.030*	0.203		0.414
K3	0.14*	0.071	0.414	

*Significant difference

The result of Post-Hoc Anova test showed that there was a significant difference between the pre-control group (K0) and the 0.15 gram (K2) glucose treatment group and the 0.25 gram (K3) glucose treatment group. No significant difference was found between K1 with K0, K2, and K3. The most significant ratio of astrocytes is between K0 and K3.

4 DISCUSSION

High-calorie diets exaggeratedly cause metabolic abnormalities (Auer *et al.*, 2015). When the body gets a diet which is high in excessive calories for a long term, it can increase blood glucose levels. This can lead to conditions of hyperglycemia (Guyton & Hall, 2011). In addition, blood glucose levels, hyperglycemia also leads to adequate infusion of insulin (CDC, 2011). The condition of hyperglycemia can increase the formation of reactive oxygen species (ROS) in the body and can improve the health of brain tissue (Ding *et al.*, 2004).

The brain consumes 20% of oxygen and 25% of glucose present in the body. Aside of oxygen, glucose is very important for the brain cell, because different from other tissues, in normal conditions the brain can only use glucose as its source of energy (Farooqui, 2015). In conditions of hyperglycemia metabolic acidosis may occur in local brain tissue with increased of brain lactate (Kagansky *et al.*, 2001).

Astrocytes are neuroglia cells in the brain, composed of plastic cells that respond quickly to environmental changes in the brain (Kimmelberg & Nedergaard, 2010). An important role of astrocytes in the central nervous system (CNS) is in the process of physiology and pathology occurring in the brain and body (Dong *et al.*, 2001; Biessels *et al.*, 1999). Cohen *et al.* (2016) reported that astrocyte from neonatal mice given low, medium, and high glucose exposure, responded to changes in environmental glucose levels with increased insulin, insulin receptors, and protein levels. Astrocytes secrete insulin but do not respond to stimuli like other insulin-producing cells. This has led to speculation that astrocytic insulin responds to glucose levels, and may be adaptive for cellular homeostasis rather than to affect the environment.

Astrocytes count between the pre-control group and the glucose diet treatment group of 0.15 gram were significantly different. This significant difference indicates a 0.15g glucose diet has an impact on astrocytes. This is due to the high levels of glucose in the blood followed by insulin insufficiency which results in reduced astrocytes as a protective response to neurons from environmental changes (Özdemir *et al.*, 2012; Kelleher *et al.*, 1993). Reduced astrocytes in the 0.15g glucose diet treatment group may also be due to high ROS that elevated blood glucose levels that cause astrocytic damage (Yang *et al.*, 2016; Takahashi *et al.*, 2012; Wang *et al.*, 2012).

High concentrations of glucose in the CNS environment affect astrocytes by increasing the ROS levels that cause oxidative stress (Hsieh *et al.*, 2013) as well as increased production of cytokine inflammation (Shin *et al.*, 2014). Under normal conditions, astrocytes have a major role in the CNS by maintaining extracellular homeostasis of neuroactive substances such as K⁺, H⁺, GABA, and glutamate. The more hyperpolarized membrane potentials compared with neurons can be found in astrocytes that provide the driving forces required for K⁺ spatial buffering and glutamate transport (Kucheryavykh *et al.*, 2007, 2009; Olsen, 2012). When these functions are impaired it will affect brain physiology.

The amount of astrocytes between the pre-control group and the 0.25g glucose diet treatment group was significantly different ($\alpha = 0.014$). The difference was more significant than the amount of astrocytes between the pre-control group and the 0.15g glucose diet treatment group, indicating that astrocytes in the 0.25-gram diet were decreased more. Wang *et al.*, (2012) reported that in experimental animal astrocytes treated with exposure to high glucose levels (15 mM) did not induce apoptosis in astrocytes, while astrocyte experimental animals treated with exposure to extremely high glucose levels (30 mM) experienced apoptosis drastically. This may explain the higher the glucose diet is given, the more astrocytes that apoptosis leads to the less astrocytes that can be calculated.

The researcher found no significant difference for the amount of astrocyte between the pre control and post control groups. No significant difference also found in the astrocyte count between the post control group and the 0.15g glucose diet treatment group. The astrocyte count between the post control group and the 0.25g glucose diet treatment group also have no significant difference. And non-

significant difference was founded in the astrocyte count between the 0.15g glucose diet treatment group and the 0.25g glucose diet treatment group.

The above non-significant differences were thought to be due to study limitations, differences in glucose levels administered between treatment groups were not much different and the majority of researchers looked at the impact of changes in astrocytic glucose levels by evaluation of morphological changes (Ogata & Kosaka, 2012; Wang *et al.*, 2012; Nardin *et al.*, 2007; Ding *et al.*, 2004; Auer *et al.*, 2015). While histological staining is best to be able to see astrocytes and its structure is silver impregnation, gold impregnation and Golgi impregnation (Lopez *et al.*, 2010).

5 CONCLUSION

Based on the study, it can be concluded that long-term high-calorie diets can cause a decrease in the amount of astrocyte in the cerebral cortex of mice and the increased calorie intake is associated with a decrease in the amount of astrocyte in the cerebral cortex.

REFERENCES

- Auer, M. K., Sack, M., Lenz, J. N., Jakovcevski, M., Biedermann, S. V., Falfán-Melgoza, C., Gass, P., *et al.* 2015. Effects of a high-caloric diet and physical exercise on brain metabolite levels: a combined proton MRS and histologic study. *Journal of Cerebral Blood Flow & Metabolism*, 35(4), 554–564. <http://doi.org/10.1038/jcbfm.2014.231>
- Biessels GJ, Cristino NA, Rutten GJ, Hamers FP, Erkelens DW, Gispen WH, 199. Neurophysiological changes in the central and peripheral nervous system of streptozotocin-diabetic rats. Course of development and effects of insulin treatment. *Brain* 122: 757–768.
- CDC, 2011. *Center for Diseases Control and Prevention*. [Online] http://www.cdc.gov/diabetes/prevention/pdf/PostHandout_Session14.pdf [Date accessed : 25 June 2016].
- Cohen, S., Liu, Q., Ryan, R., Gebremedhin, D., Harder, D., & Rarick, K. 2016. Change in Environmental Glucose Concentration Alters Astrocytic Insulin and Insulin Receptor Levels. *The FASEB Journal*, 30(1 Supplement), lb632-lb632.
- Ding, C., He, Q. & Li, P.-A., 2004. Activation of Cell Death Pathway After a Brief Period of Global Ischemia in Diabetic and Non-Diabetic Animals. *Elsevier*, Issue 188, pp. 421–429. doi:10.1016/j.expneurol.2004.04.013
- Dong Y, Benveniste EN 2001. Immune function of astrocytes. *Glia* 36:180–190. doi: 10.1002/glia.1107
- Farooqui, A. A., 2015. Effect of Long Term Consumption of High Calorie Diet and Calorie Retrixtion In Human Health. In: *High Calorie Diet and The Human Brain*. Ohio: Springer, pp. 1-2.
- Giacco, F. & Brownlee, M., 2011. Oxidative Stress and Diabetic Complications. <https://doi.org/10.1161/CIRCRESAHA.110.223545>
- Guyton, A. C. & Hall, J. E., 2011. *Guyton dan Hall Buku Ajar Fisiologi Kedokteran*. 12th ed. Singapore: Saunders Elsevier.
- Hsieh HL, Lin CC, Hsiao LD, Yang CM., 2013. High glucose induces reactive oxygen species-dependent matrix metalloproteinase-9 expression and cell migration in brain astrocytes. *Mol Neurobiol* 48, 601–614. doi: 10.1007/s12035-013-8442-6
- Kagansky N, Levy S, Knobler H 2011. The role of hyperglycemia in acute stroke. *Arch Neurol* 58:1209–1212.
- Kelleher, J. A., Chan, P. H., Chan, T. Y., & Gregory, G. A. 1993. Modification of hypoxia-induced injury in cultured rat astrocytes by high levels of glucose. *Stroke*, 24(6), 855–863 <https://doi.org/10.1161/01.STR.24.6.855>
- Kimelberg, H. K., & Nedergaard, M., 2010. Functions of astrocytes and their potential as therapeutic targets. *Neurotherapeutics*, 7(4), 338–353. doi:10.1016/j.nurt.2010.07.006.
- Kucheryavykh YV, Kucheryavykh LY, Nichols CG, Maldonado HM, Baksi K, Reichenbach A, Skatchkov SN, Eaton MJ 2007. Down regulation of Kir4.1 inward rectifying potassium channel subunits by RNAi impairs potassium transfer and glutamate uptake by cultured cortical astrocytes. *Glia* 55:274–281. doi:10.1002/glia.20455
- Kucheryavykh LY, Kucheryavykh YV, Inyushin M, Shuba YM, Sanabria P, Cubano LA, Skatchkov SN, Eaton MJ 2009. Ischemia increases TREK-2 channel expression in astrocytes: relevance to glutamate clearance. *Open Neurosci J* 3:40–47. doi: 10.2174/1874082000903010040
- Lopez, P. G., Marin, V. G. & M. F., 2010. The histological slides and drawings of Cajal. *Frontiers in Neuroanatomy*, IV(9), pp. 1–16. doi: 10.3389/neuro.05.009.2010
- Ogata, K., & Kosaka, T., 2002. Structural and quantitative analysis of astrocytes in the mouse hippocampus. *Neuroscience*, 113(1), pp. 221–233. [https://doi.org/10.1016/S0306-4522\(02\)00041-6](https://doi.org/10.1016/S0306-4522(02)00041-6)
- Olsen M 2012. Examining potassium channel function in astrocytes. *Methods Mol Biol* 814:265–281. doi: 10.1007/978-1-61779-452-0_18
- Özdemir, M. B., Akca, H., Erdoğan, Ç., Tokgün, O., Demiray, A., Semin, F., & Becerir, C., 2012. Protective effect of insulin and glucose at different concentrations on penicillin-induced astrocyte death on the primer astroglial cell line. *Neural Regeneration Research*, 7(24), 1895–1899. <http://doi.org/10.3969/j.issn.1673-5374.2012.24.008>

- Nardin, P., Tramontina, F., Leite, M. C., Tramontina, A. C., Quincozes-Santos, A., de Almeida, L. M. V., ... & Gonçalves, C. A., 2007. S100B content and secretion decrease in astrocytes cultured in high-glucose medium. *Neurochemistry international*, 50(5), 774-782.
- Sherwood, L., 2014. Kelenjar Endokrin Perifer. In: N. Yesdelita, ed. *Fisiologi Manusia : Dari Sel ke Sistem*. Singapore: EGC, pp. 782-783.
- Sherwood, L., 2014. Susunan Saraf Pusat. In: N. Yesdelita, ed. *Fisiologi Manusia : Dari Sel ke Sistem*. Singapore: EGC, p. 153.
- Shin ES, Huang Q, Gurel Z, Sorenson CM, Sheibani N (2014) High Glucose Alters Retinal Astrocytes Phenotype through Increased Production of Inflammatory Cytokines and Oxidative Stress. *PLoS ONE* 9(7): e103148. <https://doi.org/10.1371/journal.pone.0103148>
- Takahashi, S., Abe, T., Izawa, Y., & Suzuki, N., 2012. Effects of fluctuating glucose concentrations on oxidative metabolism of glucose in cultured neurons and astroglia. doi:10.4236/jdm.2012.21004
- Wang, J., Li, G., Wang, Z., Zhang, X., Yao, L., Wang, F., & Hao, A., 2012. High Glucose-Induced Expression of Inflammatory Cytokines and Reactive Oxygen Species in Cultured Astrocytes. *Neuroscience*, 202, pp. 58-68. doi:10.1016/j.neuroscience.2011.11.062
- Yang, C. M., Lin, C. C., & Hsieh, H. L., 2016. High-Glucose-Derived Oxidative Stress-Dependent Heme Oxygenase-1 Expression from Astrocytes Contributes to the Neuronal Apoptosis. *Molecular neurobiology*, 1-14. doi: 10.1007/s12035-015-9666-4
- MacIntyre DL, Sorichter S, Mair J, Berg A, McKenzie DC. Markers of inflammation and myofibrillar proteins following eccentric exercise in humans. *European Journal of Applied Physiology*. 2001;84:180-186.
- Mahmudatuss'adah A, Fardiaz D, Andarwulan N, Kusnandar F. Color Characteristics and Antioxidant Activity of Anthocyanin Extract from Purple Sweet Potato (Karakteristik warna dan aktivitas antioksidan antosianin ubi jalar ungu). *J Teknol & Industri Pangan*. 2014;25(2) 176-184.
- Malm C, Lenkei R, Sjodin B. Effects of eccentric exercise on the immune system in men. *Journal of Applied Physiology*. 1999;86:461-468.
- Maughan RJ, Donnelly AE, Gleeson M, Whiting PH, Walker KA, Clough PJ. Delayed-onset muscle damage and lipid peroxidation in man after a downhill run. *Muscle Nerve*. 1989;12(4):332-336.
- Mohanraj R, Sivasankar S. Sweet potato (*Ipomoea batatas* [L.] Lam)--a valuable medicinal food: a review. *J Med Food*. Jul 2014;17(7):733-41.
- Newton M, Morgan GT, Sacco P. Comparison between resistance trained and untrained men for responses to a bout of strenuous eccentric exercise of the elbow flexors. *J Strength Cond Res* (In press). 2007.
- Phillips SM, Tipton KD, Aarsland A, Wolf SE, Wolfe RR. Mixed muscle protein synthesis and breakdown after resistance exercise in humans. *American Journal of Physiology, Endocrinology and Metabolism*. 1997;273: E99-E107.
- Rasmussen BB, Tipton KD, Miller SL, Wolf SE, Wolfe RR. An oral essential amino acid-carbohydrate supplement enhances muscle protein anabolism after resistance exercise. *J Appl Physiol*. 2000;88:386-392.
- Sabuluntika N, Ayustaningwarno F. β -Carotene, Anthocyanin, Isoflavone Concentration, and Antioxidant Activity in Snack Bar from Sweet Potatoes and Black Soybeans as Alternative Snack Patients with Diabetes Mellitus Type 2 (Kadar β -Karoten, Antosianin, Isoflavon, dan aktivitas antioksidan pada snack bar ubi jalar kedelai hitam sebagai alternatif makanan selingan penderita diabetes melitus tipe 2). *Journal of Nutrition College*. 2013;2(4):689-695.
- Santoso WEA, Estiasih T. Purple Sweet Potato Peel (*Ipomoea batatas* var. *ayamurasaki*) Anthocyanins Copigmentation Using Copigment Na-Caseinate and Whey Protein with Stability Against Heating: A Review (Jurnal review: kopigmentasi ubi jalar ungu (*ipomoea batatas* var. *ayamurasaki*) dengan kopigmen na-kaseinat dan protein whey serta stabilitasnya terhadap pemanasan). *Jurnal Pangan dan Agroindustri*. Oktober 2014;2(4):121-127.
- Shimomura Y, Yamamoto Y, Bajotto G, Sato J, Murakami T, Shi-momura N, Kobayashi H, Mawatari K. Nutraceutical effects of branched-chain amino acids on skeletal muscle. *J Nutr*. 2006;136:529S-532S.
- Sutirta-Yasa IWP, Jawi IM, Ngurah IB, Subawa AAN. Balinese Purple Sweet Potato (*Ipomoea batatas* L) on SGOT, SGPT, MDA level and Chronic Alcohol (Umbi ubi jalar ungu Bali (*Ipomoea batatas* L) di transaminase serum, malondialdehyde hepar dan alkohol kronis). *Indonesian Journal of Clinical Pathology and Medical Laboratory*. 2011;17(3):151-154.
- Tang JE, Manolagos JJ, Kujbida GW, Lysecki PJ, Moore DR, Phillips SM. Minimal whey protein with carbohydrate stimulates muscle protein synthesis following resistance exercise in trained young men. *Applied Physiology Nutrition and Metabolism*. 2007;32:1132-1138.
- Tipton KD. Protein for adaptations to exercise exercise. *Eur J Sport Sci*. 2008;8:107-118.
- Udani JK, Singh BB. Bounceback™ Capsules for Reduction of DOMS after Eccentric Exercise: Randomized, Double-Blind, Placebo-Controlled, Crossover Pilot Studi. *Journal of the International Society of Sports Nutrition*. 2009;6(14):1-6.
- White JP, Wilson JM, Austin KG, Greer BK, St John N, Panton LB. Effect of carbohydrate-protein supplement timing on acute exercise-induced muscle damage. *J Int Soc Sports Nutr*. 2008;5(5):1-7.
- Wolfe RR. Protein supplements and exercise. *Am J Clin Nutr*. 2000;72:551S-557S.

Non-Invasive Method on Slow-Twitch Quadriceps Muscle Fibers Dominate a High Level of Fitness

Yuannita Ika Putri¹, Andre Triadi Desnantyo² and Lilik Herawati³

¹Medical Program, Faculty of Medicine, Universitas Airlangga, Jl. Mayjend Prof Dr Moestopo, Surabaya, Indonesia

²Department of Orthopedics, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

³Department of Physiology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia
lilik_heraw@fk.unair.ac.id

Keywords: Fitness Level, Muscle Fiber Type, Non-Invasive Method, VO₂max.

Abstract: Previous studies have proved that there is a linear correlation between VO₂max and slow-twitch fibers in athletes. These studies were done using biopsy, the invasive method, to estimate the muscle fiber type. There is also a non-invasive method, which is convenient to use and not conflicted by ethical law in Indonesia. However, further study regarding muscle fiber shifting and its correlation with the level of fitness using a non-invasive method to estimate muscle fiber is still lacking. This research aims to determine the distribution and correlation between level of fitness and muscle fiber type in non-athletes estimated by a non-invasive method. Muscle fiber type in the quadriceps muscle group and level of fitness were determined in 33 untrained male students with an average age of 20.5 y.o. Muscle fiber type was determined by a non-invasive method by counting the maximal repetition with 80% 1RM weight. The level of fitness was determined a week later by the *Astrand ergocycle* method. The slow-twitch muscle fibers dominated a high fitness level ($p=0.002$). However, the correlation test between muscle fiber types and fitness level was not significant ($p=0.551$). This result showed that a high fitness level, which has a higher oxygen consumption, has numerous slow-twitch muscle fibers. It is rich in myoglobin delivering oxygen to maintain the aerobic activity. Yet there is no correlation between the level of fitness and muscle fiber type as estimated by a non-invasive method in quadriceps. Further studies are needed to analyze several factors that may contribute to it.

1 INTRODUCTION

Physical fitness has a direct relationship with the aerobic energy system, muscle ATP-PC capacities, and lactate metabolism (Robergs, 2003). Physical fitness can be determined by measuring VO₂max or maximal oxygen uptake (Ganong, 2010). VO₂max reflects the maximal amount of oxygen that has been consumed during intense physical activity.

Muscle fiber has been classified into slow-twitch (Type I) fiber and fast-twitch (Type II) fiber (Scott et al., 2001). The term mixed-twitch fiber has been used if there is an equal proportion of slow-twitch type and fast-twitch type in one muscle group. Slow-twitch fibers have a greater aerobic capacity, larger vascular and capillary, and are more resistant to fatigue than fast-twitch fibers (Ganong, 2010). Fast-twitch muscle was used for power and speed events due to its anaerobic capacity (Berning and Steen, 2005). Skeletal muscle consists of muscle tissues

which can easily adapt due to the environment that change its constituent protein (Magaudda et al., 2004).

Several studies show that shifts in muscle fiber from fast-twitch fiber to slow-twitch fiber is possible due to long periods of endurance type events (Wilson et al., 2012). Athletes who are involved in long periods of endurance training have very high levels of VO₂max (Skinner, 2005) and a high percentage of slow-twitch fibers (Plowman, 2007). A previous study has proved that there is a linear correlation between VO₂max and slow-twitch fibers in athletes (Bergh et al., 1978). However, most of the research was carried out on athletes or trained men. Further study regarding muscle fiber shifting and its correlation with level of fitness in non-athletes and untrained men is still lacking. Moreover, a non-invasive method to identify muscle fiber type is still clearly unknown. The purpose of this study was to determine the distribution and

correlation between level of fitness and muscle fiber type in non-athletes estimated by non-invasive method.

2 MATERIALS AND METHOD

Thirty-three untrained males aged 19–22 years participated in this study. Muscle fiber type in the quadriceps muscle group was determined by counting maximal repetition with 80% 1 RM weight during leg extension. This method is introduced and applied in muscle groups, not to an individual muscle (Kraps, 2001). Maximal repetition at a predetermined load and muscle fiber type have a fair to moderate relationship (Douris et al., 2006).

Level of fitness was determined using the Astrand method to measure predictive value of VO₂max while using the ergocycle. The Astrand method has been proven to be accurate in determining VO₂max in healthy young men and women (Hoehn et al., 2015). Then, the VO₂max was classified in low, average, high, and very high levels of fitness.

3 RESULTS

Frequency distribution of muscle fiber type of quadriceps muscle group among participants is presented at Fig. 1. Fifty-five percent participants have slow-twitch fibers, 39% mixed-twitch fibers, and 6% slow-twitch fibers.

The slow-twitch muscle fibers dominate low levels and high levels of fitness. There were five participants with slow-twitch and two participants with mixed-twitch muscle fibers at a low fitness level. In the high level of fitness, there were seven participants with slow-twitch and four participants with mixed-twitch muscle fibers. However, the significant difference between slow-twitch and mixed-twitch muscle fibers ($p=0.002$) was only in high level of fitness. The participants with average level fitness were dominated by mixed-twitch muscle fibers, yet there was no significant difference. The fast-twitch muscle fiber type was detected in a small proportion ($p \geq 0.05$) on average and a very high level of fitness. The frequency of distribution based on classification of fitness level

and muscle fiber type of participants is presented in Fig 3.

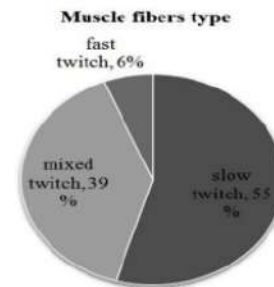


Figure 1: Frequency distribution of muscle fiber type of quadriceps muscle group (n=33).

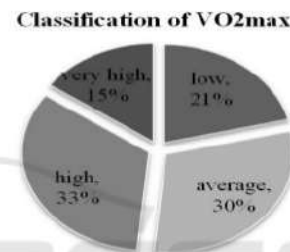


Figure 2: Frequency distribution of level of fitness (n=33).

P value was determined by the Spearman correlation test; $p = 0.551$ showed that there was no correlation between level of fitness and muscle fiber type (Table 1).

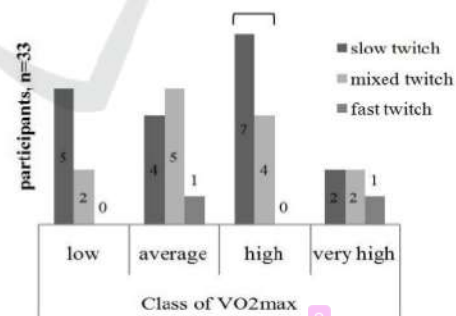


Figure 3: Frequency distribution of level of fitness on muscle fiber type.

*significant difference ($p < 0.05$) between slow and mixed-twitch muscle fibers.

Table 1. Correlation between level of fitness and muscle fiber type.

Spearman rho n=33	Classification of VO ₂ max	
Muscle fiber types	Correlation Coefficient	0.108
	Sig. (2-tailed)	0.551

4 DISCUSSION

The main finding in this study was that there is a significant difference between slow and mixed-twitch muscle fibers at a high level of fitness; however, there is no correlation between muscle fiber type and level of fitness in quadriceps of non-athletic young men. The domination of slow-twitch muscle fibers at a low and high fitness level is similar to the research by Barstow et al. (2000). Nine healthy participants were measured muscle fiber type recruitment based on the exercise intensity. The type I muscle (slow-twitch muscle fibers) was dominant in the low and/or high intensity of exercise (Barstow et al., 2000). Nevertheless, the correlation is contrary to the research from Barstow et al. (2000) and Bergh et al. (1978). One has to keep in mind that this study was done on untrained young men while their observation was done on athletes and trained men. Moreover, this study only uses quadriceps muscle to determine the muscle fiber type whereas the distribution between muscle fiber type varies in each muscle group.

There are some other factors that can influence level of fitness. Oxygen delivery is a primary factor in VO₂max limitation during exercises (Bassett and Howley, 2000). While athletes who have higher VO₂max also have a high percentage of slow-twitch fibers, VO₂max is not limited by the percentage of slow twitch muscle that someone is born with (Foss and Keteyian, 1998). Bergh's observation also found that VO₂max is higher in athletes than non-athletes in slow twitch fibers. This indicates that training and physical activities also influence VO₂max. Furthermore, studies regarding shift of muscle fiber from fast-twitch to slow twitch that was induced by training are still conflicted. It have already been cleared is muscle have the ability to alter its structural and functional properties to adapt to the environmental conditions imposed on it is known as muscle plasticity (Gransee et al., 2012). The mitogen-activated protein kinase signaling has been the possible pathway involved in exercise-induced adaptations in skeletal muscle (Hawley, 2002). Endurance exercise training can allegedly induce adaptive muscle fiber transformation and increase mitochondrial biogenesis (Wang et al., 2004).

However, the endurance training procedure and period that can actually change the fast-twitch fiber to slow-twitch fiber are still being debated. The majority of evidence still suggests that cross-innervation is the only way to effectively change the fast-twitch fiber into a slow-twitch fiber (Foss and Keteyian, 1998).

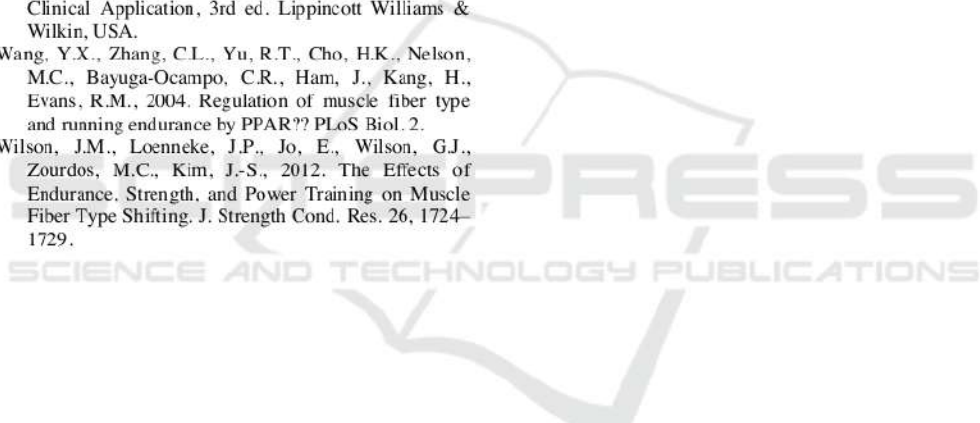
5 CONCLUSION

In summary, a high level of fitness has slow-twitch muscle fibers type domination with the invasive method; however, the correlation between the level of fitness and muscle fiber type in quadriceps of young men has not been found in this study. Many other factors can influence level of fitness and muscle fiber type distribution. Factors and metabolic change pathways as well as the training procedure and period that can actually change the muscle fiber type from fast-twitch to slow-twitch are suggested as potential for further studies.

REFERENCES

- Barstow, T.J., Jones, a M., Nguyen, P.H., Casaburi, R., 2000. Influence of muscle fibre type and fitness on the oxygen uptake/power output slope during incremental exercise in humans. *Exp. Physiol.* 85, 109–116.
- Bassett, D., Howley, E., 2000. Limiting Factors for Maximum Oxygen Uptake and Determinants of Endurance Performance. *Med. Sci. Sport. Exerc.* 32, 70–84.
- Bergh, U., Thorstensson, A., Sjodin, B., Hulten, B., Piehl, K., Karlsson, J., 1978. Maximal oxygen uptake and muscle fiber types in trained and untrained humans. *Med. Sci. Sport* 10, 151–4.
- Beming, J., Steen, S., 2005. *Nutrition for Sport and Exercise*, 2nd ed. Jones and Bartlett Publishers, Massachusetts.
- Douris, P.C., White, B.P., Cullen, R.R., Keltz, W.E., Meli, J., Mondiello, D.M., Wenger, D., 2006. The relationship between maximal repetition performance and muscle fiber type as estimated by noninvasive technique in the quadriceps of untrained women. *J. Strength Cond. Res.* 20, 699–703.
- Foss, M., Keteyian, S., 1998. *Fox's Physiological Basis for Exercise and Spor*, 6th ed. McGraw Hill, New York.
- Ganong, W., 2010. *Review of Medical Physiology*, 23th ed. The Mc Graw-Hill, California.
- Gransee, H.M., Mantilla, C.B., Sieck, G.C., 2012. Respiratory Muscle Plasticity. *Compr Physiol* 2, 1441–1462.
- Hawley, J.A., 2002. Adaptations of skeletal muscle to

- prolonged, intense endurance training. *Clin. Exp. Pharmacol. Physiol.* 29, 218–222.
- Hoehn, A.M., Mullenbach, M.J., Fontaine, C.J., 2015. Actual Versus Predicted Cardiovascular Demands in Submaximal Cycle Ergometer Testing. *Int. J. Exerc. Sci.* 8, 4–10.
- Kraps, J., 2001. Muscle Fiber Types and Training. *Track Coach* 155, 4943–4946.
- Magaudda, L., Mauro, D. Di, Trimarchi, F., Anastasi, G., Messina, G.M., 2004. Effects of Physical Exercise on Skeletal Muscle Fiber: Ultrastructural and Molecular Aspects. *J. Basic Appl Myol* 1, 17–21.
- Plowman, S., 2007. *Exercise Physiology for Health, Fitness, and Performance*. Lippincott Williams & Wilkins, USA.
- Robergs, R., 2003. *Fundamentals of Exercise Physiology*. McGraw Hill, New York.
- Scott, W., Stevens, J., Binder-macleod, S.A., 2001. Human Skeletal Muscle Fiber Type Classifications 81, 1810–1816.
- Skinner, J. 2005, 2005. *Exercise Testing and Exercise Prescription for Special Cases: Theoretical Basis and Clinical Application*, 3rd ed. Lippincott Williams & Wilkin, USA.
- Wang, Y.X., Zhang, C.L., Yu, R.T., Cho, H.K., Nelson, M.C., Bayuga-Ocampo, C.R., Ham, J., Kang, H., Evans, R.M., 2004. Regulation of muscle fiber type and running endurance by PPAR?? *PLoS Biol.* 2.
- Wilson, J.M., Loenneke, J.P., Jo, E., Wilson, G.J., Zourdos, M.C., Kim, J.-S., 2012. The Effects of Endurance, Strength, and Power Training on Muscle Fiber Type Shifting. *J. Strength Cond. Res.* 26, 1724–1729.

**PRESS**
SCIENCE AND TECHNOLOGY PUBLICATIONS

Non-Invasive Method on Slow-Twitch Quadriceps Muscle Fibers Dominate a High Level of Fitness

Yuannita Ika Putri¹, Andre Triadi Desnantyo² and Lilik Herawati³

¹Medical Program, Faculty of Medicine, Universitas Airlangga, Jl. Mayjend Prof Dr Moestopo, Surabaya, Indonesia

²Department of Orthopedics, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia

³Department of Physiology, Faculty of Medicine, Universitas Airlangga, Surabaya, Indonesia
lilik_heraw@fk.unair.ac.id

Keywords: Fitness Level, Muscle Fiber Type, Non-Invasive Method, VO₂max.

Abstract: Previous studies have proved that there is a linear correlation between VO₂max and slow-twitch fibers in athletes. These studies were done using biopsy, the invasive method, to estimate the muscle fiber type. There is also a non-invasive method, which is convenient to use and not conflicted by ethical law in Indonesia. However, further study regarding muscle fiber shifting and its correlation with the level of fitness using a non-invasive method to estimate muscle fiber is still lacking. This research aims to determine the distribution and correlation between level of fitness and muscle fiber type in non-athletes estimated by a non-invasive method. Muscle fiber type in the quadriceps muscle group and level of fitness were determined in 33 untrained male students with an average age of 20.5 y.o. Muscle fiber type was determined by a non-invasive method by counting the maximal repetition with 80% 1RM weight. The level of fitness was determined a week later by the *Astrand ergocycle* method. The slow-twitch muscle fibers dominated a high fitness level ($p=0.002$). However, the correlation test between muscle fiber types and fitness level was not significant ($p=0.551$). This result showed that a high fitness level, which has a higher oxygen consumption, has numerous slow-twitch muscle fibers. It is rich in myoglobin delivering oxygen to maintain the aerobic activity. Yet there is no correlation between the level of fitness and muscle fiber type as estimated by a non-invasive method in quadriceps. Further studies are needed to analyze several factors that may contribute to it.

1 INTRODUCTION

Physical fitness has a direct relationship with the aerobic energy system, muscle ATP-PC capacities, and lactate metabolism (Robergs, 2003). Physical fitness can be determined by measuring VO₂max or maximal oxygen uptake (Ganong, 2010). VO₂max reflects the maximal amount of oxygen that has been consumed during intense physical activity.

Muscle fiber has been classified into slow-twitch (Type I) fiber and fast-twitch (Type II) fiber (Scott et al., 2001). The term mixed-twitch fiber has been used if there is an equal proportion of slow-twitch type and fast-twitch type in one muscle group. Slow-twitch fibers have a greater aerobic capacity, larger vascular and capillary, and are more resistant to fatigue than fast-twitch fibers (Ganong, 2010). Fast-twitch muscle was used for power and speed events due to its anaerobic capacity (Berning and Steen, 2005). Skeletal muscle consists of muscle tissues

which can easily adapt due to the environment that change its constituent protein (Magaudda et al., 2004).

Several studies show that shifts in muscle fiber from fast-twitch fiber to slow-twitch fiber is possible due to long periods of endurance type events (Wilson et al., 2012). Athletes who are involved in long periods of endurance training have very high levels of VO₂max (Skinner, 2005) and a high percentage of slow-twitch fibers (Plowman, 2007). A previous study has proved that there is a linear correlation between VO₂max and slow-twitch fibers in athletes (Bergh et al., 1978). However, most of the research was carried out on athletes or trained men. Further study regarding muscle fiber shifting and its correlation with level of fitness in non-athletes and untrained men is still lacking. Moreover, a non-invasive method to identify muscle fiber type is still clearly unknown. The purpose of this study was to determine the distribution and

correlation between level of fitness and muscle fiber type in non-athletes estimated by non-invasive method.

2 MATERIALS AND METHOD

Thirty-three untrained males aged 19–22 years participated in this study. Muscle fiber type in the quadriceps muscle group was determined by counting maximal repetition with 80% 1 RM weight during leg extension. This method is introduced and applied in muscle groups, not to an individual muscle (Kraps, 2001). Maximal repetition at a predetermined load and muscle fiber type have a fair to moderate relationship (Douris et al., 2006).

Level of fitness was determined using the Astrand method to measure predictive value of VO₂max while using the ergocycle. The Astrand method has been proven to be accurate in determining VO₂max in healthy young men and women (Hoehn et al., 2015). Then, the VO₂max was classified in low, average, high, and very high levels of fitness.

3 RESULTS

Frequency distribution of muscle fiber type of quadriceps muscle group among participants is presented at Fig. 1. Fifty-five percent participants have slow-twitch fibers, 39% mixed-twitch fibers, and 6% slow-twitch fibers.

The slow-twitch muscle fibers dominate low levels and high levels of fitness. There were five participants with slow-twitch and two participants with mixed-twitch muscle fibers at a low fitness level. In the high level of fitness, there were seven participants with slow-twitch and four participants with mixed-twitch muscle fibers. However, the significant difference between slow-twitch and mixed-twitch muscle fibers ($p=0.002$) was only in high level of fitness. The participants with average level fitness were dominated by mixed-twitch muscle fibers, yet there was no significant difference. The fast-twitch muscle fiber type was detected in a small proportion ($p \geq 0.05$) on average and a very high level of fitness. The frequency of distribution based on classification of fitness level

and muscle fiber type of participants is presented in Fig 3.

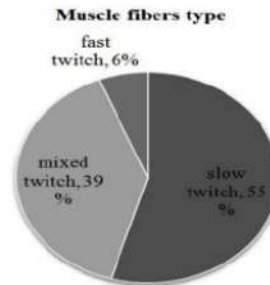


Figure 1: Frequency distribution of muscle fiber type of quadriceps muscle group (n=33).

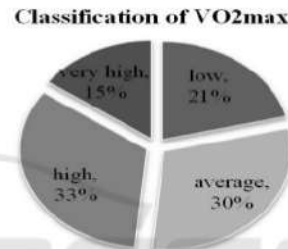


Figure 2: Frequency distribution of level of fitness (n=33).

P value was determined by the Spearman correlation test; $p = 0.551$ showed that there was no correlation between level of fitness and muscle fiber type (Table 1).

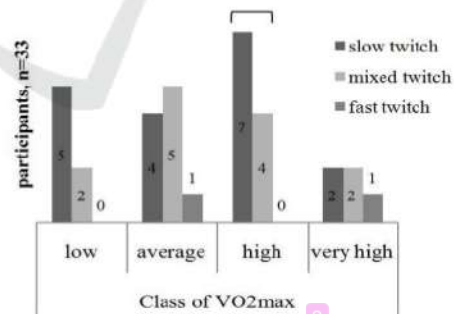


Figure 3: Frequency distribution of level of fitness on muscle fiber type.

*significant difference ($p < 0.05$) between slow and mixed-twitch muscle fibers.

Table 1. Correlation between level of fitness and muscle fiber type.

Spearman rho n=33	Classification of VO ₂ max	
Muscle fiber types	Correlation Coefficient	0.108
	Sig. (2-tailed)	0.551

4 DISCUSSION

The main finding in this study was that there is a significant difference between slow and mixed-twitch muscle fibers at a high level of fitness; however, there is no correlation between muscle fiber type and level of fitness in quadriceps of non-athletic young men. The domination of slow-twitch muscle fibers at a low and high fitness level is similar to the research by Barstow et al. (2000). Nine healthy participants were measured muscle fiber type recruitment based on the exercise intensity. The type I muscle (slow-twitch muscle fibers) was dominant in the low and/or high intensity of exercise (Barstow et al., 2000). Nevertheless, the correlation is contrary to the research from Barstow et al. (2000) and Bergh et al. (1978). One has to keep in mind that this study was done on untrained young men while their observation was done on athletes and trained men. Moreover, this study only uses quadriceps muscle to determine the muscle fiber type whereas the distribution between muscle fiber type varies in each muscle group.

There are some other factors that can influence level of fitness. Oxygen delivery is a primary factor in VO₂max limitation during exercises (Bassett and Howley, 2000). While athletes who have higher VO₂max also have a high percentage of slow-twitch fibers, VO₂max is not limited by the percentage of slow twitch muscle that someone is born with (Foss and Keteyian, 1998). Bergh's observation also found that VO₂max is higher in athletes than non-athletes in slow twitch fibers. This indicates that training and physical activities also influence VO₂max. Furthermore, studies regarding shift of muscle fiber from fast-twitch to slow twitch that was induced by training are still conflicted. It have already been cleared is muscle have the ability to alter its structural and functional properties to adapt to the environmental conditions imposed on it is known as muscle plasticity (Gransee et al., 2012). The mitogen-activated protein kinase signaling has been the possible pathway involved in exercise-induced adaptations in skeletal muscle (Hawley, 2002). Endurance exercise training can allegedly induce adaptive muscle fiber transformation and increase mitochondrial biogenesis (Wang et al., 2004).

However, the endurance training procedure and period that can actually change the fast-twitch fiber to slow-twitch fiber are still being debated. The majority of evidence still suggests that cross-innervation is the only way to effectively change the fast-twitch fiber into a slow-twitch fiber (Foss and Keteyian, 1998).


5 CONCLUSION

In summary, a high level of fitness has slow-twitch muscle fibers type domination with the invasive method; however, the correlation between the level of fitness and muscle fiber type in quadriceps of young men has not been found in this study. Many other factors can influence level of fitness and muscle fiber type distribution. Factors and metabolic change pathways as well as the training procedure and period that can actually change the muscle fiber type from fast-twitch to slow-twitch are suggested as potential for further studies.

REFERENCES

- Barstow, T.J., Jones, a M., Nguyen, P.H., Casaburi, R., 2000. Influence of muscle fibre type and fitness on the oxygen uptake/power output slope during incremental exercise in humans. *Exp. Physiol.* 85, 109–116.
- Bassett, D., Howley, E., 2000. Limiting Factors for Maximum Oxygen Uptake and Determinants of Endurance Performance. *Med. Sci. Sport. Exerc.* 32, 70–84.
- Bergh, U., Thorstensson, A., Sjodin, B., Hulten, B., Piehl, K., Karlsson, J., 1978. Maximal oxygen uptake and muscle fiber types in trained and untrained humans. *Med. Sci. Sport* 10, 151–4.
- Beming, J., Steen, S., 2005. *Nutrition for Sport and Exercise*, 2nd ed. Jones and Bartlett Publishers, Massachusetts.
- Douris, P.C., White, B.P., Cullen, R.R., Keltz, W.E., Meli, J., Mondiello, D.M., Wenger, D., 2006. The relationship between maximal repetition performance and muscle fiber type as estimated by noninvasive technique in the quadriceps of untrained women. *J. Strength Cond. Res.* 20, 699–703.
- Foss, M., Keteyian, S., 1998. *Fox's Physiological Basis for Exercise and Spor*, 6th ed. McGraw Hill, New York.
- Ganong, W., 2010. *Review of Medical Physiology*, 23th ed. The Mc Graw-Hill, California.
- Gransee, H.M., Mantilla, C.B., Sieck, G.C., 2012. Respiratory Muscle Plasticity. *Compr Physiol* 2, 1441–1462.
- Hawley, J.A., 2002. Adaptations of skeletal muscle to

- prolonged, intense endurance training. *Clin. Exp. Pharmacol. Physiol.* 29, 218–222.
- Hoehn, A.M., Mullenbach, M.J., Fontaine, C.J., 2015. Actual Versus Predicted Cardiovascular Demands in Submaximal Cycle Ergometer Testing. *Int. J. Exerc. Sci.* 8, 4–10.
- Kraps, J., 2001. Muscle Fiber Types and Training. *Track Coach* 155, 4943–4946.
- Magaudda, L., Mauro, D. Di, Trimarchi, F., Anastasi, G., Messina, G.M., 2004. Effects of Physical Exercise on Skeletal Muscle Fiber: Ultrastructural and Molecular Aspects. *J. Basic Appl Myol* 1, 17–21.
- Plowman, S., 2007. *Exercise Physiology for Health, Fitness, and Performance*. Lippincott Williams & Wilkins, USA.
- Robergs, R., 2003. *Fundamentals of Exercise Physiology*. McGraw Hill, New York.
- Scott, W., Stevens, J., Binder-macleod, S.A., 2001. Human Skeletal Muscle Fiber Type Classifications 81, 1810–1816.
- Skinner, J. 2005, 2005. *Exercise Testing and Exercise Prescription for Special Cases: Theoretical Basis and Clinical Application*, 3rd ed. Lippincott Williams & Wilkin, USA.
- Wang, Y.X., Zhang, C.L., Yu, R.T., Cho, H.K., Nelson, M.C., Bayuga-Ocampo, C.R., Ham, J., Kang, H., Evans, R.M., 2004. Regulation of muscle fiber type and running endurance by PPAR?? *PLoS Biol.* 2.
- Wilson, J.M., Loenneke, J.P., Jo, E., Wilson, G.J., Zourdos, M.C., Kim, J.-S., 2012. The Effects of Endurance, Strength, and Power Training on Muscle Fiber Type Shifting. *J. Strength Cond. Res.* 26, 1724–1729.

**PRESS**
SCIENCE AND TECHNOLOGY PUBLICATIONS

High-Calorie Diet Reduces Neuroglia Count

ORIGINALITY REPORT

18%

SIMILARITY INDEX

13%

INTERNET SOURCES

11%

PUBLICATIONS

0%

STUDENT PAPERS

PRIMARY SOURCES

- 1** sipsfk.conference.unair.ac.id 1%

Internet Source
- 2** Rochelle Goldsmith, Denis R. Joannis, Dympna Gallagher, Katherine Pavlovich et al. "Effects of experimental weight perturbation on skeletal muscle work efficiency, fuel utilization, and biochemistry in human subjects", American Journal of Physiology-Regulatory, Integrative and Comparative Physiology, 2010 1%

Publication
- 3** cmuj.cmu.ac.th 1%

Internet Source
- 4** tomnikkola.com 1%

Internet Source
- 5** "Abstracts", Diabetologia, 1997 1%

Publication
- 6** repository.uin-malang.ac.id 1%

Internet Source
- 7** D.E. Rivera-Aponte, M.P. Méndez-González,

A.F. Rivera-Pagán, Y.V. Kucheryavykh et al.
"Hyperglycemia reduces functional expression
of astrocytic Kir4.1 channels and glial glutamate
uptake", Neuroscience, 2015

Publication

<1%

8

sintadev.ristekdikti.go.id

Internet Source

<1%

9

conservancy.umn.edu

Internet Source

<1%

10

eprints.umm.ac.id

Internet Source

<1%

11

onlinelibrary.wiley.com

Internet Source

<1%

12

archive.org

Internet Source

<1%

13

I. Nyoman Suarsana, Iwan Harjono Utama, I.
Made Kardena. "Immunohistochemical
Expression of Insulin and Glucagon, Superoxide
Dismutase and Catalase Activity in Pancreas in
Hyperglycaemia Condition", Asian Journal of
Biochemistry, 2016

Publication

<1%

14

www.scitepress.org

Internet Source

<1%

15

www.ncbi.nlm.nih.gov

Internet Source

<1%

16

Bodié, Karen, Wayne R. Buck, Julia Pieh,
Michael J. Liguori, and Andreas Popp.

"Biomarker evaluation of skeletal muscle toxicity
following clofibrate administration in rats",
Experimental and Toxicologic Pathology, 2016.

Publication

<1%

17

Galih Sampoerno, Jenny Sunariani, Kuntaman.

"Expression of NaV-1.7, TNF- α and HSP-70 in
experimental flare-up post-extirpated dental pulp
tissue through a neuroimmunological approach",
The Saudi Dental Journal, 2020

Publication

<1%

18

www.semanticscholar.org

Internet Source

<1%

19

www.fasebj.org

Internet Source

<1%

20

link.springer.com

Internet Source

<1%

21

repository.unair.ac.id

Internet Source

<1%

22

www.omicsonline.org

Internet Source

<1%

23

"1-A1: Lung Cancer 1 : Poster Sessions",
Respirology, 2013.

Publication

<1%

24	scholarworks.gsu.edu Internet Source	<1%
25	repositorio.pgsskroton.com.br Internet Source	<1%
26	High Calorie Diet and the Human Brain, 2015. Publication	<1%
27	www.studyblue.com Internet Source	<1%
28	Fabrisia Ambrosio, Yong Li, Arvydas Usas, Michael Boninger L., Johnny Huard. "Chapter 22 Muscle Repair after Injury and Disease", Springer Science and Business Media LLC, 2008 Publication	<1%
29	akademik.unsoed.ac.id Internet Source	<1%
30	Putri Sari Wulandari, Juniastuti, Rury Mega Wahyuni, Mochamad Amin et al. "Predominance of Norovirus GI.4 From Children With Acute Gastroenteritis In Jambi, Indonesia, 2019", Journal of Medical Virology, 2020 Publication	<1%
31	worldwidescience.org Internet Source	<1%
32	Eline Lievens, Malgorzata Klass, Tine Bex, Wim	

Derave. "Muscle fiber typology substantially influences time to recover from high-intensity exercise", Journal of Applied Physiology, 2020

Publication

<1%

33

"Essentials of Sports Nutrition Study Guide", Springer Science and Business Media LLC, 2008

Publication

<1%

34

Anting Wulandari, Titi Candra Sunarti, Farah Fahma, Toshiharu Enomae. "The potential of bioactives as biosensors for detection of pH", IOP Conference Series: Earth and Environmental Science, 2020

Publication

<1%

35

Reinaldo Abunasser Bassit, Carlos Hermano da Justa Pinheiro, Kaio Fernando Vitzel, Antônio José Sproesser et al. "Effect of short-term creatine supplementation on markers of skeletal muscle damage after strenuous contractile activity", European Journal of Applied Physiology, 2009

Publication

<1%

36

asean-endocrinejournal.org

Internet Source

<1%

37

"Abstracts", Hepatology International, 2020

Publication

<1%

"Endurance in Sport", Wiley, 2000

38

Publication

<1%

39

heanoti.com

Internet Source

<1%

40

e-journal.unair.ac.id

Internet Source

<1%

41

doaj.org

Internet Source

<1%

42

Neural Functions of the Delta-Opioid Receptor, 2015.

Publication

<1%

43

Heikki O. Tikkanen, Hannu Näveri, Matti Härkönen. "Skeletal muscle fiber distribution influences serum high-density lipoprotein cholesterol level", Atherosclerosis, 1996

Publication

<1%

44

avicennanotes.blogspot.com

Internet Source

<1%

45

healthyeating.sfgate.com

Internet Source

<1%

46

www.jissn.com

Internet Source

<1%

47

www.e-sciencecentral.org

Internet Source

<1%

48 N Purnami, S P P Manyakori. "Reactive oxygen species levels are high risk worker of noise induced hearing loss in hospitals", Journal of Physics: Conference Series, 2018
Publication <1%

49 "Abstracts", Diabetologia, 1990
Publication <1%

50 ppjpi.unair.ac.id
Internet Source <1%

51 www.journal.unair.ac.id
Internet Source <1%

52 jissn.biomedcentral.com
Internet Source <1%

53 Rivera-Aponte, D.E., M.P. Méndez-González, A.F. Rivera-Pagán, Y.V. Kucheryavykh, L.Y. Kucheryavykh, S.N. Skatchkov, and M.J. Eaton. "Hyperglycemia reduces functional expression of astrocytic Kir4.1 channels and glial glutamate uptake", Neuroscience, 2015.
Publication <1%

54 etheses.bham.ac.uk
Internet Source <1%

55 digilib.unila.ac.id
Internet Source <1%

56 creativearts.isi.ac.id

Internet Source

<1%

57

Keyvan Hejazi, Seyyed Reza Attarzadeh Hosseini, Mehrdad Fathi, Mohammad Mosaferi Ziaaldini. "Responses of Visfatin and Resistin Concentration to Different Aerobic Training Intensities Protocols", Annals of Military and Health Sciences Research, 2020

Publication

<1%

58

mafiadoc.com

Internet Source

<1%

59

"Abstracts—APASL 2013", Hepatology International, 2013

Publication

<1%

60

jifo.or.id

Internet Source

<1%

61

kuscholarworks.ku.edu

Internet Source

<1%

62

journals.physiology.org

Internet Source

<1%

63

theses.uin-malang.ac.id

Internet Source

<1%

64

jneuroinflammation.biomedcentral.com

Internet Source

<1%

jap.physiology.org

65

Internet Source

<1%

66

www.frontiersin.org

Internet Source

<1%

67

Jeongae Yoon, Jungseo Park, Daehee Lee, Hyolyun Roh. "Comparisons of Respiratory Function and Activities of Daily Living between Spinal Cord Injury and Stroke Patients and Normal Elderly People", Journal of Physical Therapy Science, 2012

Publication

<1%

68

"Taurine 8", Springer Science and Business Media LLC, 2013

Publication

<1%

69

Jongmin Lee, Michael Reding. "Effects of Thiazolidinediones on Stroke Recovery: A Case-Matched Controlled Study", Neurochemical Research, 2006

Publication

<1%

70

staffnew.uny.ac.id

Internet Source

<1%

71

pst.or.th

Internet Source

<1%

72

Dion Krismashogi Dharmawan, Viskasari P Kalanjati, Abdurachman Abdurachman. "PENGARUH SHIELDING ALUMINIUM FOIL

<1%

TERHADAP PERUBAHAN KETEBALAN
LAPISAN EPITEL KORNEA AKIBAT PAPARAN
RADIASI GELOMBANG ELEKTROMAGNETIK
PADA TIKUS WISTAR JANTAN", Jurnal
Kedokteran dan Kesehatan : Publikasi Ilmiah
Fakultas Kedokteran Universitas Sriwijaya, 2020
Publication

73 Andrea Pereira Rosa, Caroline Paula Mescka, Felipe Maciel Catarino, Alexandre Luz de Castro et al. "Neonatal hyperglycemia induces cell death in the rat brain", Metabolic Brain Disease, 2017
Publication <1%

74 Joana M. Gaspar, Filipa I. Baptista, M. Paula Macedo, António F. Ambrósio. "Inside the Diabetic Brain: Role of Different Players Involved in Cognitive Decline", ACS Chemical Neuroscience, 2015
Publication <1%

75 dia-endojournals.ru
Internet Source <1%

76 hdl.handle.net
Internet Source <1%

77 Zhang, R.L.. "Metabolic changes of arachidonic acid after cerebral ischemia-reperfusion in diabetic rats", Experimental Neurology, 200312
Publication <1%

78 Marc Claret, Helena Corominola, Ignasi Canals, Belén Nadal et al. "S 23521 Decreases Food Intake and Body Weight Gain in Diet-Induced Obese Rats", Obesity Research, 2004
Publication <1%

79 Matthias K Auer, Markus Sack, Jenny N Lenz, Mira Jakovcevski et al. "Effects of a High-Caloric Diet and Physical Exercise on Brain Metabolite Levels: A Combined Proton MRS and Histologic Study", Journal of Cerebral Blood Flow & Metabolism, 2015
Publication <1%

80 thejnp.org
Internet Source <1%

81 Darren J. Fernandes, Shoshana Spring, Anna R. Roy, Lily R. Qiu, Yohan Yee, Brian J. Nieman, Jason P. Lerch, Mark R. Palmert. "Exposure to maternal high-fat diet induces extensive changes in the brain of adult offspring", Cold Spring Harbor Laboratory, 2020
Publication <1%

82 elibrary.almaata.ac.id
Internet Source <1%

83 journal.fk.unpad.ac.id
Internet Source <1%

84 nrl.northumbria.ac.uk
Internet Source <1%

85

ressources.modyco.fr

Internet Source

<1%

86

E. Seidel, M. Rother, J. Hartmann, I. Rother, T. Schaaf, M. Winzer, A. Fischer, K. Regenspurger. "Eccentric Exercise and Delayed Onset of Muscle Soreness (DOMS) - an Overview", Physikalische Medizin, Rehabilitationsmedizin, Kurortmedizin, 2012

Publication

<1%

87

Lilik Herawati, Gadis Meinar Sari, Roedi Irawan. "High Glycemic Index Diet Decreases Insulin Secretion without Altering Akt and Pdx1 Expression on Pancreatic Beta Cells in Mice", Chiang Mai University Journal of Natural Sciences, 2020

Publication

<1%

88

T. I. Alekseyeva. "THE GEOGRAPHICAL ENVIRONMENT AND HUMAN BIOLOGY (the anthropological aspect)", Soviet Geography, 2013

Publication

<1%

89

I. Vechetti-Júnior, A. Aguiar, R.W. de Souza, F.L. Almeida et al. "NFAT Isoforms Regulate Muscle Fiber Type Transition without Altering CaN during Aerobic Training", International Journal of Sports Medicine, 2013

Publication

<1%

90

repository.petra.ac.id

Internet Source

<1%

91

jpa.ub.ac.id

Internet Source

<1%

Exclude quotes On

Exclude matches Off

Exclude bibliography On

High-Calorie Diet Reduces Neuroglia Count

GRADEMARK REPORT

FINAL GRADE

/100

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9

PAGE 10

PAGE 11

PAGE 12

PAGE 13

PAGE 14

PAGE 15

PAGE 16

PAGE 17

PAGE 18

PAGE 19

PAGE 20

PAGE 21

PAGE 22

PAGE 23

PAGE 24

PAGE 25

PAGE 26

PAGE 27

PAGE 28

PAGE 29

PAGE 30

PAGE 31

PAGE 32

PAGE 33

PAGE 34

PAGE 35

PAGE 36

PAGE 37

PAGE 38
