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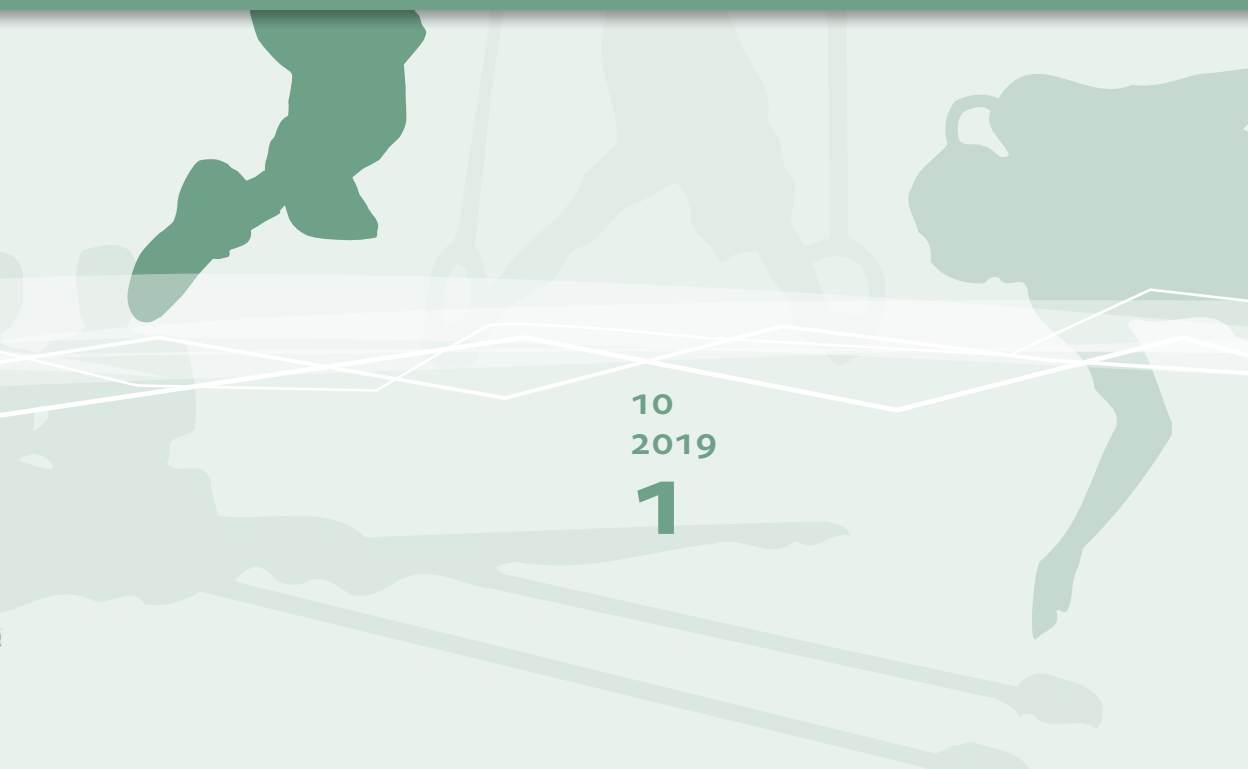

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EDITORIAL

Numerous mechanisms of the impact of exercise/sports activity on our health and quality of life have been addressed several times in previous studies, and their direct and indirect impact on an individual and the wider society has been proven many times. Nevertheless, the field of study of individual motor, cognitive, and nutritional intervention remains one of the most interesting and effective, as well as economically acceptable, approaches within the framework of public health solutions. At times, it may seem that only the desire for the ultimate performance of movement with the goal of a good sporting result receives an in-depth individual treatment, but this is not the case. It is true that with today's approaches to diagnostics and finding the background of a good result, we can get closer to an individual and, on the basis of scientific findings, direct further training regimes, as presented by the author of the first article in this issue. However, the following three articles bring us closer to the importance of individualizing the approach to each user according to their specific needs, dietary regimes and exercise incentives. Certain environments are particularly encouraging, and the Mediterranean environment is certainly one of the most suitable ones, be it a specific natural or social environment. In the final articles and the researchers' reports, we receive further confirmation of how researchers from different corners of the world, with different interests, orientations and aims, are jointly oriented towards, more or less, the same goal. How to ensure a healthy and quality life for modern people, entangled in many (virtual) communication networks, supported by innovative technologies of the digitalized world, which, due to their own development, has fallen into more or less planned, and, unfortunately, unsolicited and unwanted anthropological and ecological transformations? Often we think we know several solutions; however, either with a quick glance around us or following research on these indicators, the opposite is confirmed. Never in the familiar history of mankind have we communicated so poorly, never have we been so unsociable, or so mentally and functionally labile and incapable. Therefore, there is still a lot of room for research and the work of kinesiologists and many other professionals who strive in similar directions.

Prof. Rado Pišot, PhD
Editor in Chief

UVODNIK

Številni mehanizmi vpliva gibalne/športne dejavnosti na zdravje in kakovost življenja so bili v predhodnih študijah že večkrat obravnavani, njihov neposreden in posreden vpliv na posameznika in širšo družbo pa tudi že večkrat dokazan. Kljub temu je področje proučevanja posameznih gibalnih, kognitivnih in prehranskih intervencij še vedno eden najzanimivejših in najučinkovitejših ter ne nazadnje tudi ekonomično najsprejemljivejših pristopov v okviru javnozdravstvenih rešitev. Včasih se zdi, da je le želja vrhunske izvedbe gibanja zaradi športnega rezultata deležna poglobljene individualne obravnave, vendar ni tako. Res je sicer, da se z današnjimi pristopi v diagnostiki in iskanju ozadij dobrega rezultata posamezniku lahko popolnoma približamo in na osnovi znanstvenih ugotovitev usmerjamo nadaljnje trenažne pristope, kot so predstavili avtorji prvega prispevka v izdaji revije, ki je pred vami. Vendar pa nam naslednji trije prispevki zelo nazorno približajo pomen individualizacije pristopa za vsakega uporabnika glede na njegove specifične potrebe, prehranske režime in gibalne spodbude. Pri tem so določena okolja še posebej spodbudna in sredozemsko je z vsem, kar mu nudita posebno naravno in družbeno okolje, prav gotovo eno najprimernejših. V končnih prispevkih, poročilih raziskovalcev, pa lahko dobimo le še dodatne potrditve, kako so raziskovalci na različnih koncih sveta, z različnimi interesi, usmeritvami in cilji, ne glede na to, od kod prihajajo, skupaj usmerjeni k bolj ali manj enakemu cilju. Kako sodobnemu človeku, zapletenemu v številne (virtualne) komunikacijske mreže, podprte z inovativnimi tehnologijami digitaliziranega sveta, ki je zaradi svojega razvoja padel v bolj ali manj načrtovane, večkrat pa žal tudi neslutene in neželene antropološke in ekološke transformacije, zagotoviti zdravo in kakovostno življenje? Večkrat menimo, da poznamo ogromno rešitev, že bežen pogled okoli sebe in še toliko bolj raziskani kazalniki pa kažejo prav nasprotno. Nikoli v nam znani zgodovini človeštva nismo tako slabo komunicirali, se družili, bili duševno in funkcionalno tako labilni in nezmožni. Torej je prostora za raziskave in delo kineziologov in številnih drugih strokovnjakov, ki si prizadevajo za to, še veliko.

Prof. dr. Rado Pišot,
glavni in odgovorni urednik

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THE IMPACT OF THE 2013 RULE CHANGES ON GRIPPING CONFIGURATION IN HIGH-LEVEL JUDO ATHLETES

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ABSTRACT

Purpose: *International Judo Federation introduced a set of new rules in a short time period (2009 − 2013). The aim of this research is to determine how the rule modification influences the gripping configurations used by elite male judo athletes.*

Methods: *The sample contained 280 combats from the 2011 and 2014 World Championships. All the effective and ineffective throw attempts with related gripping configurations were registered.*

The Chi-square test was used to determine the difference between frequencies, along with Z-test for calculating the partial difference.

Results: *A total of 1707 actions and gripping configurations were registered. The Chi-square test showed that there is a significant difference in the usage of gripping configurations between the two championships ($\chi 2=32,8$; $sig<0,001$). The Z-test showed a significant increase in the usage of kenka-yotsu and ai-yotsu, and a significant decrease in the usage of central grip, cross grip and situations where only tori has established a grip. The difference in the usage of the same side grip was not detected.*

Conclusion: *The recommendation for coaches is to reduce the use of all other gripping configurations except kenka-yotsu and ai-yotsu when practicing techniques, especially unorthodox gripping like the cross grip and the same side grip.*

Keywords*: kumikata, technical-tactical analysis, performance analysis, combat sports.*

VPLIV LETA 2013 UVEDENIH SPREMEMB PRAVIL NA IZVAJANJE TEHNIK PRIJEMA PRI VRHUNSKIH MOŠKIH JUDOISTIH

IZVLEČEK

Cilj: *Mednarodna judo federacija (IJF) je v sorazmerno kratkem obdobju med leti 2009 in 2013 uvedla vrsto novih pravil. Cilj te raziskave je ugotoviti, kako so te spremembe vplivale na izvajanja tehnik prijema pri vrhunskih moških judoistih.*

Metode: *V raziskavo je bilo vključenih 280 borb iz svetovnih prvenstev v letih 2011 in 2014 in registrirani so bili vsi uspešno, kot tudi neuspešno zaključeni prijemi.*

Hi-kvadrat test je bil uporabljen za ugotavljanje razlik v porazdelitvi frekvenc in Z-test za izračun razlik.

Rezultati: *Skupno je bilo registriranih 1707 akcij in tehnik prijema. Hi-kvadrat test je pokazal, da obstaja pri izvajanju tehnik prijema med obema prvenstvoma pomembna razlika (χ^2=32,8; sig<0,001). Rezultati Z-testa so pokazali, da je prišlo do povečanja frekvence uporabe prijemov kenka-yotsu in ai-yotsu, in značilno zmanjšanje frekvenc uporabe sredinskega prijema, nasprotnega (križnega) prijema in akcij, kjer je prijem izvedel le izvajalec prijema. Ni bilo razlik med uporabo levega in desnega prijema.*

Zaključek: *Rezultati raziskave navajajo priporočilo trenerjem, da se pri treningu tehnike prijema čim manj poslužujejo vseh konfiguracij prijema razen kenka-yotsu in ai-yotsu. Še zlasti to velja za neortodoksne vrste prijemov, kot so nasprotni prijem in levi oz. desni prijem.*

Ključne besede*: kumi kata, tehnično-taktična analiza, izvedbena analiza, borilni športi.*

INTRODUCTION

A continuous search for improvement made a significant change in judo rules in the last decade. Aiming to promote more attacking style and improve audience understanding of the fight, International Judo Federation introduced a set of new rules in a short time period (Boguszewski, 2011; Franchini, Takito, & Calmet, 2013; Ito et al., 2013; Calmet, Pierantozzi, Sterkowicz, Challis, & Franchini, 2017). Including blue and white judogi, excluding the smallest point *koka*, adding and changing the rules of the fight in the situation of an equal score at the end of the regular time of the fight – it was all a prelude to the most significant rule change in the history of the sport. In 2009, IJF limited direct contact of the attacker's hand below the belt of the opponent (allowed only in counter-attack or as a second part of the combination of techniques). First in 2013, all techniques that include leg grab were completely banned (Franchini, Takito & Calmet, 2013). This is highly important because the execution of some of the most

efficient techniques (te guruma, kata guruma, kuchiki taoshi, morote gari) include grabbing the leg of the opponent (Miarka, Ferreira Julio, Del Vecchio, Calmet, & Franchini, 2010). Secondly, they reduced the importance of penalties in favor of attacking scores. Thirdly, kumikata fighting (grip fighting) was totally altered by forbidding the competitors to break grip with both hands simultaneously. Also, they demand from the judokas to attack "immediately" in the situations where they are having any other grip that is different from the classic judo grip. For both of the above-mentioned infringements, judokas will be penalized with shido (International Judo Federation – IJF, 2013).

These are sport-changing modifications since grip fighting phase makes up a large part of the total combat time (Barreto et al., 2019) and having a dominant grip is one of the most important factors for the positive outcome of the combat (Kajmovic, Rađo, Mekic, Crnogorac & Colakhodzic, 2014). The players who are able to establish their grip during the fight have more chances to apply their throwing technique or to enforce a penalty to their opponent by making them passive. Grip fighting is also an important factor that distinguishes elite judokas from average and it is documented that it is different in relation to sex, age, weight and judokas' proficiency (Calmet, Miarka & Franchini, 2010; Miarka et al., 2012, Miarka et al., 2014; Miarka, Sterkowicz-Przybycien & Fukuda, 2017; Barreto et al., 2019; Dal Bello, Aedo-Muñoz, Brito, & Miarka, 2019). IJF assumed that changing the kumikata rules will shorten the grip fight and force the judokas to spend more time in firm contact, which is necessary to perform a throw.

Influence of the rule modifications was investigated in the terms of scores and penalties, match duration and the efficiency of judo techniques (Adam et al., 2012; Franchini, Takito & Calmet, 2013; Calmet et al., 2017; Calmet, Pierantozzi, Sterkowicz, Takito, & Franchini, 2017). There is scarce evidence about the impact made to gripping strategy used in combat. Therefore, the aim of this research is to determine how the rule modification influences the gripping configurations used by elite male judo athletes. We hypothesised that the rule modification will influence gripping configurations in elite male judo athletes.

METHODS

Sample

The sample contained 280 fights from two World Championships (2011 Paris World Championships and 2014 Chelyabinsk World Championships). To ensure the elite characteristic of the sample, preliminary rounds of the tournament were excluded. Final, bronze medal matches, semi-finals, repechages, 1/4 and 1/8 finals from each of the seven men weight divisions were analyzed. For a more detailed analysis, the categories were classified as light (-60kg and -66kg), middle (73kg, -81kg and -90kg) and heavy (-100kg and +100kg) according to a previous classification made elsewhere (Escobar-Molina, Courel, Franchini, Femia, & Stankovic, 2014; Stankovic, Cuk, Milosevic, & Stamenkovic, 2015).

Variable Data

Effective actions that ended with a score announced by the referee and ineffective actions in which a contestant clearly unbalanced his adversary were included in the analysis. The observers' task was to associate the appropriate grip configuration with every action that was registered. Gripping variables were as follows: a) ai-yotsu (both athletes used the same grip – right or left); b) central grip (both athletes were gripping the sleeves or lapels at the same time); c) same side grip (the athlete attacking was using a classic lapel grip, but instead of holding the opposite sleeve, he was holding the sleeve on the same side of lapel grip); d) kenka-yotsu (each athlete was holding the opposite grip compared to the opponents grip (i.e., right versus left)); e) cross grip (the athlete attacking was having a classic sleeve grip, but instead of holding opposite lapel, he was holding the lapel on the same side of sleeve grip) and f) only one athlete (tori) was having a grip (the athlete attacking performed the grip and applied the technique before the opponent establishes his grip) (Courel, Franchini, Femia, Stankovic, & Escobar-Molina, 2014; Stankovic et al., 2015). These grip configurations take into consideration the interaction between the fighters, instead of analyzing only the fighter who is performing the throw attempt. The ai-yotsu and kenka-yotsu grip explain clearly the relations between the judokas. Cross grip, same side grip, and central grip are unorthodox gripping configurations that favor one of the athletes and the referee is obliged to stop the fight and award a penalty to an athlete that was holding this kind of grip for more than five seconds without initiating an attack. There were also situations where the attack was initiated before the opponent was able to establish his grip.

Procedures

All videos included were provided by the International Judo Federation via their official Dartfish.tv – Channel. Landscape view of the entire competition area and video quality (standard definition 480/60i) provided the necessary ecological validity of the sample. The free computer version of Lince 1.2.1 software, flexible digital recording software that enables data exportation, was used to collect data (Gabin, Camerino, Anguera & Castañer, 2012).

Reliability Testing

Two experts with more than 25 years of judo experience, at least 4th Dan-degree black belt and PhD in Sports Science conducted the analysis. The reliability measures were assessed through intra-observer and inter-observer testing procedures. The following Kappa values and strength of agreement classifications were used: 0.0 to 0.2, poor; 0.21 to 0.40, fair; 0.41 to 0.60, moderate; 0.61 to 0.80, substantial; 0.81 to 1.00, almost perfect (Hopkins, 2000). The index and classification of Kappa values for Inter-expert

(0.74) and Intra-expert (0.88 and 0.91) measurements were classified as "Strong" and "Almost perfect".

Statistical Analysis

To determine the difference between the two world championships, the Chi-square test at the level of statistical significance of 0,05% with contingency tables to determine the difference between frequencies was used, along with the Z-test for calculating the partial difference between each variable that was analyzed. Data were analyzed using the IBM SPSS 20.0.

RESULTS

A total of 280 matches were analyzed, from which 1707 actions were extracted (6.1 per match). Number of actions per match increased from 5.4 in 2011 to 6.8 in 2014. The difference in the gripping configurations applied between the two world championships was determined by the χ^2 test (Table 1). A test result of sig <0.001 indicates that there are statistically significant differences in the gripping configurations used.

Table 1. Chi-square test for gripping configurations observed at two championships.

	AI-YOTSU	CENTRAL GRIP	SAME SIDE GIRP	KENKA-YOTSU	CROSS GRIP	TORI GRIPS	Total
2011	183 (24,11%)	78 (10,28%)	37 (4,87%)	288 (37,94%)	85 (11,2%)	88 (11,59%)	759
2014	257 (27,11%)	81 (8,54%)	47 (4,96%)	436 (45,99%)	51 (5,38%)	76 (8,02%)	948
Total	440	159	84	724	136	164	1707
χ^2=32,8; sig<0,001							

To determine which gripping configurations contributed to the differences between the two samples, a Z-test was performed for the proportions of the two independent samples. Based on the results obtained, it can be concluded that the ai yotsu and kenka-yotsu configurations were more prevalent in 2014, and the central grip, cross grip and tori grips were more used in 2011.

Table 2. Z-test for gripping configurations observed at two championships.

	2011	2014	z	sig
AI-YOTSU	183 (24,11%)	257 (27,11%)	-2.77	0,006
CENTRAL GRIP	78 (10,28%)	81 (8,54%)	4.01	<0.001
SAME SIDE GRIP	37 (4,87%)	47 (4,96%)	-0.35	0.723
KENKA-YOTSU	288 (37,94%)	436 (45,99%)	-5.11	<0.001
CROSS GRIP	85 (11,2%)	51 (5,38%)	15.63	<0.001
TORI GRIPS	88 (11,59%)	76 (8,02%)	8.04	<0.001

By using the χ^2 test we found a statistically significant difference when comparing two championships separately by each weight category ($p<0.05\%$). To determine which gripping configurations contributed to the differences between the two samples, the Z-test was performed. In Table 3 the difference between the two championships by weight category was presented.

Table 3. Z-test for gripping configurations observed at two championships by weight division.

	LIGHTWEIGHT (-60 ,-66)	MIDDLEWEIGHT (-73 ,-81, -90)	HEAVYWEIGHT (-100, +100)	2011-2014 (Total)
AI-YOTSU	↔ (p=0,682)	↑ (p<0.001)	↑ (p=0.003)	↑
CENTRAL GRIP	↔ (p=0,922)	↓ (p<0.001)	↔ (p=0.633)	↓
SAME SIDE GRIP	↑ (p=0.036)	↑ (p=0.003)	↓ (p<0.001)	↔
KENKA-YOTSU	↑ (p<0.001)	↔ (p=0,112)	↑ (p=0.017)	↑
CROSS GRIP	↓ (p<0.001)	↓ (p<0.001)	↓ (p<0.001)	↓
TORI GRIPS	↓ (p<0.001)	↔ (p=0.335)	↓ (p<0.001)	↓

↔ There is no statistical difference between the two championships; ↑ there is a statistically significant increase in the usage of kumikata; ↓ there is a statistically significant decrease in the usage of kumikata.

DISCUSSION

The aim of the present study is was to determine how the rule modification influences the gripping configurations used by elite male judo athletes. A total of 1707 gripping configurations connected to the throwing attempt were registered in a sample of 280 fights, with 6.1 throwing attempts per match on average. A similar number of fights (242) and throwing attempts (1462) were analyzed in studies conducted by Courel et al. (2014) and Escobar-Molina et al. (2014), noting that their sample consisted of both male and female combats. On average, in these two studies, there was the same number of throw attempts per match (6.0 vs. 6.1). A similar result (7.0) was reported on the sample of International championship matches held during 2011 and 2012, while there were significantly more throwing attempts per combat (9.0) registered at the 2012 Olympics (Miarka et al., 2016). The dominant configurations in both championships

were kenka yotsu, followed by ai yotsu. While using kenka-yotsu, athletes are typically in an asymmetrical position which increases their chance to score (Mayo, Dopico-Calvo, & Iglesias-Soler, 2019) while not compromising the defense (Courel et al., 2014). In seniors, the same conclusion was reached by Courel et al. (2014), while in two other studies ai yotsu was the dominant gripping configuration (Kajmovic & Radjo, 2014; Kajmovic, et al., 2014). A possible explanation is a different sample used in the terms of the level of competition (national vs. elite) and different age categories (cadet vs. senior) when compared to our sample.

As expected, new gripping rules have increased the difficulty of breaking the grip, leading to a significant increase of grip configurations where tori and uke have a strong connection (kenka-yotsu and ai-yotsu). Consequently, a shorter time period judokas spent separated led to a significant decrease in the situations where only one judoka (tori) had a grip. These trends were clearly visible even when the sample was divided by weight category on light, middle and heavyweight.

International Judo Federation wanted to discourage the use of any unorthodox gripping that will give a clear attacking or defensive advantage to one of the contestants. To avoid a potential penalty, they demand from the judokas to attack "immediately" in the situations where they are having any other grip than the classic judo grip. The result is a significant decrease in the usage of cross grip. The decrease is observed in the whole sample, but also when analyzing by weight category. The use of the central grip decreased significantly. Since central grip configuration is a defensive grip, used to block the opponent's attacks rather than to produce our own, the registered decrease can be characterized as a positive outcome of the rule changes.

We hypothesize that the absence of significant differences in the usage of same side grip was due to a modification of one of the most utilized judo techniques − kata guruma (Miarka et al., 2010; Witkowski, Maśliński, & Kotwica, 2012). The classic kata guruma is performed by grabbing the opponent's leg, which was previously allowed. Now, judokas avoid breaking new rules while applying kata guruma by grabbing the sleeve instead of the leg of the opponent (Ito et al. 2013). The significant increase of the same side grip was observed in light and middleweight categories, while there was a decrease in heavyweight. Kata guruma is rarely used by heavyweights since for executing the technique one needs to hold complete weight of the opponent on the shoulders.

The present results demonstrated the differences in the usage of gripping configurations before and after the rule change. The fact that ai yotsu and kenka yotsu combined for 73% of all grip configurations used in 2014 (vs. 62% in 2011) further highlights the importance of the firm connection between the judokas during the execution of the throw. By shortening the allowed time to use unorthodox grips, the usage of these grips during the attacking actions was reduced significantly (from 16% in 2011 to 10% in 2014).

CONCLUSION

The current research aimed to compare gripping configurations used in two world championships. Summarizing the results it can be stated that the aimed outcomes of the gripping rule modification have been achieved. By making it harder to break the grip of the opponent, judokas were forced to use the gripping configurations that include a firm relationship with their adversary, thus providing more attacking attempts per combat. The recommendation for coaches is to significantly reduce the use of all other gripping configurations when practicing techniques, especially unorthodox gripping like cross grip and same side grip. These findings will help coaches build adequate training regimes in order to improve their competitors' technical and tactical skills that are necessary for competing at the highest level of competition.

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HEALTH BENEFITS INDUCED BY ADHERENCE TO THE MEDITERRANEAN LIFESTYLE COMPONENTS DIET AND PHYSICAL ACTIVITY

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ABSTRACT

The purpose of this overview is to present the evidence that adherence to Mediterranean lifestyle components is beneficial for functional and cognitive health. Although Mediterranean diet is the principal component of this lifestyle, other components, like physical activity and socializing, form complex interactions and together they complete into the Mediterranean lifestyle. Individual components and their interactions have not been studied thoroughly, however, there is an increasing attention for these matters through scientific literature in original research, reviews and meta-analysis. This paper considers the recent knowledge and trends related to defining the indicators concerning these lifestyle components, as well as summarizes the health benefits induced by adherence to them and explains why Mediterranean lifestyle components are important for health.

Keywords: *lifestyle, Mediterranean diet, physical activity, health benefit, interactions.*

PREHRANA IN GIBALNA AKTIVNOST KOT ZDRAVJU KORISTNI SESTAVINI SREDOZEMSKEGA ŽIVLJENJSKEGA SLOGA

IZVLEČEK

Namen preglednega članka je predstaviti dosedanja dognanja o tem, kako lahko ima upoštevanje sredozemskega načina življenja dobrodejne učinke na funkcionalno in kognitivno zdravje posameznika. Medtem ko številni avtorji trdijo, da je sredozemska prehrana poglavitna sestavina zdravega načina življenja, le ta z drugimi dejavniki, kot so gibalna aktivnost in bogato socialno življenje, tvori zapletene interakcije in skupaj z njimi dopolnjuje sredozemski način življenja. Posamezne komponente in njihov medsebojni vpliv še niso popolnoma raziskane, vendar pa jim raziskovalci v izvirnih znanstvenih raziskavah, preglednih člankih in meta-analizah, posvečajo vedno več pozornosti. Prispevek obravnava najnovejša dognanja in trende v zvezi z opredelitvijo kazalcev omenjenih komponent sredozemskega življenjskega sloga, poleg tega pa pojasnjuje tudi, zakaj so sredozemske sestavine življenjskega sloga tako pomembne za zdravje.

Ključne besede: *življenjski slog, sredozemska prehrana, telesna dejavnost, zdravje, interakcije.*

INTRODUCTION

The attention to the possible benefit for health of the diet and the lifestyle typical of Mediterranean countries came from the “seven countries study”. Started in 1947 by Ancel Keys and co-workers the study compared diet and lifestyles in the USA, Finland, Yugoslavia, Japan, the Netherlands, Italy and Greece, and led to the discovery that Italy, Greece and Yugoslavia (particularly the coastal region of Croatia) had a much lower incidence of non-communicable degenerative diseases (Keys, Fidanza, Karvonen, Kimura & Taylor, 1972). Later on, Ancel Keys and his co-workers settled in Italy in the small village of Pioppi, south of Naples, and deeply analysed the lifestyle and the food choice not only in Italy but also in Greece (particularly on the island of Crete), Spain, Portugal and Croatia. From their work, the foundation of the concept of Mediterranean diet and lifestyles were set (Keys et al., 1986). Unfortunately, in those countries, 60 years later, the traditional way of eating and the healthy lifestyles have been cancelled, to a great extent due to homogenization of dietary choices and living habits typical of the global economy (Bach-Faig et al., 2011; Martinez-Lacoba, Pardo-Garcia, Amo-Saus & Escribano-Sotos, 2018).

CHARACTERISTICS OF MEDITERRANEAN DIET

Mediterranean diet within the scientific fields of dietetics, nutrition and food technology is predominantly handled as a traditional dietary pattern with a focus on its constituents (e.g., Bach et al., 2006; Katz & Meller, 2014; Davis, Bryan, Hogson & Murphy, 2015). It is plant-based with freshly-harvested vegetables, fruits, nuts and seeds, beans and legumes, many herbs and spices, and whole grains. With frequent consumption of fish and other sea foods, selective dairy intake and quite limited consumption of meat, eggs and sweets, but emphasizing the use and consumption of healthful fats like extra virgin olive oils and fishy fats, and moderate amounts of (red) wine.

The Mediterranean diet is not an homogeneous model globally nor within the Mediterranean area, as it is highly dependent on the region, and influenced by socio-cultural, religious and economic factors (Bach et al., 2006). Despite these regional variations, the average nutrient content of the diet is relatively consistent among various studies (Davis et al., 2015). For eight studies the percentage of total daily energy (9.3 MJoule) was as follows: 37% as fat of which 5% polyunsaturated, 19% monounsaturated, and 9% saturated (note the ratio of 2 for unsaturated to saturated); 15% protein; 43% carbohydrate; with for some constituents: fibre 33 g/day, vitamin C 225 mg/day and folate 508 μg/day. Thus, the diet promotes high intake of fibre, results in a favourable ratio of omega-6 and omega-3 essential fatty acids (Trichopoulou et al., 2014; Davis et al., 2015), and especially increases the non-enzymatic antioxidant capacity through the consumption of antioxidants and polyphenols from extra virgin olive oil (Zamora-Ros et al., 2013).

MEDITERRANEAN DIET-INDUCED HEALTH EFFECTS

The combination of foods and the content of nutrient constituents made the Mediterranean diet a subject of many scientific studies, that investigated the potential health effect during the intervention by Mediterranean eating (reviewed by Sofi, Macchi, Abbate, Gensini & Casini, 2014; Martinez-Lacoba et al., 2018). An early systematic review by Serra-Majem, Roman and Estruch (2006) investigated 35 experimental studies referring to the Mediterranean diet as an intervention and showed favourable effects on lipoprotein levels, endothelium-dependent vasodilatation, insulin resistance, metabolic syndrome, antioxidant capacity, myocardial and cardiovascular mortality, and cancer incidence. Moreover, Sofi et al. showed by analysing 18 cohort prospective studies that adherence to the Mediterranean diet for three to 18 years reduced the risk of overall mortality, with a clear reduction of the incidence for cardiovascular, cancer, and neurodegenerative diseases and stroke (Sofi, Cesari, Abbate, Gensini & Casini, 2008; Sofi, Abbate, Gensini & Casini, 2010). In recent years, these beneficial health effects have been confirmed, namely in the form of improved insulin sensitivity (Ryan et al., 2013), reduced cancer risk (Giacosa et al., 2013), and particularly well-demonstrated the reduced risk of cardiovascular diseases (de Lorgeril & Salen, 2006; 2011; Ibarrola-

Jurado et al., 2011; Nordmann et al., 2011; Bonaccio et al., 2018; Estruch et al., 2018). Lower prevalence of general obesity and metabolic syndrome has been shown (Ibarrola-Jurado et al., 2011), and also the improvement of quality of life and diminished pulmonary inflammation in asthmatic patients (Sexton et al., 2013; Papamichael, Itsiopoulos, Susanto & Erbas, 2017; Papamichael et al., 2018). Finally, higher adherence to a Mediterranean diet was associated with a reduction in mortality (Trichopoulou, Bamia & Trichopoulos, 2009; Bonaccio et al., 2018). Thus, in conclusion, adherence to the Mediterranean diet, the plant-based diet as described above, seems to provide longevity with a reduced risk for chronic non-communicable diseases.

DIET AS PART OF MEDITERRANEAN LIFESTYLE

Long and healthy (functional and cognitive) ageing is of importance to humans as a species, and perhaps these health benefits attributed to the diet, in combination with where, and in which cultural environmental settings the diet is embedded, were the reasons that in 2010 the Mediterranean diet got inscribed in the *UNESCO* representative list of intangible cultural heritage of humanity (*UNESCO*, 2010).

On *UNESCO*'s webpages, one can find the following description: *'The Mediterranean diet involves a set of skills, knowledge, and traditions concerning crops, harvesting, fishing, animal husbandry, conservation, processing, cooking, and particularly the sharing and consumption of food. Eating together is the foundation of the cultural identity and continuity of communities throughout the Mediterranean basin. It is a moment of social exchange and communication, an affirmation and renewal of family, group or community identity. The Mediterranean diet emphasizes values of hospitality, neighbourliness, intercultural dialogue and creativity, and a way of life guided by respect for diversity.*'

These writings clearly emphasize a particular social ensemble of traits that centres around food production, harvesting and consumption, guided by the Mediterranean climate and region. An update by the *Mediterranean Diet Foundation Expert Group* (Bach-Faig et al., 2011), additionally adds to emphasize sobriety and moderation, with inclusion of cultural and lifestyle components that are based on the Mediterranean diet pyramid, such as conviviality, culinary activities, adequate rest, and physical activity. Mediterranean diet, when used in dietetics or nutritional sciences, often refers to the plant-based and micronutrient-balanced diet, while often, in the wider scientific fields like the social sciences, or in specific fields like kinesiology, this *UNESCO*-recognized Mediterranean intangible heritage as such, should be, more appropriately, referred to as Mediterranean lifestyle.

UNESCO, the *Scientific Committee of the International Foundation of Mediterranean Diet* and others acknowledge the specific lifestyle characteristics (Sotos-Prieto et al., 2015; Yannakoulia, Kontogianni, & Scarmeas, 2015; Dernini et al., 2017). They indicate that such lifestyle components are worth being identified (Bach et al., 2006), as they might be valuable to human health and heritage.

BRAIN HEALTH INFLUENCED BY MEDITERRANEAN LIFESTYLE COMPONENTS

Brain function, overwhelmingly studied, is a good example to demonstrate its dependence on lifestyle components. In relation to Mediterranean lifestyle components beneficial to cognitive health, next to adherence to the diet, Yannakoulia et al. (2015) particularly mention the participation in leisure activities, social interaction, physical activity and the quality of sleep. Each of these factors have been individually demonstrated to effectively maintain better cognitive performance, promote healthy cognitive ageing, reduce depressive symptoms, and delay neurodegeneration (e.g., Polidori, Nelles & Pientka, 2010; Schreiber et al., 2016; Clare et al., 2017; Kivipelto, Mangialasche & Ngandu, 2018; Zhao et al., 2018).

Sofi et al. came to the conclusion (Sofi et al., 2008; 2010) that the adherence to the Mediterranean diet reduced mild cognitive impairment and the risk to undergo Parkinson's and Alzheimer's diseases. More recent studies confirm that higher adherence to the Mediterranean diet is associated with improved cognition (Féart et al., 2009; Martínez-Lapiscina et al., 2013; Ye et al., 2013), assessed through, amongst others, Mini Mental State Examinations and the clock drawing tests. Adherence to the Mediterranean diet thus establishes lower risk of cognitive impairment (Ye et al., 2013; Gardener et al., 2015), it reduces the risk of Alzheimer's disease (Scarmeas et al., 2006), and induces better performance in the executive function domain (Gardener et al., 2015).

The positive impact of the Mediterranean diet on brain health is detectable also at morphological level. Among 672 cognitively normal participants from the U.S.A., with an average of 79.8 years of age, higher adherence to the Mediterranean diet was associated with larger frontal, parietal, occipital, and average cortical thickness (Staubo et al., 2017). In line with this, among 400 Scottish elderly persons, a low adherence to the Mediterranean diet predicted brain atrophy (Luciano et al., 2017). A study with 4447 participants in the Netherlands showed that a higher diet quality, especially the one that abode by the Mediterranean diet, was associated with larger overall and hippocampal brain tissue volumes (Croll et al., 2018). Similarly, among 459 participants in the United Kingdom, a higher and prolonged adherence (over 11 years) to guidelines for healthy diet was associated with larger hippocampal volume (Akbaraly et al., 2018). These studies clearly indicate that diet itself affects brain volume and structure.

Further, higher adherence to the Mediterranean diet has been shown to reduce the incidence of depression from a meta-analysis among 20 longitudinal and 21 cross-sectional studies (Lassale et al., 2018), and in addition, a diet with a low potential to induce inflammation, was associated with lower depression incidence in four longitudinal studies (Lassale et al., 2018). A recent randomized controlled trial showed that a 12-week intervention with Mediterranean diet significantly reduced the symptoms of major depression (Jacka et al., 2017). Thus, as for functionality of the brain, a condition as behaviour in the form of depression, is clearly influenced by diet as well. Presumably, it is influenced in both directions, depending on the quality of diet.

Moreover, a healthy diet maintains a healthy balanced intestinal microbiota (Cryan & Dinan, 2012; Dash, Clarke, Berk & Jacka, 2015; Johnson & Foster, 2018), and research indicates that this symbiosis establishes an intestines-brain axis, and is of major support to the health of the brain, by influencing the development of the brain, as well as behaviour and mood. Interestingly, in the intestines, the microbial fermentation of host-indigestible dietary fibres produces short-chain fatty acids that act as signals in the host (Kelly, Minuto, Cryan, Clarke & Dinan, 2017; Johnson & Foster, 2018). Supplementation of such fatty acids to mice has been shown to alleviate selective and enduring alterations induced by repeated psychosocial stress (van de Wouw et al., 2018). Such fatty acids are not the only products from the presence of microbiota that can influence the host's endocrine signalling. Not even closely do we have proper understanding of the microbiota-intestines-brain axis.

Continuing to reason along this axis, which means drawing associations between the consumption of specific foods and brain health might seem far-fetched. The examples of depression studies mentioned in the previous paragraph make it very plausible for food (the microbiota-intestine-brain axis) to affect our mood and behaviour. Besides, the following examples emphasize this importance. There is established evidence that altered microbiota populations exist in human patients with autism spectrum disorders, schizophrenia, depression and obesity, compared to unaffected patients and can contribute to (brain) inflammation as well (Cryan & Dinan, 2012; Dash et al., 2015; Kelly et al., 2017; Johnson & Foster, 2018). Another accent comes from a recent large cohort, in which removal of the vermiform appendix − that hosts microbiota, pathogens and immune cells − decades before the onset of Parkinson's disease, lowers the risk of obtaining Parkinson's disease (Killinger et al., 2018). Even more interesting is the fact that bacteria are presumed to live in our brains during our life (Roberts, Farmer & Walker, 2018). Altogether, food consumption not only determines the quantity and quality of the micronutrients available to the host, but influences the contamination of the host with microorganisms and potential symbioses as well, consequently having effect on the host by the microorganism's metabolism and the production of endocrine signals.

Brain health is a complex matter and dependent on various lifestyle factors. The same can be claimed about human health in general. Finding the palette for optimal living requires identifying the details, relations and synergies of lifestyle components.

HOW TO MEASURE ADHERENCE TO THE MEDITERRANEAN LIFESTYLE

To measure adherence to the Mediterranean diet, questionnaires on food consumption frequency have been used. In general, when conducting population-based prospective investigations, the participants are invited to complete extensive, validated, food or physical-activity frequency questionnaires at baseline. During the follow-up, adherence is assessed by multiple-items scales that incorporate salient characteristics of both eating habits and/or physical activity patterns. Usually, the populations' range

of the scores and the higher scores, describe the population's greater adherence to the topic or lifestyles of interest.

More recently, in order to assess adherence to lifestyle-habits, Sotos-Prieto et al. (2015) designed the 28-indicator Mediterranean lifestyle (*MEDLIFE*) index that additionally included physical activity patterns, adequate rest, social interactions and conviviality. Expanding on the *MEDLIFE* index, and beyond the obvious category (1) health and nutritional benefits, Dernini et al. (2017) characterized the multiple dimensions and benefits of the Mediterranean lifestyle through a methodological framework (*Med Diet 4.0*). It identifies and recognizes country-specific and culturally appropriate variations, i.e., regional food diversity, making a future-derived scale internationally applicable. Additionally, the framework introduces several sustainability categories and proposes to assess specific indicators for benefits in additional areas: (2) richness in biodiversity and low environmental impact; (3) high social and cultural food values; and (4) positive local economic returns. The framework is described by the *Scientific Committee of the International Foundation of Mediterranean Diet* (Dernini et al., 2017) and would be of special interest as it describes a wider lifestyle with various components, but up till now a practical index has not been tested.

The 24-hour dietary recall (Thompson & Byers, 1994), the questionnaires on food consumption frequency (Sampson, 1985), together with the recent scales and frameworks like *MEDLIFE* (Sotos-Prieto et al., 2015) and the *Med Diet 4.0* (Dernini et al., 2017) are easily implemented. Especially the latter two would facilitate the comparison of studies that investigate adherence to the Mediterranean lifestyle and the contributing interrelated lifestyle components (Bach et al., 2006). Such comparison is important for understanding the quality of human life (both in health and of footprint), and the identification of common and/or cultural-specific lifestyle components, that could gain attention and thus might find a way of becoming tangible heritage.

MEDITERRANEAN LIFESTYLE INTERVENTIONS

The state of health across the lifespan − during childhood, adolescence and old age − is a product of the cumulative factors experienced (Calder et al., 2018). In general, a healthy diet with the specific distribution and prevalence of physical and sedentary activities influence physiological and metabolic functions that altogether determine disease, cognition and functionality (Calder et al., 2018; Martin et al., 2018). However, the interactions of such components are poorly studied. Therefore, the following sections of this paper will recapitulate the details of various systematic reviews that include meta-analysis of randomized controlled trials (or cohorts), where adherence to the components 1) physical activity and 2) Mediterranean diet, were addressed as an intervention, either separately or in combination.

MEDITERRANEAN DIET AS AN INTERVENTION

In relation to health benefits induced by Mediterranean diet as an intervention, Kastorini et al. (2011) reviewed 35 clinical trials and Garcia et al. (2016) reviewed 29 randomized controlled trials. Both reviews showed that waist circumference was significantly reduced, while also systolic and diastolic blood pressures, blood glucose and triglycerides levels were significantly reduced with adherence to the Mediterranean diet. High-density lipoprotein cholesterol levels were increased as reported by Kastorini et al. (2011), although no change was observed by Garcia et al. (2016). Both reviews showed that adherence to the Mediterranean diet positively effects the biomarkers linked to the metabolic syndrome, especially for interventions longer than 3 months in duration. Interestingly, it was mentioned that adherence to the Mediterranean diet was significantly beneficial when the study was of high quality and the intervention was longer in duration (Kastorini et al., 2011; Garcia et al., 2016), besides, it was conducted in Europe (Garcia et al., 2016).

Esposito, Kastorini, Panagiotakos and Giugliano (2011) reviewed 16 randomized controlled trials, 1 to 24 months in duration, were Mediterranean diet was used as an intervention compared to a control diet. The Mediterranean diet groups showed greater reductions in body weight and body mass index for trials longer than 6 months in duration, while the effect was larger in association with increased physical activity or energy restriction. Thus, typically none of the studies reported weight gain with adherence to a Mediterranean diet more than 6 months in length, which made the authors conclude that Mediterranean diet is useful as an intervention targeted to lose weight (Esposito et al., 2011), despite the diet being high in fat of predominantly extra virgin olive oils origin.

PHYSICAL ACTIVITY AS AN INTERVENTION

Despite the fact that plenty of intervention studies based on physical activity are available in the scientific literature, the current discussion restricts itself to the most relevant systematic reviews and meta-analysis of randomized controlled trials.

Physical activity as an intervention during randomized controlled trials was reviewed by Kodama et al. (2007) who identified 25 intervention studies with an average length of about 7 months. Aerobic training resulted in increases of high-density lipoprotein cholesterol levels (Kodama et al., 2007), with no association between exercise frequency or intensity. Strasser, Siebert and Schobersberger (2010) identified 13 randomized controlled trials, in which the effect of physical resistance training on average 3 times a week for 1.5 to 12 months, was compared between a control group and patients with abnormal glucose regulation. The physical activity reduced the fat mass and systolic blood pressure (Strasser et al., 2010), while no statistically significant effects on total cholesterol, high- and low-density lipoprotein cholesterol, triglycerides and diastolic blood pressure were observed. Further, Cornelissen and Smart (2013) identified 93 trials and showed that physical activity as endurance, dynamic resistance,

and isometric resistance training lowered both systolic and diastolic blood pressures for interventions smaller than 6 months. Whereas interventions longer than 6 months induced smaller reductions in blood pressures, and the combination of these types of physical training lowered only diastolic blood pressure (Cornelissen & Smart, 2013). Lin et al. (2015) identified 29 randomized controlled trials with physical activity as an intervention with a medium duration of 3 months. It was shown that exercise significantly improved cardiorespiratory fitness and lowered the levels of fasting insulin, triglycerides and leptin, while increasing the levels of both high-density lipoprotein cholesterol and apolipoprotein A1, and interleukin-18. The effects of physical activity were more pronounced in persons over 50 years of age, men, and persons suffering from type 2 diabetes, hypertension and metabolic syndrome.

Physical activity improves the blood pressure regardless of the type of exercise, and, just like diet, positively influences the indicators of metabolic syndrome.

CONCURRENT PHYSICAL ACTIVITY AND MEDITERRANEAN DIET AS AN INTERVENTION

Recently, the randomized controlled trials assessing overall health resulting from the combined intervention, physical activity and adherence to Mediterranean diet, were systematically reviewed (Malakou et al., 2018). This meta-analysis identified 11 randomized controlled trials executed between 2003 and 2017, of which the intervention duration lasted from 2 months to 6 years. The combined intervention reduced body weight, body mass index, waist circumference, both systolic and diastolic blood pressures, while as well reducing the levels of blood glucose, triglycerides and total cholesterol, and increasing the high-density lipoprotein cholesterol levels. No evidence of an effect on insulin concentrations was found. Although the authors mention the high degree of heterogeneity between the results from the trials, and the need for well-designed and thoroughly executed randomized controlled trials, the combination of Mediterranean diet and physical activity as an intervention clearly provides a reduction in weight (especially with interventions shorter than 12 months in duration), and a reduced metabolic syndrome risk.

Interestingly, Malakou et al. (2018) mention that none of the randomized controlled trials compare the combined effect against control groups receiving only physical activity, Mediterranean diet or no treatment respectively. Only two studies compared the combined intervention results with usual control group (Droste et al., 2013; Dunn, Siu, Freund & Boutcher, 2014) and found a reduced metabolic syndrome risk for the combined intervention. Still, it is not clear whether a synergistic effect of the concurrent interventions exists.

In addition, the results of recent studies seem to suggest that there are synergistic effects. In the U.S.A., out of 170.672 women and men aged 51 to 71 years at baseline in 1996/1997 and followed-up in 2009, adhering to high physical activity levels and Mediterranean diet, was associated with lower risk of mortality than groups only ad-

hering to physical activity recommendations or only following the Mediterranean diet (Behrens et al., 2013). In a study in Spain, among 19.467 female and male university graduates aged 27 to 46 years of age at baseline in 1999 and followed-up in 2016, similar results were found (Alvarez-Alvarez et al., 2018a). More specifically, the combination of interventions showed a reduced risk for cardiovascular disease as compared to the physical activity or Mediterranean diet separately (Alvarez-Alvarez et al., 2018b).

In combination with these epidemiological studies, it is concluded that adherence to a Mediterranean lifestyle, and most likely the individual Mediterranean lifestyle components, high physical activity and richly consuming the plant-based Mediterranean diet, will provide better health perspectives. This seems additionally true for living out of the geographical region from which the Mediterranean diet is originating.

CONCLUSIONS

Mediterranean lifestyle seems to be the palette we should strive to adhere to. It incorporates diet, physical activity and other lifestyle components, all worth promoting publicly for all ages. Health benefits, only induced by its components of diet and physical activity, seem numerous: increasing general and cognitive health with a reduced risk for non-communicable diseases, especially metabolic syndrome. However, further studies are needed that will investigate the synergy effects of combined components that determine the essential, effect-inducing, interactions between the Mediterranean lifestyle components. This can be done by thoroughly planned randomized controlled trials, using the established scales to assess the adherence, and the proper inclusion of multiple control groups.

For adults, the *World Health Organisation* recommends a minimum of 150 minutes of moderate-intense physical activity throughout the week. The *International Society for Nutritional Psychiatry Research,* recognizes diet and nutrition as central determinants of both physical and mental health, referred to as nutritional or orthomolecular medicine (Zell & Grundmann, 2012; Sarris et al., 2015), with a recent success story that concerns the reversing of cognitive decline (Bredensen, 2017). The Mediterranean lifestyle embraces these recommendations. Besides, it promotes outdoor physical activities, organic food consumption, and sustainable novel food production.

Thus, the adherence to the Mediterranean lifestyle can nowadays be geographically applicable anywhere, and it gives the opportunity for practitioners, care givers and the public to create and adopt to more personalized nutritional and functional therapy, resulting in a better general health.

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HOW DOES EXERCISE SUPPORT DIETARY APPROACHES TO WEIGHT LOSS AND BETTER HEALTH?

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ABSTRACT

The rapid global rise of obesity incurs a heavy personal and healthcare burden due to obesity-associated morbidities and shortening of life. The purpose of this review is to provide evidence-based strategies for prevention, reversal, and mitigation of obesity and its sequelae. To that end, this review highlights the features of human physiology that favor fat accretion and interfere with fat loss. Strategies for prevention of obesity include understanding the basis for the strong motivating properties of palatable food, for human inability to consciously detect calories eaten or calories expended through exercise, for metabolic and hormonal adaptations to negative energy balance that drive weight regain, and for evolutionary natural selection which likely led to high human capacity for fat storage. Reversal of obesity is difficult primarily due to metabolic, hormonal, and behavioral reactions to body fat loss. Reduced resting metabolic rate presents a physiological challenge whether the weight loss is achieved through dietary restriction or energy expenditure of exercise. Increased insulin sensitivity after body fat loss drives resynthesis of storage substrates including triglycerides in the adipose tissue, muscle glycogen, and proteins, thus contributing to weight regain. Reduced basal plasma leptin concentration elicits a strong hunger drive. Mitigation of obesity-associated morbidities involves adding exercise energy expenditure to deliberate control of the quantity of food eaten, reducing postprandial hyperinsulinemia by lowering the carbohydrate load of the diet, and exercising after, rather than before, the meals to facilitate improved glucose tolerance.

Keywords*: obesity morbidities exercise insulin leptin body weight.*

KAKO GIBALNA VADBA DELUJE KOT PODPORA DIETI PRI ZNIŽEVANJU TELESNE MASE IN IZBOLJŠEVANJU ZDRAVJA?

IZVLEČEK

Hiter globalni razmah debelosti in prekomerne telesne mase zaradi številnih z njim povezanih bolezni in posledično krajšanja življenjske dobe, predstavlja vedno večje breme tako za posameznike kot tudi za zdravstvene sisteme. Namen preglednega članka je predstaviti na dokazih temelječe strategije za preprečevanje in ublažitev posledic prekomerne telesne mase. Izpostavili bomo fiziološka ozadja, ki imajo odločilno vlogo pri kopičenju maščobnega tkiva, ter tista, ki preprečujejo izgubo maščobe. Strategije za preprečevanje prekomerne telesne mase vključujejo tako razumevanje osnovnih vzvodov, ki vodijo do močne navezanosti človeka na okusno hrano, kot tudi razumevanje osnov človekove nezmožnosti, da bi zavestno prepoznal količino kalorij, ki jih je prejel z zaužito hrano ali tistih, ki jih je s telesno aktivnostjo porabil. Izpostavili bomo presnovne in hormonalne adaptacije na negativno energijsko bilanco, ki vodijo v pridobivanje telesne mase in evolucijsko naravno selekcijo, ki je verjetno vodila do visoke sposobnosti človeka, da v telesu kopiči zaloge maščobe. Spreminjanje trenda naraščanja prekomerne telesne mase je težavno predvsem zaradi presnovnih, hormonalnih in vedenjskih odzivov na izgubo telesnih maščob. Pri zmanjšani stopnji presnove v mirovanju predstavlja poseben fiziološki izziv vprašanje ali gre v teh primerih za zmanjšanje telesne mase zaradi restriktivne prehrane ali zaradi povečanja porabe energije, kot posledico gibalne aktivnosti. Povišana stopnja inzulinske rezistence po izgubi telesnih maščob vodi v resintezo skladiščenih substratov, vključno trigliceridov v maščobnem tkivu, mišični glikogen in proteine, kar prispeva k ponovnemu pridobivanju telesne mase. Zmanjšane koncentracije bazalnega leptina v plazmi sprožijo občutek lakote. Zmanjšanje posledic s prekomerno telesno maso povezanih bolezni, ob zavestnem nadzorovanju količine zaužite hrane, vključuje tudi dodatno porabo energije s pomočjo gibalne vadbe, zniževanje postprandialne hiperinzulinemije z nižanjem količine ogljikovih hidratov v prehrani ter z izvajanjem gibalne/športne aktivnosti po zaužitem obroku, raje kot pred njim, saj to izboljšuje toleranco za glukozo.

Ključne besede: *debelost, slabotnost, gibalna vadba, inzulin, leptin, telesna masa.*

INTRODUCTION

Obesity has risen rapidly over the past half a century in all of 200 sample countries of the world (NCD Risk Factor Collaboration, 2017). It increased from 3.2% in men and 6.4% in women in 1975 to 10.8% and 14.9%, respectively, in 2014. In 2014, 2.3% of world's men and 5% of women were severely obese, and 0.64% men and 1.6% women were morbidly obese. By 2025, global obesity is projected to reach 18% in men and 21% in women, and 6 and 9% are, respectively, likely to become severely obese. In the US, 32.2% of men and 35.5% of women were obese in 2016 (Hales, Carrol, Fryar & Ogden, 2017). Their health care burdened the economy with 147 billion USD (Finkelstein, Trogdon, Cohen & Dietz, 2009). The corresponding health care costs of obesity in Europe in 2008 were 10.4 billion euros (Muller-Riemenschneider, Reinhold, Berghofer, & Willich, 2008).

Obesity-associated morbidities include hypertension (Vaněčková et al., 2014), atherosclerosis (Lovren, Teoh, & Verma, 2015), hypercoagulability of blood (Samad & Ruf, 2013), endothelial dysfunction (Iantorno et al., 2014), coronary vascular (Rankinen, Sarzynski, Ghosh, & Bouchard, 2015), kidney (Ritz, Rychlik, Locatelli, & Halimi, 1999), and heart disease (Després et al., 1996), stroke (Field et al., 2001), and particularly type 2 diabetes (T2D). These obesity-linked morbidities increase the risk of mortality by two to three fold (Adams et al., 2006). The close association between obesity, peripheral tissue resistance to insulin action, and T2D is reflected in the frequently used descriptive term "diabesity" (Farag & Gaballa, 2011).

Since the driver of recent rapid increases in obesity is the interaction between behavioral choices and human physiological barriers, the purpose of this review is to describe behavioral strategies that could prevent or reduce obesity and mitigate its associated morbidities.

METHODS

The data for this review are based, in part, on PubMed search for the scientific reports on the behavioral and physiological controls of food intake and on the physiological, psychological, and hormonal barriers to weight loss, as well as, in part, on the author's research findings and views on the regulation of energy balance in humans (Borer, 2005; 2008; 2010; 2014; 2019; Borer, Wuorinen, Chao, & Burant, 2005; Borer, Wuorinen, Ku & Burant, 2009; Wuorinen & Borer, 2013; and Lin & Borer, 2016).

Five points will be interpreted from the evidence-based research:

(1) The endocrine basis of obesity-associated morbidities; (2) Physiological features that facilitate overeating, (3) Evolutionary burden of high human capacity for obesity, (4) Failure of spontaneous physical activity to compensate for obesity; and (5) Dietary and exercise solutions to some obesity-associated morbidities. Integration of these points will guide the recommendation for behavioral strategies toward prevention, reversal, or mitigation of obesity and its associated morbidities.

RESULTS

1. The endocrine basis of obesity-associated morbidities

Obesity leads to a disturbance in the endocrine regulation of body energy storage and its mobilization by reducing the effectiveness of its chief endocrine agent insulin. Circulating glucose and amino acids elicit insulin secretion, and activate its four chief actions, to increase uptake of these nutrients by muscle and other energy-depleted tissues, to reduce the concentration of circulating glucose by increasing its metabolism, to further reduce circulating nutrients by promoting their storage in the form of muscle and liver glycogen, adipocyte triglyceride, and tissue protein, and finally, to block the breakdown, release, and metabolism of metabolic fuels from their inert storage form. It is less well-recognized that a second hormone, leptin, also plays a key role in the meal-associated regulation of energy balance. While its release from the white adipose tissue (WAT) is universally recognized, it is less well known that leptin gets also released from the stomach during meal eating (Sobhani et al., 2000). Its secretion and actions are linked to that of insulin in a counter-regulatory fashion. Insulin stimulates leptin release during meal-eating, and leptin then restrains all four of the insulin's actions as well as insulin release. It indirectly counter-regulates the energy storage actions of insulin by promoting lipolysis and stimulation of lipid metabolism (Borer, 2014). This endocrine counter-regulation of short-term energy balance is disrupted in obesity by the resistance of peripheral tissues to the actions of both insulin and leptin.

Increased insulin and leptin resistance in obesity (Samuel, Petersen, & Shulman, 2010; Shulman, 2014a) is reflected in the proportional rise in fasted, basal and stimulated concentration of both hormones as a function of increased body fat (Figure 1). The effect of obesity on the basal insulin concentration is expressed in a disposition index (DI) (Lorenzo et al., 2010). DI is a product of insulin sensitivity and the amount of insulin secreted in response to blood glucose level. Plotted as insulin response as a function of insulin sensitivity, the parabolic curve shows that little insulin is needed to stimulate the glucose uptake when insulin sensitivity is high, but a high insulin concentration is required when the peripheral tissues are insulin-resistant and when insulin sensitivity is low. Insulin-resistant peripheral tissues in obesity thus require high basal and stimulated insulin concentrations.

The rise in the basal or fasted concentrations of insulin and leptin are a consequence of a fundamental relationship between prevailing hormone concentration and the number of specific hormone receptors on the cell membrane. The number of receptors on energy-storing cells (like WAT, liver, or muscle) varies with the state of energy depletion or repletion. Energy depleted adipocytes are smaller and have a higher density of insulin receptors on their membranes than lipid-packed adipocytes in over-fed or obese state (Olefsky & Reaven, 1975). This relationship is explained in Figure 2 (Mendelson, 1996). In this hypothetical example, a biological response is possible when insulin binds to 5000 receptors. Any time the cell has in excess of 5000 insulin receptors (called "spare receptors"), the cell sensitivity to insulin, and the affinity of the hormone

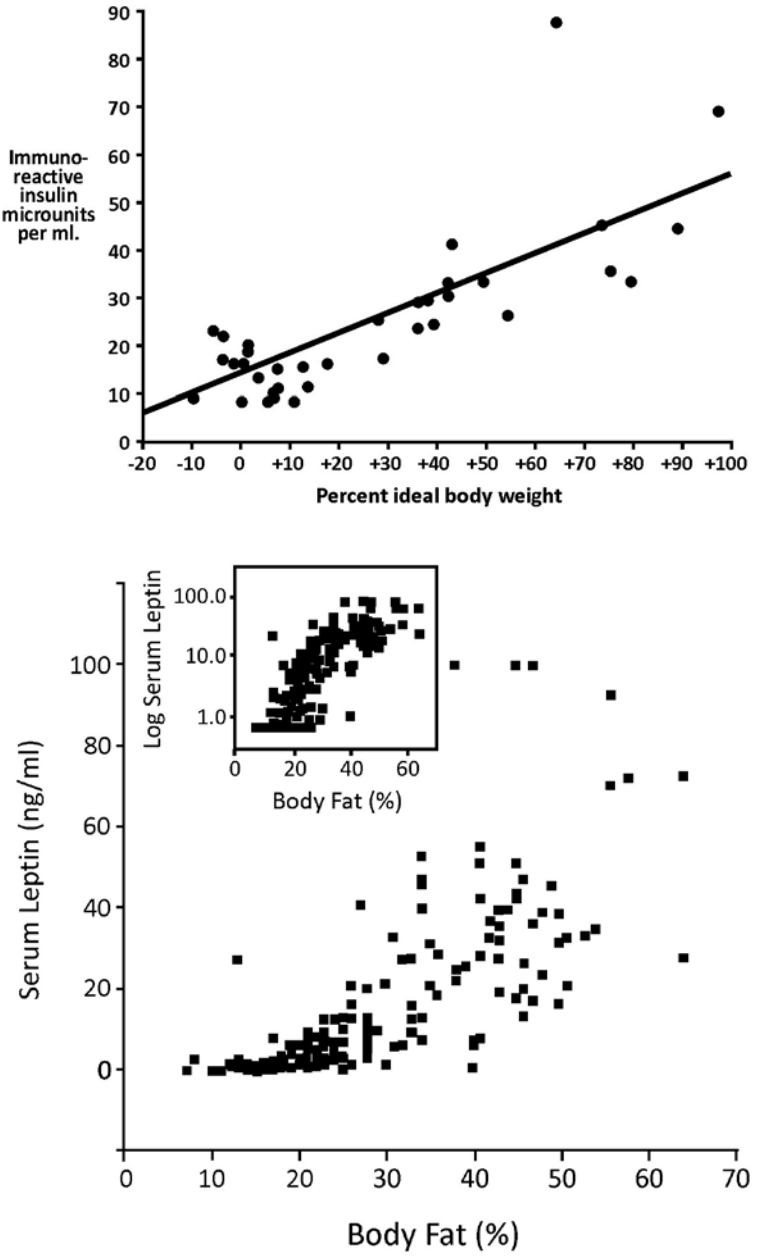

Figure 1. The positive correlation between fasting serum insulin (top) and fasting serum leptin (bottom) as a function of percentage body weight or body fat. Data for insulin from Bagdade, 1968 and for leptin from Considine et al., 1996.

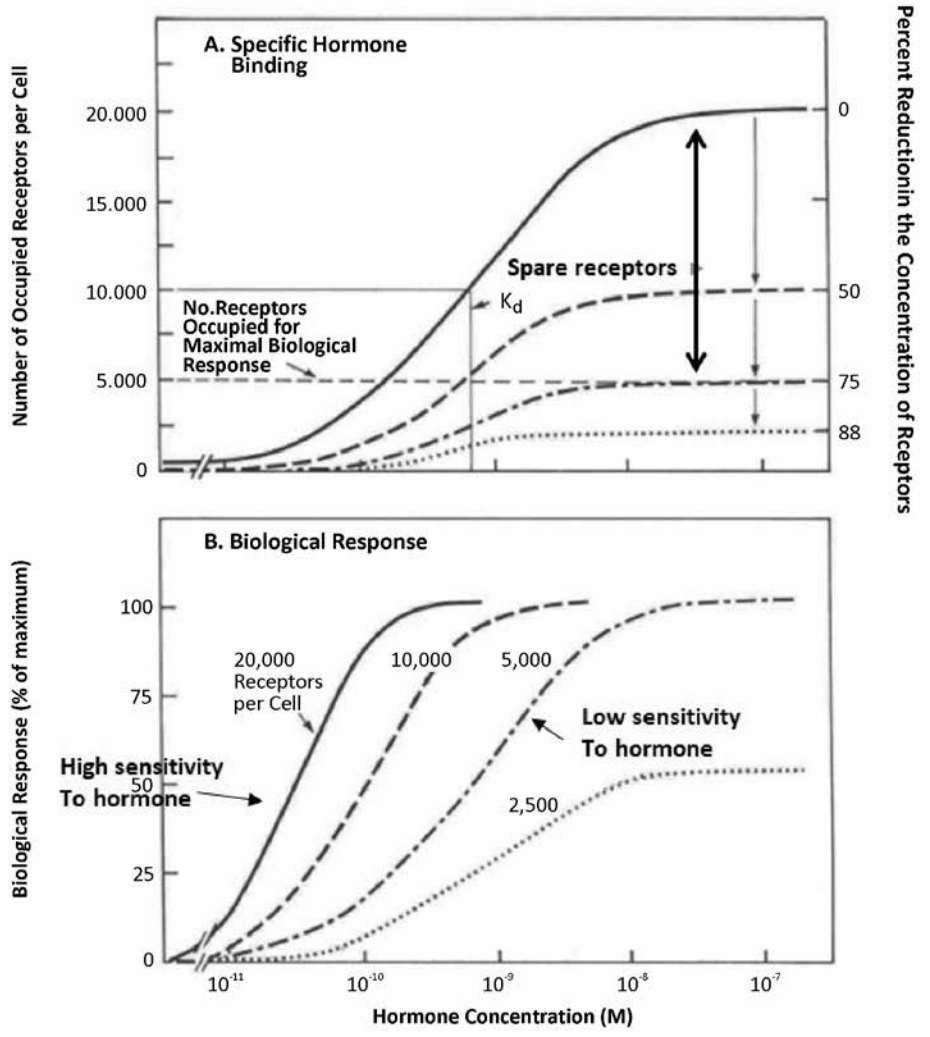

Figure 2. The sensitivity of peripheral tissues to fasting concentration of a hormone declines in parallel with the number of receptors on the target cell surface and the repletion of target cells with storage fuels. As the amount of storage fuel and the cell size increase, the number of receptors on the surface membrane declines. At the same Km (A), tissue sensitivity to a hormone increases in proportion to the number of "spare receptors above the threshold number required to elicit a biological response (5000 receptors in this example). With the smaller number of receptors in energy-replete cells, resistance to a hormone manifests in the form of a higher hormone concentration required to elicit the biological response (B). From Mendelson, 1996.

for the cell are increased, and the biological effect is achieved with lower insulin concentration (Figure 2A). The figure also shows the way to express hormone-receptor affinity or hormone sensitivity as half-maximal concentration of the hormone producing the biological effect (Kd or dissociation constant). When the cell is more energy replete and has fewer (about 5,000 to 10,000) membrane receptors, hormone concentration required to produce full (100%) biological response will have to be higher (Figure 2 B).

This fundamental rule of hormone interaction with the number of its receptors in the context of cellular energy depletion or repletion explains why obese tissues become more resistant to insulin and why the basal concentration of insulin and leptin rise with obesity. So, postprandial hyperglycemia and hyperinsulinemia are the consequence, respectively, of reduced effectiveness of insulin to stimulate glucose uptake by peripheral tissues and to inhibit glucose mobilization from the liver and free fatty acid mobilization from WAT because of insulin resistance. Hyperglycemia and compensatory hyperinsulinemia (Taylor, 2013) lead to glycation of circulating proteins and the formation of advanced glycation products associated with pathological oxidative stress (Nowotny, Jung, Höhn, Weber & Grune, 2015). High fasting concentrations of FFAs resulting from diminished insulin suppression of their mobilization from storage fat (Yazıcı & Sezer, 2017) directly interfere with insulin signaling in the muscle (Schenk & Horowitz, 2007).

Obesity-associated pathologies also result from excess fat deposition in ectopic sites when the capacity of adipocytes to hypertrophy exceeds the capacity of fat storage in the WAT. Excess fat storage in the liver (van der Zijl et al., 2011; Taira et al., 2013; Shulman, 2014b), the pancreas (van der Zijl et al., 2011), the muscle (Taira et al., 2013), and the kidney (Guebre-Egziabher et al., 2013) cause lipotoxicity in addition to insulin resistance. Non-alcoholic fatty liver disease (Than & Newsome, 2015) and steatohepatitis (Neuman et al., 2014) result from lipotoxic fat accumulation in the liver. Obesity drives the progression from insulin resistance, reduced glucose tolerance, and pre-diabetes to T2D. The incidence of T2D has increased from 4.4 million or 2.4% of US population in 1970s (Fox et al. 2006) to 29.1 million or 9.3% of the population in 2014 (National Diabetes Statistics Report, 2017). Globally, in 2010, there were 284 million diabetics representing 6.4% of the world population. If the increases continue, there will be 490 billion of diabetics in 2030 (Farag & Gaballa, 2011).

2. Physiological features that facilitate overeating

Overwhelming evidence indicates that excessive food intake, rather than insufficient physical activity, is the primary cause of weight gain and obesity. Why is this behavior not subject to negative feedback to counteract the excessive energy gain? This question is often either overlooked or incorrectly attributed. The incorrect attribution is due to the hypothesis which posits that changes in the quantity of body fat control hunger, meal eating, and motivation for physical activity in a way that maintains healthy

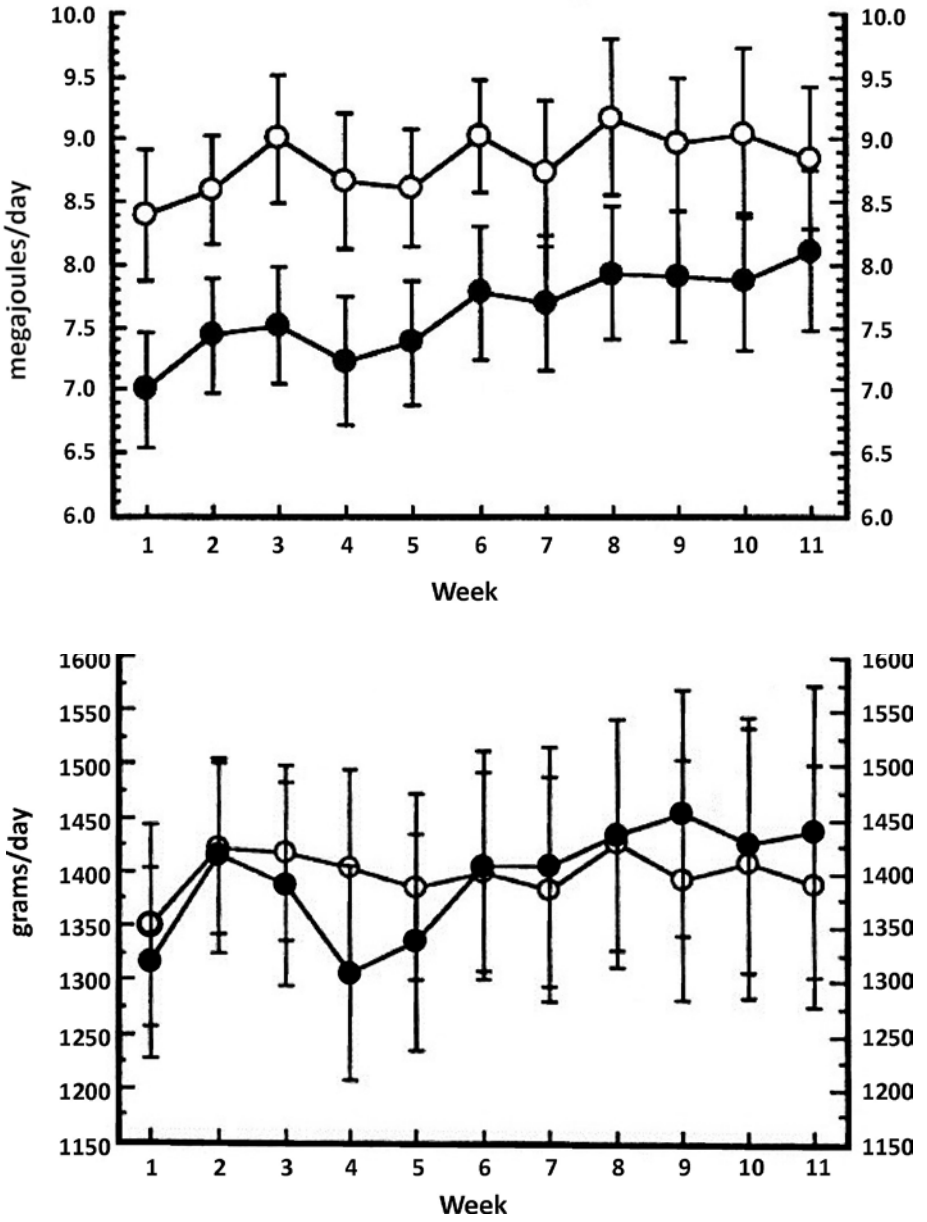

Figure 3. Energy content of diets (35-30% fat open circles, 20-25% fat solid circles) did not affect the amount of food eaten over 11 weeks (top). Instead, a similar volume of food was eaten over 11 weeks unaffected by dietary energy density (bottom). From Kendall, Levitsky, Strupp, & Lissner, 1991.

body fat content (Schwartz, Woods, Porte, Seeley, & Baskin, 2000). This hypothesis is not supported by facts. The simple and convincing answer to the feedback question is that humans (and probably most animals) cannot directly detect calories eaten in meals or calories expended in physical activity. This flaw in our physiological design, compounded by the strong motivating properties of palatable food, allow environmental influences such as portion size, easy availability of meals, and social facilitation, to drive food overconsumption. How good is the evidence that humans cannot track meal-associated intake of calories and exercise-associated expenditure of calories? That the volume of food eaten rather than the nutrient energy is the critical determinant of nutrient intake was demonstrated almost 30 years ago (Kendall, Levitsky, Strupp, & Lissner, 1991). Lower energy low-fat (20-25% fat) or higher energy high-fat diets (35-40% fat diet) were available for 11 weeks. The volunteers spontaneously ate a constant volume of food per day regardless of the 1.1 KJ daily energy difference in the two diets (Figure 3) and ended up with a different weight change.

A more relevant demonstration of human inability to track calories eaten in a meal or expended in exercise was done 18 years later in a study demonstrating that only a variable quantity of food taken by mouth and processed by gastrointestinal tract affected the sensation of hunger and fullness, while intravenous infusion of nutrients and substantial pre-meal exercise expenditure had no such effect (Borer, Wuorinen, Ku, & Burant, 2009, Figure 4).

Furthermore, changes in plasma concentrations of both insulin and leptin correctly tracked calories gained or lost, but exerted no influence on the perception of hunger or satiation in contradiction to the homeostatic hypothesis of Schwartz et al. (2000). (Figure 5).

These data show that our perception of satiation is based on gastrointestinal fullness, a signal that can easily be overlooked, and that insulin and leptin, postulated to affect appetite in response to changes in the size of WAT (Schwartz et al., 2000), do not operate during regular meal-to meal eating as such meal-associated changes in body fat are exceedingly small.

The second flaw in our physiological design is that food provides a powerful positive motivation to eat whether or not we are experiencing energy deprivation (Berridge, 2009). Food activates the same brain centers of reward as the various pleasurable events like sex, stimulating drugs, and direct electrical or pharmacological stimulation by neurotransmitters such as dopamine (Berridge, 2009), morphine-like endogenous opiates, and endocannabinoids (Kirkham & Williams, 2001). That palatable food alone and in the absence of deprivation can powerfully increase weight gain and obesity was demonstrated four decades ago with the cafeteria-diet experiment by Sclafani and Springer (1976, Figure 6).

Just by making highly palatable fatty and sweet food items available in addition to the less palatable standard diet, the authors observed sustained increase in weight gain and adiposity of laboratory rats. It is certain that some of human overeating is a consequence of easy and convenient availability of fast foods commercially designed for high palatability.

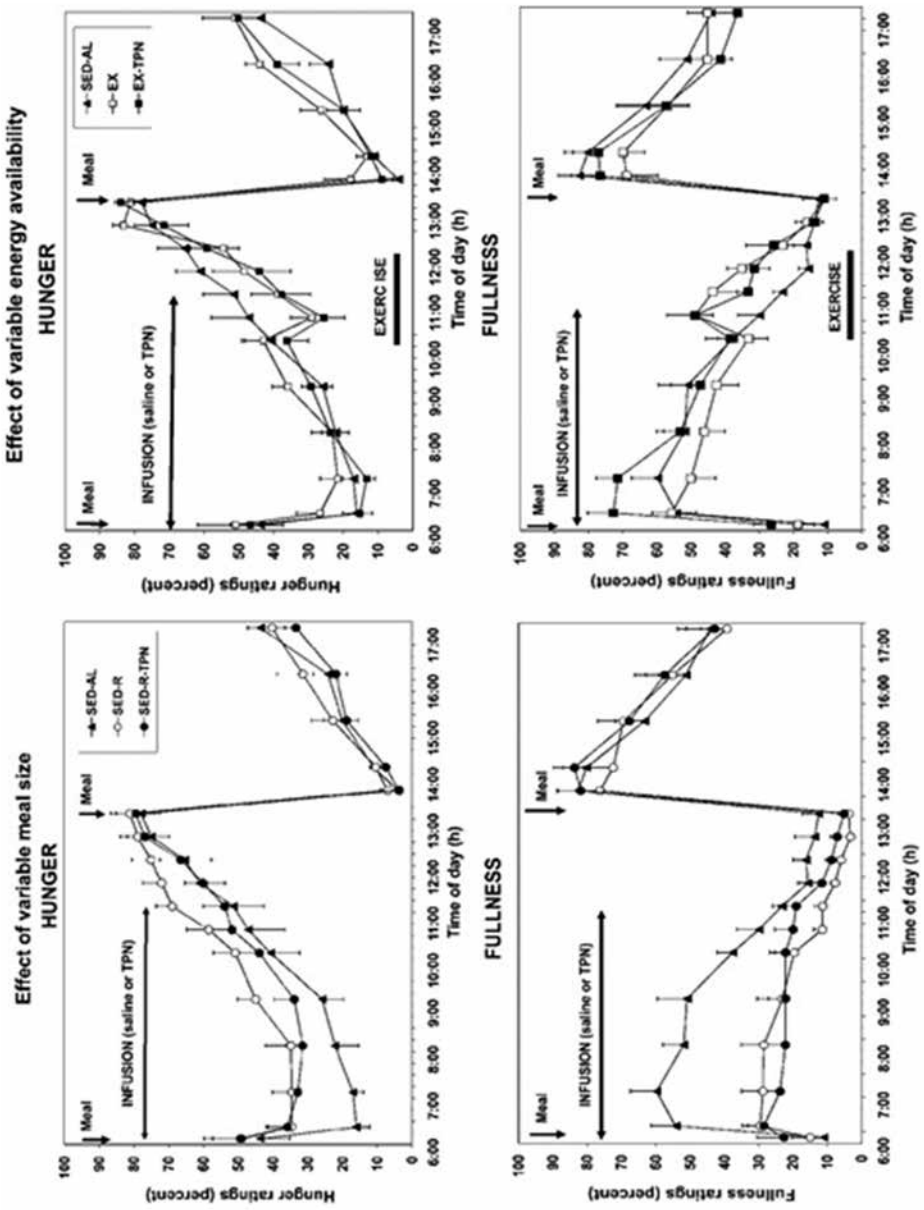

Figure 4. Hunger (top left) and fullness (bottom left) are affected only by variable-size meals that transit through the mouth and gastrointestinal tract (2,090 KJ meals=SED-AL, 418 KJ meals=SED-R) but not by 1521 KJ of parenteral nutrition (SED-R-TPN) infused intravenously or by 2 hours of mid-morning moderate-intensity exercise expending 2315KJ (top and bottom, right). From Borer, Wuorinen, Ku, & Burant, 2009.

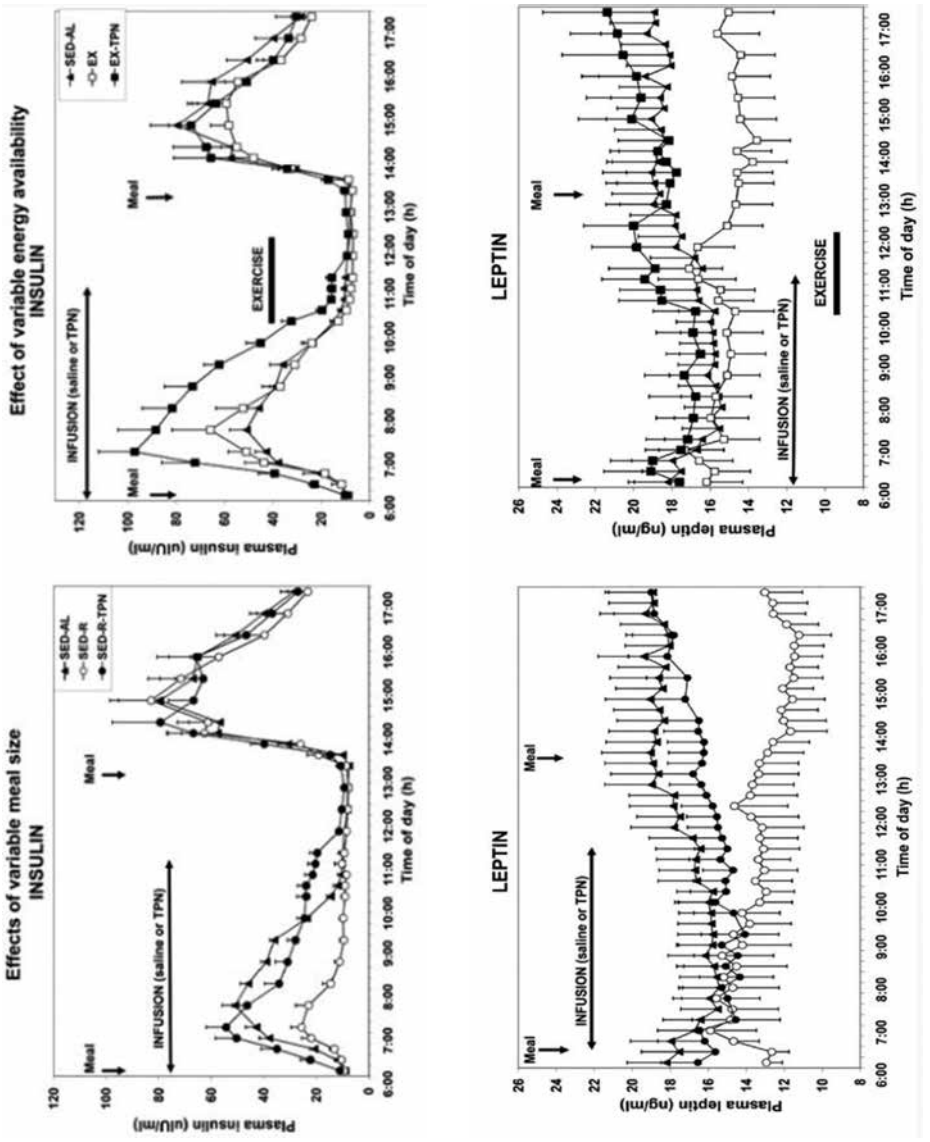

Figure 5. Accurate quantitative responses of circulating insulin (top) and leptin (bottom) concentrations to the changes in energy as a function of variable meal size (SED-AL, SED-R), intravenous infusion of total parenteral nutrition (SED-R-TPN) or energy expenditure of exercise (EX-AL, EX-TPN). From Borer, Wuorinen, Ku, & Burant, 2009.

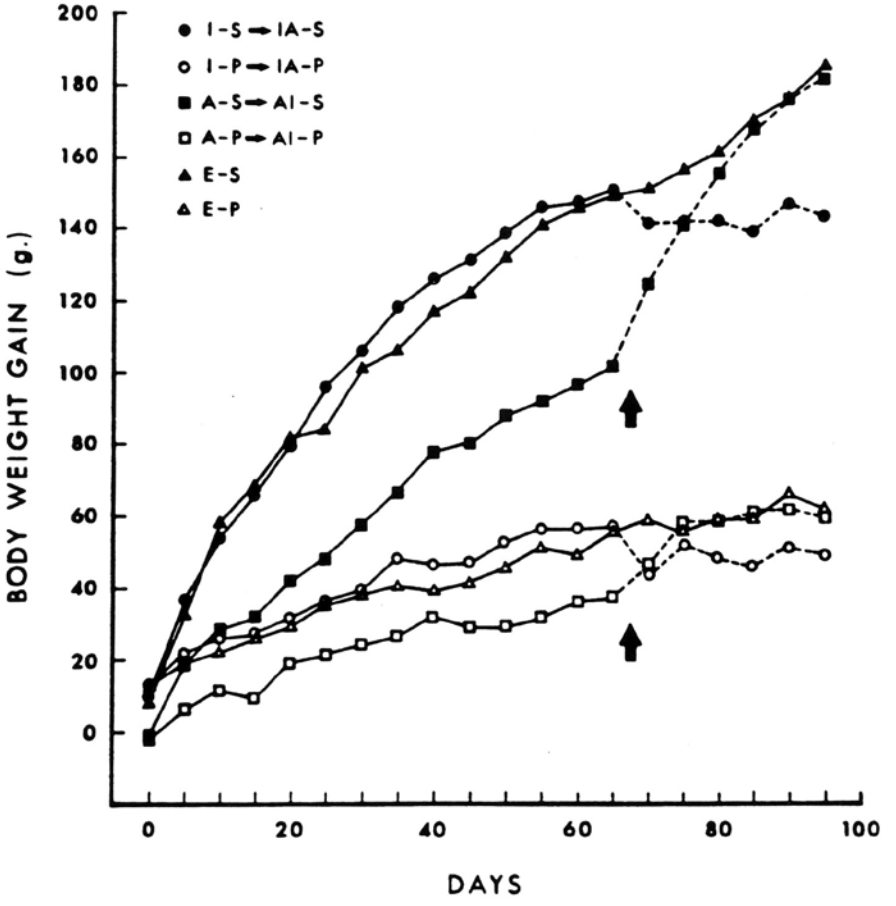

Figure 6. Cafeteria-diet phenomenon. Rapid weight gain in rats during 65 days of free access to a variety of supermarket palatable foods in addition to laboratory chow in groups I-S (solid circles) and E-S (solid triangles), compared to lower weight trajectories in rats given lab chow (groups I-P, open circle, A-P,open rectangles, and E-P, open triangles). The same fast-food dietary access with activity wheel present led to slower fat accretion during 65 days but attained the same level of obesity as E-S group after the wheel access was removed (Group A-S, solid rectangles). Introduction of activity wheels on day 65 to group E-S stopped weight gain on the fast-food diet.

3. Evolutionary burden of high human capacity for obesity

Given that humans are unable to directly track calories in meals or calories expended in exercise, easy access to palatable food, and reduced opportunity for physical exertion in the modern societies lead inexorably to obesity and its metabolic pathologies. So, how did humans end up with the largest capacity to become obese among the primates (Stini, 1981)? Natural selection toward increased brain size and the capacity of the woman to bear numerous offspring may have driven the evolution of increased capacity to store body fat in humans. Evolution of larger brains in human ancestors became exponential over the past two million years (Figure 7, top) and resulted in about three-fold greater brain mass compared to that in higher primates (Ruff, Trinkaus & Holliday, 1997, Figure 7, bottom.).

As human brain consumes between 20 and 25% of resting energy metabolism, natural selection toward bigger brains required larger energy stores. Non-arboreal existence in human ancestors has favored the evolution of unusually large brains and fat depots but not in the arboreal primates (Heldstab, van Schaik, & Isler, 2016). Similarly, the natural selection for increased fat storage capacity has provided human ancestral females with the advantage of being able to support the energy cost of pregnancy (about 18,828 KJ/day) and, with about 1,255 to 1,674 KJ/day, to feed additional children. It is therefore useful to be mindful of our large capacity for fat storage and of the fact that natural selection does not operate on post-reproductive portion of the life span when most metabolic pathologies develop.

4. Failure of spontaneous physical activity to compensate for obesity

Voluntary physical activity declines in both humans (Rising et al., 1994; Schulz & Schoeller, 1994, Figure 8) and animals as the body fat mass increases. This indicates that behavioral energy expenditure does not serve as a component of energy regulatory feedback to maintain stable healthy body weight. Instead of increasing as the body fat rises, spontaneous physical activity is non-homeostatic in that, the fatter the humans and animals become, the less motivated they are to be physically active (Borer, 2010).

The decline in voluntary running in experimental obesity is due to reduced motivation rather than a physical difficulty to move a larger body mass. In support of this conclusion are data showing no performance deficit in obese animals if running is enforced with a negative reinforcement (Borer, Potter & Fileccia, 1983, Figure 9). Similarly, obese humans seeking publicity and financial incentives to lose weight in the televised "The Biggest Looser" program, clearly demonstrate that increased motivation can produce large increases in physical activity and decreases in food consumption in obese individuals (Fothergill et al., 2016; Knuth et al., 2014) that they do not show spontaneously (as shown in Figure 8).

This unfortunate non-homeostatic design for energy intake and motivation to move (Borer, 2010) may have been the result of evolutionary pressures to take advantage of

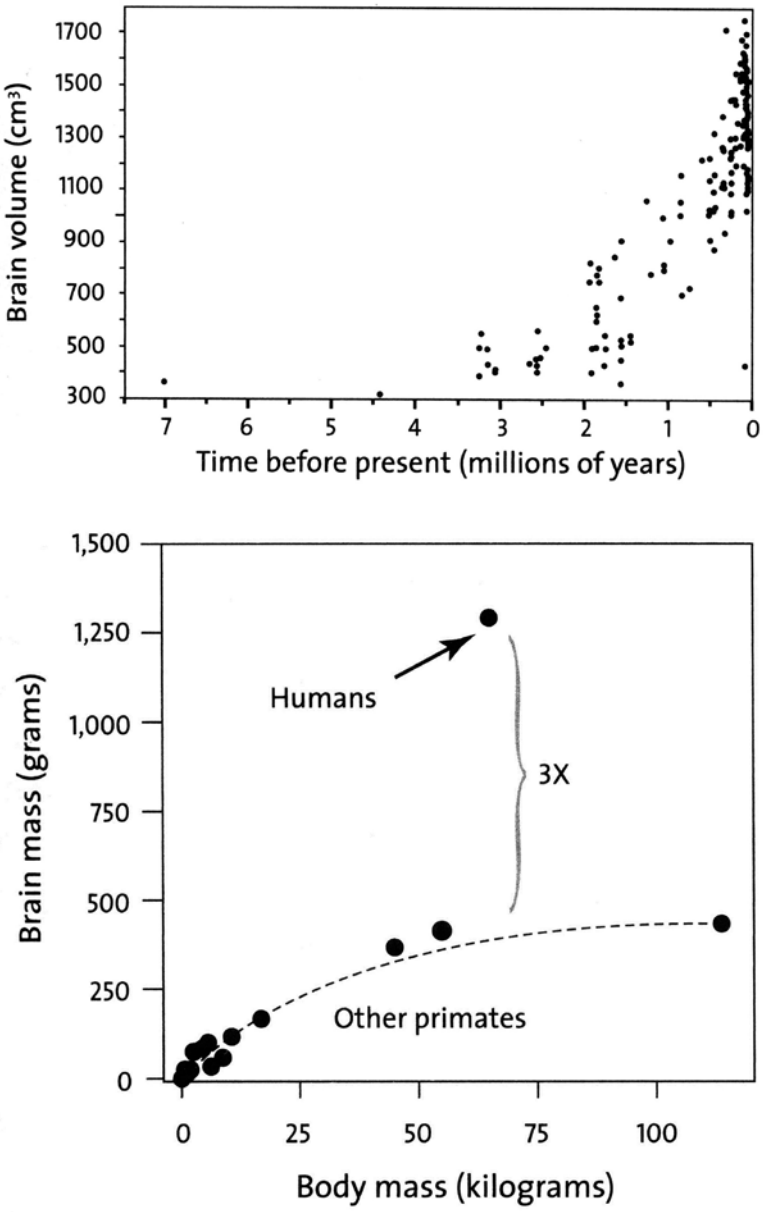

Figure 7. Exponential evolution of human brain volume during the last three millennia (top) producing about 4-fold difference between human and primate brains (bottom). Data from Ruff, Trinkaus & Holliday, 1997, illustration from Lieberman, 2013, pages 101 and 107.

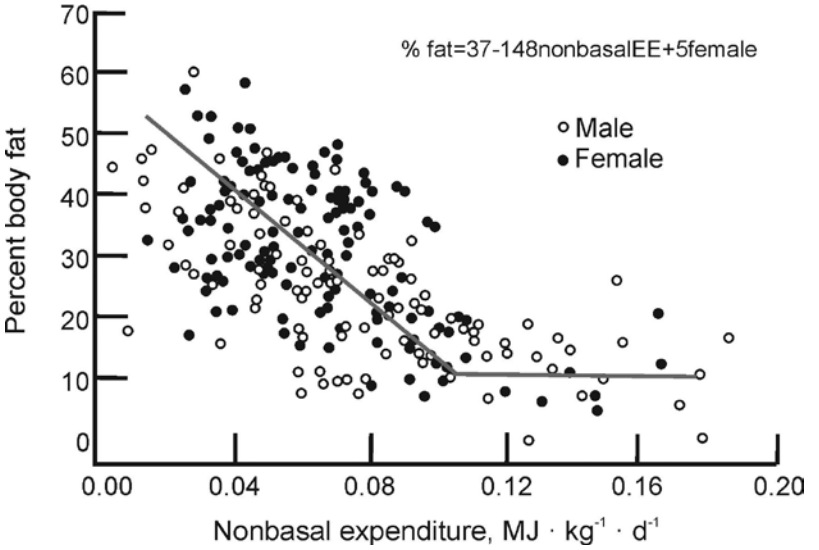

Figure 8. Inverse relationship between non-basal daily energy expenditure as a function of human percent body fat. From Rising et al., 1994 and Schulz & Schoeller, 1994.

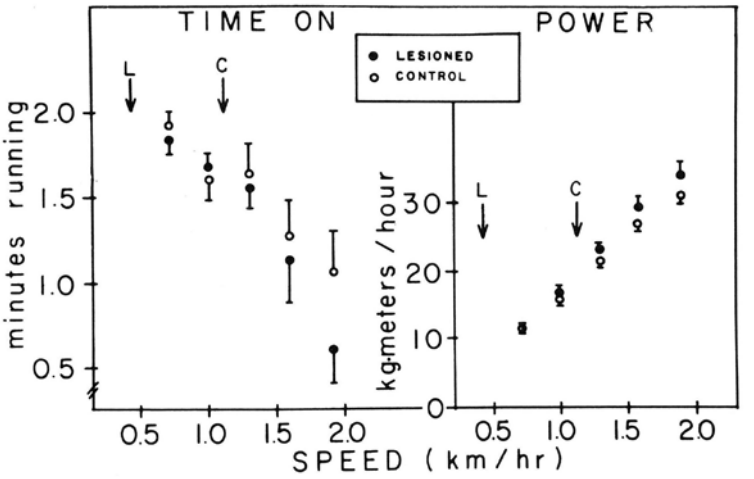

Figure 9. Obesifying septal lesions in golden hamsters (Mesocricetus auratus) produced 82% reduction in the level of spontaneous wheel running. However, when forced to run on a treadmill with electrified off-ramp grid as a negative reinforcement, obese hamsters showed no deficit in duration of running (left) or power production (right) compared to lean non-lesioned animals throughout the range of tested treadmill speeds.

uncertain food availability in human past by increasing the search for it when the food is scarce (Chakravarthy & Booth, 2004). Beyond the lower quantity of spontaneous physical activity with the rise in obesity, staying inactive or sedentary over several hours reduces cardiovascular health and increases risk of the morbidities associated with obesity (Després, 2016). The volumes of prescribed physical activity usually fall short of compensating for the ease with which excessive calories can be ingested and stored (Borer, 2008). Unless physical work is required for the procurement of food or some other life necessity, as was evident in Cuba during early 1990s when food embargo led to food scarcity and population weight declines (Rodríguez-Ojea, Jiménez, Berdasco & Esquivel, 2002), human ingenuity to make voluntary physical work unnecessary is likely to persist and obesity is likely to continue to rise.

5. Dietary and exercise solutions to some obesity-associated morbidities

Obesity, and particularly T2D, are characterized with hyperglycemia, not only immediately after the meals, but over postprandial periods spanning substantial periods of wakefulness (van Dijk et al., 2011). Persistent hyperglycemia, as reflected in elevated hemoglobin A1c, has been associated with coronary heart disease and increased mortality (Després et al., 1996). The association of hyperglycemia and hyperinsulinemia in T2D with obesity is firmly established as both can be reduced with weight loss (Taylor, 2013). It is probable that the rapid rise in obesity and T2D in the US population since 1970's (National Diabetes Statistics Report, 2017) may have been facilitated by a 30.5% increase in daily carbohydrate consumption from 213 g per day in 1965 to 278 g per day or 51% of daily calories in 2011 (Cohen et al., 2015). The currently high carbohydrate consumption in the US falls within the 45 to 65% of daily calorie range recommended in 2010 by US Departments of Agriculture and Health and Human Services (Dietary Guidelines for Americans, 2010). To test the hypothesis that the postprandial hyperglycemia is largely driven by the high insulin response to a high-carbohydrate diet, carbohydrate content of the isocaloric meals was reduced in a recent study (Lin & Borer, 2016) from 60% to 30% over a 24-hour period.

The remarkable outcome of the study was that the postprandial insulin area under the curve was reduced by 39% by the third low-carbohydrate meal, after a 24-hour exposure to the changed diet, but not after the high-carbohydrate meal (Figure 10). This reduced a homeostatic measure of insulin resistance by 37% (Figure 11).

Another insight provided by the study was that exercising for 2 hours at moderate intensity before the meals aggravated carbohydrate intolerance rather than reducing plasma glucose as exercise is expected to do (Figure 12).

The study provides helpful information that a simple dietary intervention consisting of a decrease in dietary carbohydrate and increase in healthy dietary fat and protein could restrain hyperinsulinemia that may drive fat synthesis in WAT and ectopic sites. Also, that exercise before the meals, but not after the meals (Heden et al., 2015), exacerbates postprandial glucose intolerance.

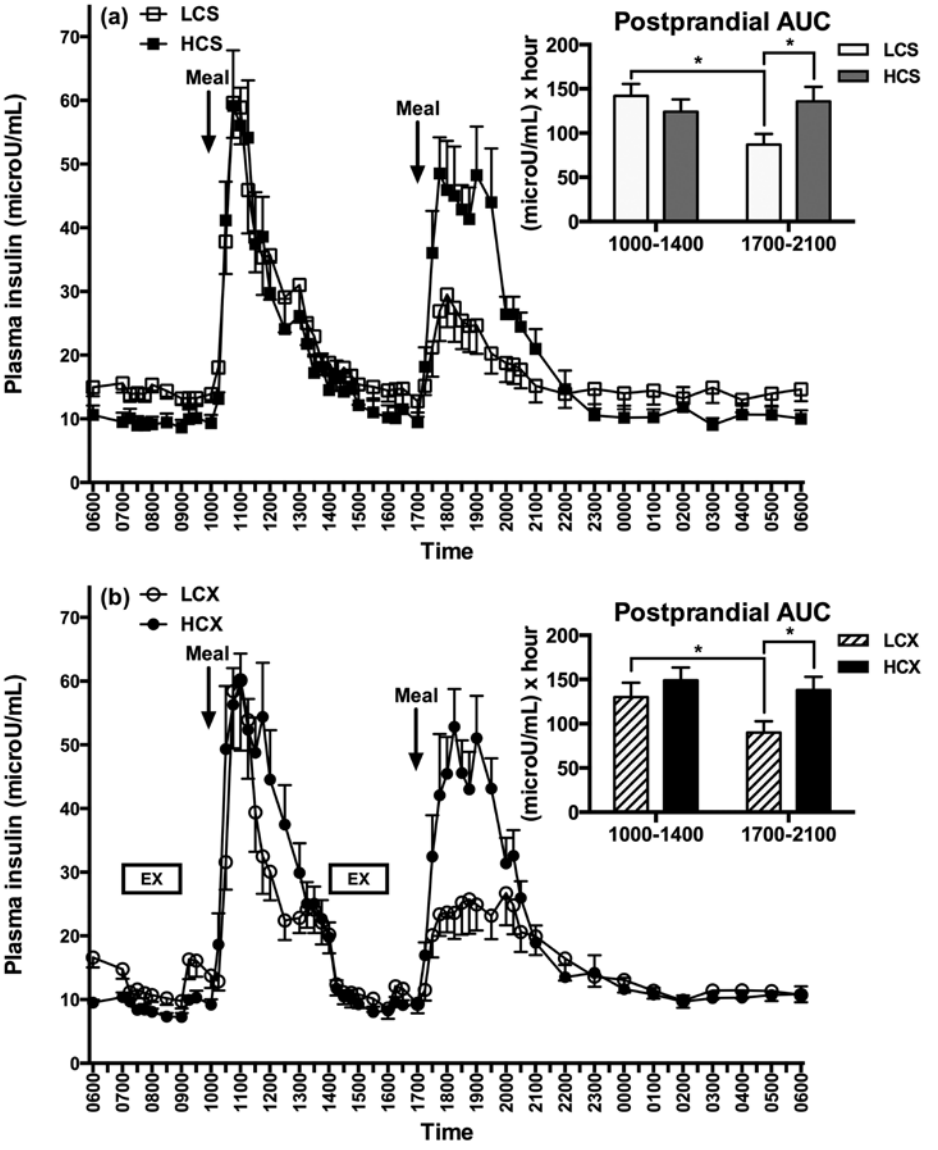

Figure 10. Reduction in postprandial insulin responses after the third low-carbohydrate meal in either (a) sedentary (LCS) or (b) exercise trials (LCX) but not in, respectively, high-carbohydrate sedentary (HCS) or exercise (HCX) trials. From Lin & Borer, 2016.

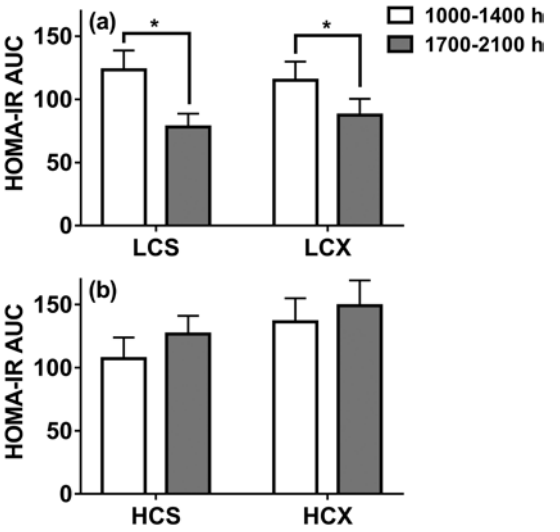

Figure 11. Reduction in HOMA-IR measure of insulin resistance after the third low-carbohydrate meal in either (a) sedentary (LCS) or (b) exercise trials (LCX) but not in, respectively, high-carbohydrate sedentary (HCS) or exercise (HCX) trials. From Lin & Borer, 2016.

It would be remiss not to emphasize the advantage of combining exercise with the recommended caution in selection of quantities and quality of food. This emphasis should mitigate the problems of the two already-mentioned weaknesses of physical activity in preventing or reversing obesity, its non-homeostatic nature, and its low power to overcome the ease of ingesting palatable food calories. The benefits of exercise are so impressive that since at least 2009 (Salis, 2009), the term "exercise is medicine" has been applied to the American College of Sports Medicine position stand on the benefits of exercise (Garber et al., 2011) and to the standing category of scientific presentations at the annual meeting of the American College of Sports Medicine. These sources document strong scientific evidence that regular exercise contributes to primary and secondary prevention of diabetes, hypertension, cancer (particularly breast and colon cancer), depression, osteoporosis and dementia, and while it is not very effective in weight loss, it helps maintain healthy body weight, and reduces all-cause mortality. Furthermore, it benefits human health regardless of ethnicity or age. Finally, exercise also assists weight control through temporary suppression of hunger (King, Burley & Blundell, 1994).

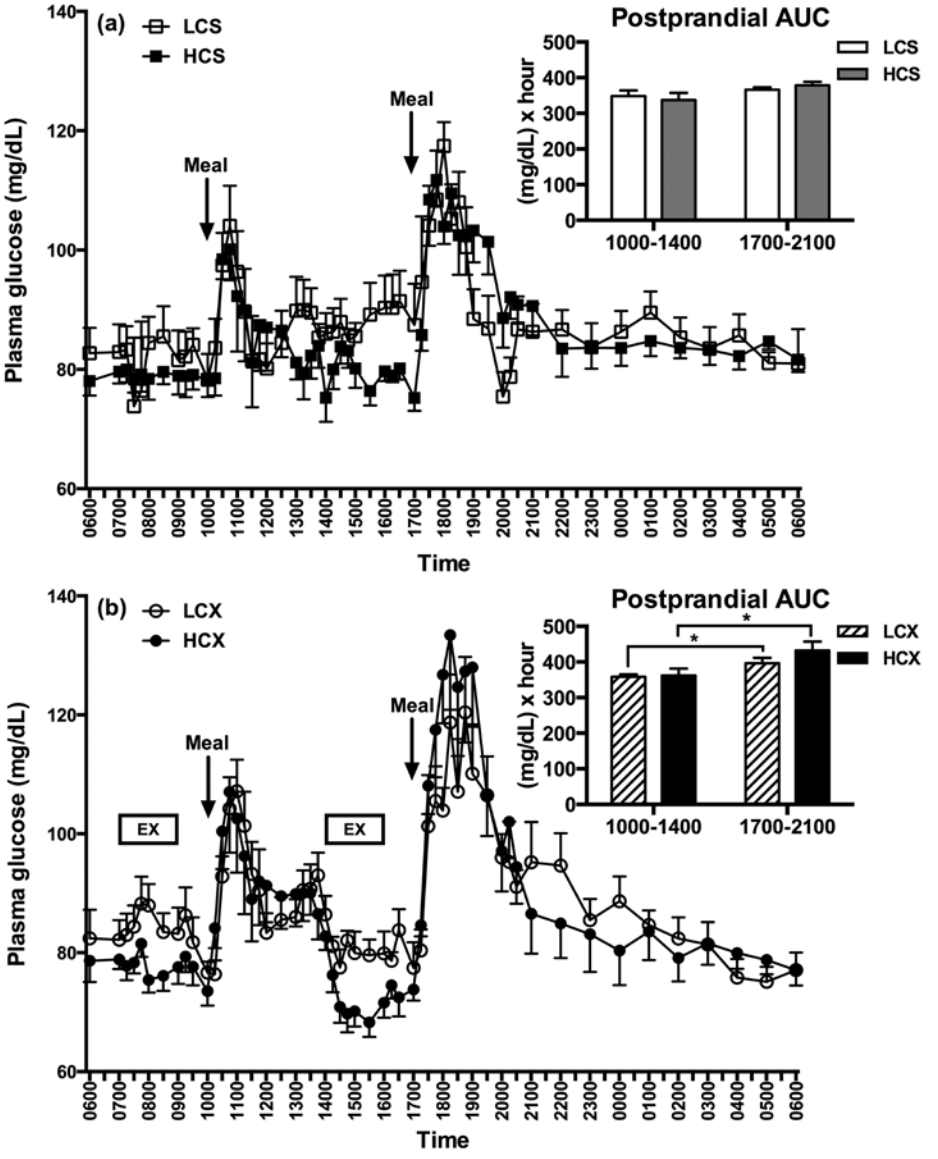

Figure 12. Exacerbation of postprandial glucose intolerance in exercise trials (bottom) but not in sedentary trials (top) after the third low-carbohydrate as well as high-carbohydrate meals high-carbohydrate meals. From Lin & Borer, 2016.

DISCUSSION

The reviewed data were selected to help formulate some inferences, and provide guidance, regarding behavioral prevention, reversal, or mitigation of obesity and its associated morbidities. *Prevention of obesity* should entail the awareness that humans are unable to track calories eaten or calories expended in exercise, elaborated in the second section on The Physiological Features that Facilitate Overeating. This fact and the evidence for the powerful motivational draw to eat palatable food, discussed in the same section, should provide a cautionary note to individuals with healthy weight to exercise vigilance and restraint about quantities of food eaten and monitor and respond to their gastrointestinal signals of fullness. Preferential selection of naturally nutritious food rather than "fast food" that is commercially manipulated for maximal palatability should help counteract our innate motivation to seek palatability. Selecting a diet that is rich in healthy fats and protein and avoiding over-indulging in high-carbohydrate diet should control postprandial insulin response and the property of the high circulating concentrations of this hormone to engage in excessive energy storage. Conscious avoidance of long sedentary periods and introducing opportunities for physical work should, along with prudent eating pattern, help establish a stable and healthy body weight level.

Reversal of obesity presents a more formidable challenge. Three powerful obstacles to maintenance of weight loss include physiological defense responses to any weight reduction, be it from obese level or a healthy level. The first one is a persistent reduction in resting metabolism, the second is increased hunger, and the third is heightened efficiency of energy storage. For this reason, most of the deliberately lost weight through food restriction, with or without additional exercise, is regained in the matter or months or years (Wing et al., 2016, Figure 13).

The effect of deliberate weight loss on resting metabolic rate (RMR) was studied by Kevin Hall in individuals responding to the challenge of large weight losses seeking to win "The Biggest Loser" televised competition and compared to weight loss produced by Roux-en-Y gastric bypass surgery (Knuth et al., 2014). Both approaches produced between 40 and 49 kg weight loss with a smaller lean body mass loss in the television competition (16%) than in gastric-surgery patients (30%). However, in both groups, the reduction in RMR (characterized as the metabolic adaptation) was similarly proportional to, and associated with, a reduction in plasma leptin (Knuth et al., 2016). This metabolic adaptation in the form of reduced metabolic rate occurs in response to negative energy balance caused either by fasting or by energy expenditure of exercise. It is currently viewed as an evolutionary defense response against deviations in total daily energy expenditure (Pontzer, 2015). In this view, higher energy expenditure due to increased body mass is sustained with high energy intake, but any reduction in intake and exercise energy expenditure is compensated by a reduction in resting metabolism. This therefore means that once the increased body mass is acquired, attempts to reduce its lipid component will trigger downward adjustments in RMR. It also appears that a lack of change in gastro-intestinal scaling during weight loss does not affect the outcome, as

voluntary-effort and gastrectomy weight losers displayed similar metabolic adaptation (Knuth et al., 2014; 2016). While this metabolic adaptation was shown to persist for up to 30 weeks post weight loss, it is not yet known whether moderate food restriction and at least 1 hour of exercise that are practiced by successful weight-loss maintainers (McGuire, Wing, Klem, Seagle, & Hill, 1998) can, over much longer periods of time, lead to reduced total energy expenditure setpoint through proportional reductions in all components of body mass, as well as in gastrointestinal remodeling. This is suggested by a study in which an individual totally abstained from eating for 382 days and lost 125 kg or 60.4% of initial weight. Five years after returning to ad-libitum eating, his weight increased to only 89 kg from the post-fasting level of 82 kg (Stewart & Fleming, 1973).

The other two variables that interfere with weight-loss maintenance and promote weight regain are a significant increase in insulin sensitivity as a result of weight loss which powerfully drives fat and glycogen re-synthesis and blocks triglyceride breakdown, and reduction of fasted plasma leptin to very low concentration (Figure 1). As most of leptin is released from the subcutaneous WAT, its role in weight-reduced state is to reduce satiation and increase hunger. This was demonstrated in powerful suppression of hunger by leptin administration to individuals who were experimentally undergoing a 10% weight loss (Rosenbaum & Leibel, 2014) and in persons with genetic inability to produce leptin in whom hormone administration suppressed both the hunger and reduced obesity (Farooqi & O'Rahilly, 2014). The appetite-suppressing effects of increases in basal leptin act on the previously-mentioned brain substrates of reward (Berridge, 2009).

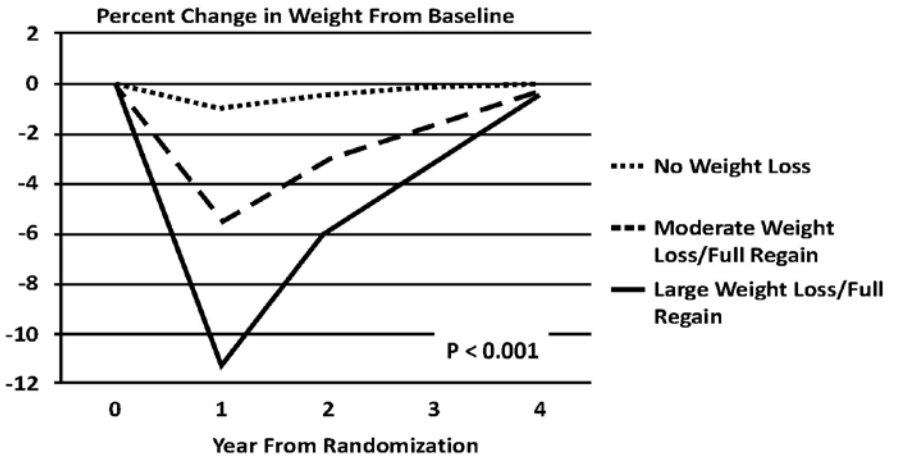

Figure 13. Patterns of weight loss and regain as percent difference from the start during 4 years of an intensive lifestyle diet-and-exercise intervention in the Look AHEAD Clinical Trial. From Wing et al., 2016.

While there are no highly effective behavioral strategies for rapid weight loss, it is possible to sustain weight loss through deliberate control over the quantity of food eaten, daily exercise, and frequent monitoring of the weight balance (McGuire, et al., 1998). In 750 individuals tracked by the National Weight Control Registry, a 13.5-kg weight loss was maintained for about 6 years by eating a low-calorie diet (5,792.3 kJ/d and 25% of daily calories from fat) and by engaging in high levels of physical activity (11,847.3 kJ/week).

The strategies for the *mitigation of morbidities associated with obesity* include reducing the carbohydrate content of the diet to lower postprandial insulinemia and glycemia (Lin & Borer, 2016), exercising shortly after eating a meal (Heden et al, 2015) rather than before the meals (Lin & Borer, 2016) because the former reduces postprandial glycemia while the latter exacerbates it. In addition, controlling the quantity of food eaten and changes in body weight with daily or at least weekly weighing provides helpful feedback for adjustments in energy balance, and engaging in about an hour of moderate daily physical activity contributes to a negative energy balance. Increased exercise energy expenditure and negative energy balance may, due to reduction in total metabolic rate, be responsible for the many health benefits of exercise including lower inflammatory responses leading to reduced cardiovascular disease risk, and lower stress levels contributing to endocrine and psychological health as a consequence of the reduction in non-exercise energy expenditure (Pontzer, 2015).

CONCLUSIONS

The rapid global rise of obesity incurs a heavy personal and healthcare burden due to obesity-associated morbidities and shortening of life. We explain the features of human physiology that favor fat accretion and interfere with fat loss for the benefit of individuals who use this survey of evidence on strategies for prevention, reversal, and mitigation of obesity and its sequelae. Obesifying features of human physiology include strong motivating properties of palatable food, inability to consciously detect calories eaten or expended through exercise, and hormonal and metabolic adaptations to negative energy balance that drive weight regain. We also point to the evolutionary burdens of high human capacity for fat storage and absence of a compensatory role for spontaneous physical exertion in counteracting the weight gain. Adding exercise energy expenditure to deliberate control of the quantity of food eaten will reduce the incidence of some obesity-linked risk factors that lead to cardiovascular disease despite the metabolic adaptation of reduced resting metabolism. Deleterious concomitants of obesity can also be mitigated by reducing postprandial hyperinsulinemia, namely by lowering the carbohydrate load of the diet and by exercising after, rather than before, the meals to facilitate greater glucose tolerance.

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THE BENEFITS OF PHYSICAL ACTIVITY AND EXERCISE ON PHYSICAL, COGNITIVE AND DAILY LIFE ACTIVITIES IN AGING ADULTS

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ABSTRACT

Due to increased longevity, degenerative diseases and disabilities have become one of the largest health care problem. The state of well-being with a low risk of premature health problems is important for successful aging. Even if the impact of physical activity and exercise on performance of daily life activities is still poorly understood, it seems that regular training has important benefits on physical and cognitive functioning in healthy elderly population. Combined training including strength, balance, flexibility exercises and activities that improve cardiorespiratory fitness, are important to ensure the independency of elderly people.

Keywords: *physical activity, exercise, physical functioning, daily life activities, older adults.*

VPLIV GIBANJA NA TELESNE IN UMSKE SPOSOBNOSTI ZA IZVAJANJE VSAKODNEVNIH OPRAVIL V STAROSTI

IZVLEČEK

Ena izmed posledic podaljševanja povprečne življenjske dobe so tudi različne telesne omejitve in številne degenerativne bolezni, ki postajajo vse večji zdravstveni problem. Kvalitetno staranje je povezano z dobrim počutjem posameznika in nizkim tveganjem za zgodnji pojav bolezni. Vpliv redne telesne aktivnosti in vadbe na sposobnost izvajanja vsakodnevnih opravil v starosti še ni povsem pojasnjen, je pa vadba dokazano povezana z boljšimi telesnimi in kognitivnimi sposobnostmi starejše osebe. Kombinirani trening, ki vključuje vaje za moč, ravnotežje in gibljivost, v povezavi z rednimi vzdržljivostnimi telesnimi aktivnostmi, pomembno prispeva k ohranjanju samostojnosti starostnika.

***Ključne besede**: telesna aktivnost, telesna vadba, vsakodnevne telesne aktivnosti, starejše osebe.*

INTRODUCTION

European today can expect to live longer. According to Eurostat (2019) in 2017, one fifth (19%) of the Europeans population was aged 65 and over. The share of elderly people tends to increase. Especially for those aged 80 + years it will be more than double by 2080 to reach 13% of the whole population. The consequence of this increased longevity is that degenerative diseases and disabilities have become one of the largest health care problems. The negative impact of a longer life span is a potential for suffering physical frailty and it could become questionable whether life can be enjoyed fully under physical conditions that constrain daily activities (Spiduso, Francis, & MacRea, 2005). The degree to which participation in physical activity (PA) and exercise translates into improved physical functioning and enhanced performance of daily life activities (ADL) is not yet clear. There is not a simple linear relationship between being active and being independent on others, but at least no increase in disabilities after being regular physically active was found (Chodzko-Zajko et al., 2009).

During aging structural and functional attenuation occurs in most physiological systems, even in the absence of diseases. These age-related changes can influence daily life activities through reduction in functional capacity. Advancing primary aging is mainly associated with the decline in PA volume and intensity, higher prevalence of degenerative conditions, body composition changes, and the decrease in maximal aerobic power. Aging is also characterized by the reduction in muscle strength and power and by the decline in flexibility, balance and cognitive functions (Shephard, 1997; Hunter,

McCarthy & Bamman, 2004; Chodzko-Zajko et al., 2009). At present, aging including loss of abilities is an inevitable process. There is, however, evidence that regular exercise has anti-aging effects. Target strength and aerobic training can attenuate a cardio-respiratory decline, muscle wasting and improve resistance to the development of disability with aging. Most common age-associated chronic conditions cause alteration in physiological functions and thus physiological interventions, of which physical exercise is a good example, can be a remedy (Tseng, 1995; Garatachea et al., 2015). Regular aerobic exercise improves endothelial function with increasing nitric oxide production and thus regulate vascular tonus. In addition, aerobic exercise stimulates angiogenesis and the reverse cholesterol transport. It increases heart rate variability, reduces activity of angiotensin II and inhibits blood coagulation. Resistance exercise improves muscle mass and strength in elderly. The molecular mechanisms involved are calcium flux, ATP/ADP ratio, intracellular pH redox balance. Post-exercise gene transcription mostly involves myogenic regulators. Exercise also attenuates neurodegeneration due to aging, by maintaining the hippocampal structure and upregulating neurotrophic factors, such as BDNF (brain derived neurotrophic factor) important for synaptic plasticity and cognitive performance (Garatachea, et al., 2015; Slutsky & Etnier, 2016).

The primary goal of care for the elderly is to ensure their independent life as long as possible. There is evidence of an association among habitual PA in later life and the maintenance of effective functions (Wanderley et al., 2011).

OBJECTIVES

The aim of this article is to present a short overview of the literature regarding the benefits of PA and exercise on physical functioning and daily life activities in an adult, aging population. For this purpose, databases PubMed and Scopus were searched in February 2019 for literature sources published from 1995 to 2018 using research strategy: (physical activity OR exercise) AND physical functioning AND daily life activities AND older adults. A literature search was conducted including articles based on the following criteria: (1) clinical trials and reviews (2) published in English language. The research strategy generated 168 articles which were analyzed using the algorithm: review the titles, for the remaining review the abstracts and for the last remaining review the full text. Finally, 22 articles were selected to address the objective of the study: impact of physical activity and exercise on the ability to perform everyday task and independency in the elderly. Other relevant literature from the field was included.

SUCCESSFUL AGING

Successful aging (Rowe & Kahn, 1997) is determined by three main components: low probability of disease and disease-related disability, high cognitive and physical functional capacity, and active engagement with life. Subjects are considered to suc-

cessfully age if they can perform physical activities expected from an adult with no or little difficulties. Their ability to perform basic physical daily activities such: walking, stair climbing, bathing, dressing, doing housework, gardening etc. is usually valued through questionnaires (Strawbridge, Cohen, Shema, & Kaplan, 1997). Physical reserve in old age is of a great significance and can be define as the distance from physical frailty: musculoskeletal function, aerobic capacity, and motor coordination decline. Individuals that still have sufficient physical reserve can continue to live in their homes and to carry out regular daily activities (Spiduso, Francis, & MacRea, 2005). Cognitive reserve, the capacity to maintain healthy brain functions, is an important issue in successful aging. Identified components of cognitive reserve are childhood intelligence, higher mental ability, better management of stressful experiences, better use of health services, implementation of health education in lifestyle and a choice of cognitively more stimulating leisure activities. Managing the components that influence on cognitive aging and cognitive reserve is an important issue to maintain brain functions in old age (Whalley, Deary, Appleton, & Starr, 2004). Especially hippocampus is important for cognitive performance. Studies have shown that maintaining a normal body weight and being physically active are beneficial for hippocampal structure and function (Slutsky & Etnier, 2016). The state of well-being with a low risk of premature health problems is important for successful aging (Rowe & Kahn, 1997).

MAIN CONDITIONS THAT INFLUENCE DAILY LIFE ABILITIES IN OLDER ADULTS

Decrease in bone and muscle mass, including faster decline in type II muscle fibers, decrease in tensile strength of tendons and ligaments, increase in muscle and related structure stiffness and the articular cartilage weakness are some of the most important aging conditions that influence daily life abilities in older adults (Shephard, 1997; Anish, 2009). Impairments in leg muscle power as well age – related decline in sensory capabilities, are important factors underlying mobility limitations in older adult daily life (Bean et al., 2004). Using bed rest as an aging model to study degenerative physiology of human systems we can follow physiological alterations at different ages. For example, the negative effect of bed rest on muscle mass and function was greater in older men, whereas metabolic disturbance was greater in younger adult men (Pišot et al., 2016). The available evidence suggests that bone mass reduction in the case of extreme physical inactivity represents an acceleration of the normal ageing of the bone and underlines the importance of being active to maintain tissue balance (Bilancio, Lombardi, Cirillo, Pišot, Rittweger, & De Santo, 2012). There was no significant impairment in cognitive performance, mental health and satisfaction with life after the 14-day bed rest, except in the delayed recall of older adults (Dolenc & Petrič, 2013). The obtained results provide evidence that favourable living, as well the quality of social interactions can protect against cognitive decline during physical inactivity (Dolenc & Petrič, 2013; Dimec Časar, Tušak, & Dolenc, 2015). When computerized cognitive training is being

implemented during the bed rest study the improved in cognitive performance was evident and can successfully moderate detrimental bed rest effects in healthy older adults (Marušič et al., 2015; Marušič et al., 2017).

PHYSICAL ACTIVITY TO IMPROVE PHYSICAL FUNCTIONING IN DAILY LIFE ACTIVITIES OF ELDERLY

Healthy older adults who are able to engage in exercise can develop positive adaptations to the training. When compared to older adults (60–74 years), 73% of the reduction in total energy expenditure in nonagenarians is attributed to a reduction in PA level. The reduced physical activity in nonagenarians is associated with less physical functionality (Frisard et al., 2007). Nevertheless, multicomponent exercises including muscle power training enhance muscle mass, power output, and functional outcomes also in nonagenarians (Cadore et al., 2014).

Exercise, even at moderate level, in particular avoiding sedentary behavior, may delay disabilities and improve survival in older age. Types of activities that bring joy and are in the same time easy to include in daily life are suitable. For example, regular practice of daily life activities will allow their maintenance. Positive association was found among house/garden work and physical/mental well - being in older women (Peeters, van Gellecum, van Uffelen, Burton, & Brown, 2014). Simple interventions like pet ownership are important in maintaining daily life abilities levels of older people (Raina, Waltner-Toews, Bonnett, Woodward, & Abernathy, 1999). Even regular walking induces benefits for health, in addition is simple, safe and free of charge. We can walk anytime and anywhere: at home, up the stairs, in the nature in shopping malls (Drev, 2010). Dance, especially challenging dance programs are an effective countermeasure of aging on the brain. Dancing has a superior potential to induce more positive effects on brain volumes in elderly people to peperitive physical exercises (Rehfeld et. al., 2018). An important message is that exercises in old age are not beneficial only for physical functioning, but they also are neuro-protective (Herold, Törpel, Schega, & Müeler, 2019).

But for most health outcomes, additional benefits occur as the amount of PA increases through longer duration, greater frequency and finally, higher intensity. Ideally, exercise programs for successful aging should include endurance training, resistance training and exercise for flexibility and balance (Simonsick, Guralnik, Volpato, Balfour, & Fried, 2005; Chodzko-Zajko et al., 2009). In this case gradually increasing regular PA is extremely important. When preparing the training program, we must consider any health restrictions of the elderly subject (Gerževič & Plevnik, 2014). The WHO guidelines are relevant to all healthy adults aged 65 years and over unless specific medical conditions: older adults should do at least 150 minutes (for additional benefits 300 min) of moderate-intensity aerobic PA or do at least 75 minutes (for additional benefits 150 min) of vigorous intensity aerobic PA throughout the week. Aerobic activity should be performed in bouts of at least 10 minutes duration. Older adults should perform PA to

enhance balance and prevent falls on 3 or more days per week. Muscle-strengthening exercise should be done on 2 or more days a week. When older adults cannot do the recommended amounts of PA due to health conditions, they should be as physically active as conditions allow (Global Recommendations on Physical Activity for Health - 65 years and above, 2011).

Endurance activities for elderly

Improvements in daily life abilities are often achieved by endurance training. Endurance exercises for elderly usually include brisk walking or jogging, swimming, yard work and dancing. Endurance training is an effective tool against the cardiorespiratory decline observed during aging. After an 8-year follow-up of older adults, Paterson, Govindasamy, Vidmar, Cunningham, and Koval (2004) report that a lower cardiorespiratory fitness is a significant determinant of becoming dependent. Authors suggest that initiatives to encourage physical activity in older adults should emphasize exercise to maintain or improve cardiorespiratory fitness. Thais de Lima, Corrêa Kanan, Augustin Schwanke, and Mânica da Cruz (2013) suggest that 3 months aerobic training program by treadmill walking result in significant increases in step length and self-selected walking speeds in healthy, independent, elderly women. Frequent, especially brisk pace walking is a relatively safe and easy activity also for hip fracture prevention (Feskanich, Flint, & Willett, 2014). Aerobic exercise can improve physical performance but even a number of aspects of cognition and brain function (Hillman, Erickson, & Kramer, 2008).

Heart rate is commonly used as a guide to exercise intensity. The American Heart Association suggest the target ranges for moderate-intensity exercise as 50% to 75% of average maximum heart rate. Exercise sessions should maintain target heart rate for 20 to 60 minutes (continuous or intermittent), with a minimum of 3 x 10-minute bouts collected throughout the day. According to American College of Sports Medicine, to achieve cardiorespiratory fitness aerobic exercise 3 to 5 days per week should be performed (McDermott & Mernitz, 2004).

Strength training for elderly

Physical activity maintains muscular strength and endurance, flexibility and balance, all factors important for independent living of an elderly person. Generally, a progressive resistance training protocol can produce substantial increases in muscle strength and power of aging people (Skelton, Young, Greig, & Malbut, 1995; Hanson et al., 2009). Leg strength and endurance are necessary for housekeeping, food preparation, shopping etc. Neuromuscular activation deficits precede changes in muscle size and strength, and this may be the initial mechanism that influences leg muscle power loss (Reid et al., 2014). A progressive resistance training program is effective in improving leg power in elderly men and women (Earles, Judge, & Gunnarsson, 2001; Bean et al., 2004; Holviala et al., 2014). Furthermore, for improvement daily life activities of el-

derly, a functional muscle power training program based on higher velocity movements that mimic daily life activities should be prescribed (Cress, Conley, Balding, Hansen-Smith, & Konczak, 1996; Miszko et al., 2003; Bean et al., 2004; Henwood & Taaffe, 2005). To combine, a progressive resistance training that incorporates rapid rate-of-force development movements may be safely undertaken in healthy older adults and results in significant gains in muscle strength, muscle power, and physical performance (Henwood & Taaffe, 2005). Resistance exercises are powerful physical interventions to induce functional brain changes, especially by improvements in executive functions. Resistance exercises lead to mantain white matter and to smaller white matter lesions (Herold, Törpel, Schega, & Müeler, 2019). Incorporating the elastic resistance training in nursing homes could be an effective strategy against functional decline during aging (Urzi, Marušič, Ličen, & Bužan, 2019). Resistance training should be performed at least twice per week and exercises should target the major muscle groups. Patients can exercise all muscle groups at each session or divided the series into shorter sessions of 3 to 4 muscle groups that are worked on alternation, so 4–6 sessions per week. Each set should consist of 8 to 12 repetitions at a somewhat hard to harder intensity level using the Borg Rating of Perceived Exertion Scale. Sessions should be no longer than an hour, with 48 hours between sessions (McDermott & Mernitz, 2004).

Balance and flexibility training for elderly

Combined exercises including strength, balance and flexibility exercises are effective in reducing the risk of falls (Campbell et al., 1997) and consequent limitations in daily life activity in old age. Flexibility is the range of motion around a joint and is associated with injury prevention. Of particular importance in aging is the maintenance of posterior thigh and ankle flexibility and of lower back flexibility. Appropriate flexibility can protect against chronic lower back pain and maintain the ability to perform daily life activities. Activities that improve flexibility include exercises that lengthen the muscles such as tai-chi, yoga, and stretching. A static stretching program including all major muscle groups performed a minimum of 2 to 3 times per week can improve agility and balance. Stretching exercises can be involved in warm-up and cool-down phases of an aerobic or resistance training (McDermott & Mernitz, 2004). A fitness program that includes exercises to improve flexibility, and strength, with an emphasis on balance (for safety external support must be provided) involving the lower body muscles would be a good choice for elderly patient (McDermott & Mernitz, 2004).

PHYSICAL ACTIVITY PROGRAMS INCLUDING COGNITIVE TASKS

Physical activity and exercise alone are neuro – protective (Guadagni et. al, 2018; Northey, Cherbuin, Pumpa, Smee, & Rattray, 2018; Tyndall et. al., 2018; Herold, Törpel, Schega, & Müeler, 2019), but less is known how to combine physical and cognitive

training for greater effects on cognitive functions and how brain training alone influence mobility in older adults. Cognitive training itself can improve mobility-relatated outcomes in older adult, especially for challenging walking conditions (Marušič, Verghese, & Mahoney, 2018). Physical activity programs for older adults can bring greater benefits when cognitive tasks are integrated. For example, challenging dance programs that combine aerobic fitness, sensorimotor skills and cognitive demands are promising in counteracting the decline in physical and cognitive abilities during aging (Müller et. al., 2017; Rehfeld et. al., 2018). Older adults should be made aware of the plasticity of the brain and the potential to maintain or improve their cognitive functioning when engage in mentally challenging physical activity (e.g. activities that combine physical and cognitive tasks as dance, tai-chi) (Gheysen et al., 2018). A systematic review of the effect of aerobic exercise on cognition in older adults showed an improving in auditory attention and cognitive processing speed (Angevaren et al., 2008). Physical activity, alone or combined with cognitive and nutritional interventions could enhance functional fitness in older adults (Paravlić, Marušič, Gerževič, Urzi, & Šimunič, 2016). Simultaneous training of cognitive and physical abilities presents an important technique to improve cognitive and motor-cognitive performance, so offering a better basis on daily life functioning (Gerževič, Plevnik, & Marušič, 2017). Even exercise at moderate level reduces the risk of developing cognitive impairment in older adults (Paterson, Jones, & Rice, 2007). It seems that brain derived neurotrophic factors as metabotrophin mediate the effects of exercise on cognition (Gomez Pinilla, Vaynman, & Ying, 2008). Although the effects of exercise on cognition are promising, information about the specific dose and type of exercise are still missing (Taylor, 2014).

Daily life abilities can be also impaired because of sleep disorders, which are common in elderly population. Regular physical exercise has been found as beneficial to initiating and maintaining sleep (Montgomery & Dennis, 2002).

CONCLUSIONS

State of well-being with a low risk of premature health problems is crucial for successful aging. Even still poorly understood relationship between physical activity and performance of daily life abilities, it seems that regular training has important benefits on physical functioning and daily life abilities in healthy elderly population. In particular, a variety of resistance exercise trainings favorably impact walking and balance activities, through maintaining muscle strength, power and neuromuscular capability of aging people. An additional beneficial effect on physical functioning is achieved if rapid movements that mimic daily life abilities are incorporated in the training programs. Combined training including strength, balance and flexibility exercises are effective in reducing the risk of falls the consequences of which can very limited performance of daily life abilities in the old age. Old adults should be also encouraged to emphasize exercise, such as brisk walking, to maintain cardiorespiratory fitness, a significant de-

terminant of healthy aging. Importantly, in the preparation of the training program is necessary to consider any health restrictions of the subject.

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REPORTS AND REVIEWS/POROČILA IN OCENE, 73–80

5th INTERNATIONAL SCIENTIFIC CONFERENCE ON "EXERCISE AND QUALITY OF LIFE"

Novi Sad, Serbia, 11–13 April, 2019

A delegation from the Institute for Kinesiology Research attended the hospitable EQOL2019 in Novi Sad, organised by the Faculty of Sports and Physical Education of the University of Novi Sad. The plenary lectures of the conference covered various aspects within the subtopic 'from active childhood to healthy aging' in a very informative way: Wlodzimierz Starosta: *Model of children's comprehensive movement education in a family as a fundament of healthy, physically active, successful and long life*; Antonino Bianco: *Field-based tests for the assessment of physical fitness in youth practicing sports: a systematic review within the ESA program*; James S. Skinner: *Exercise and quality of life in the elderly*; Francisco B. Ortega: *Fitter kids for a healthier adult society*; Jozsef Betlehem: *How can health literacy influence health status?*; Jorunn Sundgot-Borgen: *Exercise and quality of life in healthy adolescents, women with eating disorders and female elite athletes*; Dejan Magoc: *Impact of 5-2-1-0: a community-based childhood obesity prevention initiative*; Sanja Music Milanovic: *Physical (in)activity in early school-age: What are we doing wrong?*; Visnja Djordjic: *The post-milennials' lifestyle and what physical education can do about it?*; Sanja Salaj: *Physical activity and motor skills in preschool children*; Finn Berggren: *HEPA Europe – Before – Now – and ???*.

The conference allowed sufficient time for the oral presentations of both the invited speakers and work sessions, as well for poster sessions, where young and old could gather and discuss the themes.

From the main lectures, it was obvious that there is a role for attendees and organisers to raise awareness of the importance of physical activity during primary school periods, to battle sedentary lifestyles, and to consider physical activity as an integrated element of obligatory academic courses. HEPA Europe, a network of organisations recognized by WHO which emphasises health-enhancing physical activity, could have an important role in this (for more on HEPA Europe visit: http://www.hepaeurope2019.org/). From this perspective, it seems that new field-based tests for the assessment of physical activity for young people might even be of interest for (early) detection of cognitive and physical disabilities in children.

The abstracts of the conference have been published in BMC Sports Science, Medicine and Rehabilitation, Volume 11, Supplement 1 (https://doi.org/10.1186/s13102-019-0119-7), while more details of the conference and its associated journal can be found elsewhere (http://eqol.rs and www.eqoljournal.com). The well-organised conference is highly commended for its invitation to renowned academic speakers, and for attracting several hundred participants who had the chance to share knowledge in a stimulating environment, which was especially rewarding for young researchers.

Cécil Meulenberg

REPORTS AND REVIEWS/POROČILA IN OCENE, 73–80

5. MEDNARODNA ZNANSTVENA KONFERENCA »EXERCISE AND QUALITY OF LIFE«

Novi Sad, Srbija, 11.–13. april 2019

Sodelavci Inštituta za kineziološke raziskave ZRS Koper so se že tradicionalno udeležili 5. EQOL2019 konference v gostoljubnem Novem Sadu, ki jo je organizirala Fakulteta za šport in telesno vzgojo Univerze v Novem Sadu. Plenarna predavanja konference: Wlodzimierz Starosta: *Model of children's comprehensive movement education in a family as a fundament of healthy, physically active, successful and long life*; Antonino Bianco: *Field-based tests for the assessment of physical fitness in youth practicing sports: a systematic review within the ESA program*; James S. Skinner: *Exercise and quality of life in the elderly*; Francisco B. Ortega: *Fitter kids for a healthier adult society*; Jozsef Betlehem: *How can health literacy influence health status?*; Jorunn Sundgot-Borgen: *Exercise and quality of life in healthy adolescents, women with eating disorders and female elite athletes*; Dejan Magoc: *Impact of 5-2-1-0: a community-based childhood obesity prevention initiative*; Sanja Music Milanovic: *Physical (in)activity in early school-age: What are we doing wrong?*; Visnja Djordjic: *The post-milennials' lifestyle and what physical education can do about it?*; Sanja Salaj: *Physical activity and motor skills in preschool children* in Finn Berggren: *HEPA Europe – Before – Now – and ???* so na zelo informativen način zajemala različne vidike letošnje glavne teme "Od aktivnega otroštva do zdravega staranja".

Konferenca je obsegala tako govorne predstavitve aktivnih udeležencev, kot tudi sekcijo poster predstavitev, kjer je bilo več časa za razpravo namenjenega predvsem tistim, ki so šele na začetku akademske poti.

Plenarna predavanja so tudi tokrat opozarjala na očitno vlogo, ki jo imajo udeleženci in organizatorji konference pri ozaveščanju javnosti o pomenu gibalne/športne dejavnosti v osnovnošolskem obdobju, pri boju proti sedentarnemu življenjskemu slogu in pri upoštevanju telesne dejavnosti kot integriranega elementa v učnih načrtih. Pri tem bi lahko izpostavili pomembno vlogo mreže organizacij »HEPA Europe«, pod okriljem Svetovne zdravstvene organizacije, ki promovira gibalno/športno aktivnost za krepitev zdravja populacije (več o »HEPA Europe« na http://www.hepaeurope2019.org/). V tej smeri lahko razumemo tudi nove terenske teste za oceno GŠA za mlade, ki naj bi pripomogli k (zgodnjemu) odkrivanju kognitivnih in telesnih pomanjkljivosti pri otrocih.

Povzetki konference so bili objavljeni v reviji BMC Sports Science, Medicine and Rehabilitation, Volume 11 Supplement 1 (https://doi.org/10.1186/s13102-019-0119-7), več podrobnosti o konferenci in znanstveni reviji lahko najdete tudi na (http://eqol.rs in www.eqoljournal.com).

Dobra organizacija konference z aktualnimi predavanji priznanih strokovnjakov ter več kot 100 predstavljenimi prispevki, zagotavlja spodbudno okolje in dobro priporočilo za vse mlade raziskovalce, ki si želijo akademske rasti.

Cécil Meulenberg, prevod Saša Pišot

REPORTS AND REVIEWS/POROČILA IN OCENE, 73–80

REPORT ON THE FIRST BELT AND ROAD PHYSICAL EDUCATION FORUM

Zagreb, Croatia, 16–18 April 2019

The first Belt and Road[1] Physical Education Forum was organised by the Faculty of Kinesiology, University of Zagreb with the aim that the institutions of higher education from countries included in the initiative discuss the coordinated development of sports and sport education.

In this two-day event, each institution was presented, pointing out the important facts as well as giving an overview of their activities and projects. They also proposed the possibilities of further collaboration within the 16+1 initiative. The Science and Research Centre, Institute for Kinesiology Research was presented by the director prof. Rado Pišot, PhD. Additionally, the meeting with the representatives of Beijing Sport University was organised where also prof. Boštjan Šimunič, PhD and Saša Pišot, PhD presented the possibilities of mutual collaboration on common institute's research fields.

Based on the premise of respecting the diversity of sports sciences there were 32 institutions from 16 countries that signed the consensus of promotion the development of physical education research, namely: Beijing Sport University, Beijing Normal University, Capital University of Physical Education and Sports (CUPES), Charles University, Chulalongkorn University, Comenius University in Bratislava, Gdansk University of Physical Education and Sport, German Sport University Cologne, Josef Pilsudski University of Physical Education Warshaw, Latvian Academy of Sport Education, Lithuanian Sports University, Masaryk University, National Sports Academy "Vassil Levski", Palacky University Olomouc, Russian State University of Physical Education, Sport, Youth and Tourism, Science and Research Centre Koper, Sports University of Tirana, Ss. Cyril and Methodius University in Skopje; Transylvania University of Brasov, University of Alberta, University of Belgrade, University of Ljubljana, University of Montenegro, University of Niš, University of Primorska, University of Sarajevo, University of Split, University of Tartu, University of Worcester, University of Zagreb, the University "Vasile Alecsandri" of Bacau and Western University. In this way they enabled sports to make its due contribution in promoting human health and changing human limits.

[1] The Belt and Road Initiative (BRI) is a global development strategy adopted by the Chinese government involving infrastructure development and investments in 152 countries and international organizations in Asia, Europe, Africa, the Middle East, and the Americas. The leader of the People's Republic of China, Xi Jinping, originally announced the strategy during official visits to Indonesia and Kazakhstan in 2013. The "Belt" refers to the overland routes for road and rail transportation, called "the Silk Road Economic Belt"; whereas the "Road" refers to the sea routes, or the 21st Century Maritime Silk Road. (available on https://en.wikipedia.org/wiki/Belt_and_Road_Initiative).

According to the consensus, the institutions are willing to jointly build a platform for collaborative research and academic exchanges, strive to improve the level of sports scientific research, and consolidate and enhance the competence of the countries along the Belt and Road in physical education research.

The first forum is certainly a welcome opportunity to open up the scientific and research potential of the Institute for Kinesiology Research of the Science and Research Centre Koper, but we will need to wait for the response from the future potential partners, so in the meanwhile we can look for similar initiatives.

Saša Pišot

REPORTS AND REVIEWS/POROČILA IN OCENE, 73–80

POROČILO PRVEGA FORUMA "BELT AND ROAD" ZA IZOBRAŽEVANJE V ŠPORTU

Zagreb, Hrvaška, 16.–18. april 2019

Prvi forum »Belt and Road«[2] za izobraževanje v športu je organizirala Kineziološka fakulteta Univerze v Zagrebu z namenom, da visokošolskim ustanovam držav, vključenih v iniciativo, ponudi prostor za razpravo o usklajenem razvoju športa in izobraževanja v športu.

Ta dvodnevni dogodek je bil namenjen predstavitvi ustanov in podrobnejšemu pregledu njihovih dejavnosti in projektov ter prikazu možnosti nadaljnjega sodelovanja v okviru pobude 16 + 1. Znanstveno-raziskovalno središče Koper, Inštitut za kineziološke raziskave je predstavil direktor prof. Rado Pišot. Ob tem je bilo organizirano samostojno srečanje s predstavniki Pekinške univerze za šport, kjer sta možnosti za razvoj sodelovanja na skupnih področjih predstavila prof. Boštjan Šimunič in dr. Saša Pišot.

Skladno s spoštovanjem raznolikosti znanosti o športih je 32 ustanov iz 16 držav (Pekinška univerza za šport, Pekinška Normal univerza, Kapital univerza za telesno vzgojo in šport (CUPES), Karlova univerza v Pragi, Univerza Chulalongkorn, Univerza Comenius v Bratislavi, Univerza za telesno vzgojo in šport v Gdansku, Nemška univerza za šport v Kölnu, Univerza »Josefa Pilsudskega« za telesno vzgojo v Varšavi, Latvijska akademija za športno vzgojo, Litovska univerza za šport, Masarykova univerza v Brnu, Nacionalna športna akademija »Vassil Levski« v Sofiji, Univerza Palacky Olomouc, Ruska državna univerza za telesno vzgojo, šport, mladino in turizem, Znanstveno-raziskovalno središče Koper, Univerza za šport v Tirani, Uuniverza Cirila in Metoda v Skopju, Transilvanska Univerza v Brasovu, Univerza v Alberti, Univerza v Beogradu, Univerza v Ljubljani, Univerza v Črni Gori, Univerza v Nišu, Univerza na Primorskem, Univerza v Sarajevu, Univerza v Splitu, Univerza Tartu, Univerza iz Worcestra, Univerza v Zagrebu, Univerza »Vasile Alecsandri« v Bacauu in Univerza Western) podpisalo soglasno izjavo za promocijo razvoja raziskovanja športa in telesne vzgoje, s katero želijo omogočiti, da šport v svoji vlogi še nadalje ustrezno prispeva k promociji zdravja ljudi in premikanju človeških omejitev.

Glede na podpisano izjavo so institucije podpisnice pripravljene graditi platformo za skupne raziskave in akademske izmenjave, si prizadevati za izboljšanje ravni znanstvenih raziskav s področja športa ter utrditi in povečati usposobljenost držav ob »Belt and Road« pri raziskovanju telesne vzgoje.

[2] Pobuda Belt and Road (BRI) je globalna razvojna strategija, ki jo je sprejela kitajska vlada in vključuje razvoj infrastrukture in naložbe v 152 držav in mednarodnih organizacij v Aziji, Evropi, Afriki, na Bližnjem vzhodu in v Ameriki. Vodja Ljudske republike Kitajske Xi Jinping je strategijo prvotno napovedal med uradnimi obiski Indonezije in Kazahstana leta 2013. »The Silk Road Economic belt« se nanaša na kopenske poti (cestni in železniški promet) - »Belt«, medtem ko se »Road« nanaša na morske poti ali pomorsko svileno pot 21. stoletja. (dostopno na https://en.wikipedia.org/wiki/Belt_and_Road_Initiative).

Prvi forum je bil zagotovo dobrodošla možnost in odskočna deska za nadaljnje odpiranje raziskovalnih potencialov Inštituta za kineziološke raziskave ZRS Koper, seveda pa bo potrebno počakati na odziv bodočih potencialnih partnerjev in hkrati iskati podobne pobude.

Saša Pišot

REPORTS AND REVIEWS/POROČILA IN OCENE, 73–80

RESEARCH EXCHANGE AT ONE OF THE TOP AMERICAN INSTITUTIONS − UNIVERSITY OF MICHIGAN

Uroš Marušič, Ph.D. employed at the Science and Research Centre Koper and Alma Mater Europaea-European Center, Maribor, visited the Functional Neuroimaging, Cognition and Mobility Laboratory at one of the most prestigious and biggest higher education institutions in the USA, the University of Michigan (http://pdresearch.rad.med.umich.edu/). The exchange was carried out within the framework of the operation "Mobility of Higher Education Teachers AMEU-ECM 2018-2021" funded by the Ministry of Education, Science and Sport, between September 2018 and February 2019. According to Shanghai ranking score, the University of Michigan ranks the 20th among all universities in the world (http://www.shanghairanking.com/ARWU2019.html).

Marušič was actively involved in the laboratory work of Nicolaas Bohnen, MD, Ph.D., and Martin Muller, Ph.D., who are proactive in the research area of postural instability and mobility difficulties of Parkinson's disease patients. Their studies successfully combine behavior with neuroimaging data, especially with positron emission tomography (PET) and cholinergic receptors. In the framework of this exchange, researchers have recently published the common research manuscript: **Müller, M. L., Marusic, U., van Emde Boas, M., Weiss, D., & Bohnen, N. I. (2019)**. Treatment options for postural instability and gait difficulties in Parkinson's disease. *Expert review of neurotherapeutics*, 19(12), 1229-1251. https://doi.org/10.1080/14737175.2019.1656067.

During the exchange at the University of Michigan, Marušič also dived into the field of neuroergonomics, where he successfully completed the study with elderly patients with type 2 diabetes.

Parallel with his intensive research work, Marušič delivered numerous lectures at the University of Michigan Medical School for undergraduate, doctoral and postdoctoral students.

The exchange in the USA has brought many positive effects for both institutions. Namely, in the period between April and October 2019, a joint neuroergonomic study KOGIS (Cognitive and Motor Benefits of Standing) was conducted at the Mediterranean Health Centre (ZRS Koper), where researchers examined new possibilities for ergonomic arrangement of office workers and consequently the effects of newly developed ergonomic worktables on musculoskeletal discomfort, brain electrocortical activity, cognitive ability and work efficiency.

Uroš Marušič

REPORTS AND REVIEWS/POROČILA IN OCENE, 73–80

IZMENJAVA NA ENI VODILNIH AMERIŠKIH UNIVERZ - UNIVERZA V MICHIGAN-u

Raziskovalec Znanstveno-raziskovalnega središča Koper in Alma Mater Europaea-e, se je v sklopu razpisa »Mobilnost slovenskih visokošolskih učiteljev 2018-2021« Ministrstva za izobraževanje, znanost in šport, med septembrom 2018 in februarjem 2019 mudil na eni največjih in najprestižnejših ameriških visokošolskih institucij, Univerzi v Michigan-u (Ann Arbor, Michigan, ZDA), natančneje v Laboratoriju za funkcionalno možgansko slikanje, kognicijo in mobilnost (http://pdresearch.rad.med.umich.edu/). Na Shanghaiski lestvici najboljših 500 univerz na svetu, je Univerza v Michiganu uvrščena na prestižno 20. mesto (http://www.shanghairanking.com/ARWU2019.html).

Dr. Marušič je raziskoval v laboratoriju prof. dr. Nicolaas-a Bohnen-a in dr. Martina Müller-ja, ki delujeta predvsem na področjih posturalne nestabilnosti in težav mobilnosti pri Parkinsonovih bolnikih ter v svojih raziskavah uspešno primerjata vedenjske vzorce z rezultati možganskih slik, predvsem pozitronske emisijske tomografije (PET) in holinergičnih receptorjev. V sklopu izmenjave so raziskovalci objavili skupni pregledni članek: **Müller, M. L., Marusic, U., van Emde Boas, M., Weiss, D., & Bohnen, N. I. (2019)**. Treatment options for postural instability and gait difficulties in Parkinson's disease. *Expert review of neurotherapeutics*, 19(12), 1229-1251. https://doi.org/10.1080/14737175.2019.1656067.

Dr. Marušič se je med izmenjavo na Univerzi v Michiganu poglobil tudi v področje nevroergonomije, kjer je uspešno zaključil študijo na pacientih s sladkorno boleznijo tipa 2.

Vzporedno z intenzivnim raziskovalnim delom je dr. Marušič izvedel številna predavanja za dodiplomske, doktorske in podoktorske študente v sklopu Medicinske fakultete Univerze v Michiganu.

Izmenjava v ZDA je prinesla številne pozitivne učinke za obe inštituciji. Tako je že v obdobju od aprila do oktobra 2019 potekala skupna nevroergonomska raziskava KOGIS (Kognitivne in gibalne prednosti stoječega delovnega mesta) v Mediteranskem centru zdravja ZRS Koper, v okviru katere smo preverjali nove možnosti ergonomske ureditve delovnih mest pisarniških delavcev in posledične učinke novo razvite ergonomske delovne mize na skeletno-mišično neugodje, možgansko elektrokortikalno aktivnost, kognitivne sposobnosti in delovno učinkovitost.

Uroš Marušič

GUIDELINES FOR AUTHORS

1. Aim and scope of the journal:
Annales Kinesiologiae is an international interdisciplinary journal covering kinesiology and its related areas. It combines fields and topics directed towards the study and research of human movement, physical activity, exercise and sport in the context of human life style and influences of specific environments. The journal publishes original scientific articles, review articles, technical notes and reports.

2. General policy of Annales Kinesiologiae
Annales Kinesiologiae pursues the multi-disciplinary aims and nature of Kinesiology with the main goal to promote high standards of scientific research.

a) Reviewing: Each manuscript, meeting the technical standards and falling within the aims and scope of the journal, will be subjected to a double-blind peer-review by two reviewers. Authors can propose up to two reviewers for revision of their work and also up to two reviewers they would like to avoid.
The referees are chosen by the Editors. Assessments by the referees will be presented anonymously to the author and will be returned to the author for correction. The corrected copy of the manuscript, with the list of corrections on a separate page, should be returned to the responsible Editor.

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3. Manuscript preparation

a) Language and style: The language of Annales Kinesiologiae is USA English. The authors are responsible for the language, grammar, and style of the manuscript, which need to meet the criteria defined in the guidelines for authors. Manuscripts are required to follow a scientific style style. The journal will be printed in grayscale.

b) The length of the manuscript should not exceed 36,000 characters (excluding spaces).
Text formatting: It is required to use the automatic page numbering function to number the pages. Times New Roman font size 12 is recommended, with double spacing between lines. Use the table function, not spreadsheets, to make tables. Use an equation editor for equations. Finally, all lines need to be number, were the first line of a pages is assigned line number 1.

c) Miscellaneous: Whenever possible, use the SI units (Système international d'unités).

d) The **title page** should include the title of the article (no more than 85 characters, including spaces), full names of the author(s) and affiliations (institution name and address) of each author; linked to each author using superscript numbers, as well as the corresponding author's full name, telephone, and e-mail address.

e) The authors are obliged to prepare two **abstracts** – one short abstract in English and one (translated) in Slovene language. For foreign authors translation of the abstract into Slovene will be provided. The content of the abstract should be structured into the following sections: purpose, methods, results, and conclusions. It should only contain the information that appears in the main text, and should not contain reference to figures, tables and citations published in the main text. The abstract is limited to 250 words.

f) Under the abstract a maximum of 6 appropriate **Keywords** shall be given in English and in Slovene. For foreign authors the translation of the key words into Slovene will be provided.

g) The **main text** should include the following sections: Introduction, Methods, Results, Discussion, Conclusions, Acknowledgement (optional), and References. Individual parts of the text can form sub-sections.

h) Each **table** should be submitted on a separate page in a Word document after the Reference section. Tables should be double-spaced. Each table shall have a brief caption; explanatory matter should be in the footnotes below the table. Abbreviations used in the tables must be consistent with those used in the main text and figures. Definitions of symbols should be listed in the order of appearance, determined by reading horizontally across the table and should be identified by standard symbols. All tables should be numbered consecutively Table 1, etc. The preferred location of the table in the main text should be indicated preferably in a style as follows: *** Table 1 somewhere here ***.

i) Captions are required for all **figures** and shall appear on a separate manuscript page, under the table captions. Each figure should be saved as a separate file without captions and named as Figure 1, etc. Files should be submitted in *.tif or *.jpg format. The minimum figure dimensions should be 17x20 cm and a resolution of at least 300 dpi. Combinations of photo and line art should be saved at 600–900 dpi. Text (symbols, letters, and numbers) should be between 8 and 12 points, with consistent spacing and alignment. Font type may be Serif (Times Roman) or Sans Serif (Arial). Any extra white or black space surrounding the image should be cropped. Ensure that participant-identifying information (i.e., faces, names, or any other identifying features) should be omitted. Each figure should be saved as a separate file without captions and named as Figure 1, etc. The preferred location of the figure in the main text should be indicated preferably in a style as follows: *** Figure 1 somewhere here ***.

j) References

The journal uses the Harvard reference system (Publication Manual of the American Psychological Association, 6th ed., 2010), see also: https://www.apastyle.org). The list of references should only include work cited in the main text and being published or accepted for publication. Personal communications and unpublished works should only be mentioned in the text. References should be complete and contain up to seven authors. If the author is unknown, start with the title of the work. If you are citing work that is in print but has not yet been published, state all the data and instead of the publication year write „in print".

Reference list entries should be alphabetized by the last name of the first author of each work. Titles of references written in languages other than English should be additionally translated into English and enclosed within square brackets. Full titles of journals are required (no abbreviations).

Where available, DOI numbers should be provided in the form of a resolvable URL https://doi.org/10.1037/rmh0000008.

Examples of reference citation in the text

One author: This research spans many disciplines (Enoka, 1994) or Enoka (1994) had concluded...

Two authors: This result was later contradicted (Greene & Roberts, 2005) or Greene and Roberts (2005) pointed out...

Three to six authors:
a) first citation: Šimunič, Pišot and Rittweger (2009) had found... or (Šimunič, Pišot & Rittweger, 2009)
b) Second citation: Šimunič et al. (2009) or (Šimunič et al., 2009)

Seven or more authors:
Only the first author is cited: Di Prampero et al. (2008) or (Di Prampero et al., 2008).
Several authors for the same statement with separation by using a semicolon: (Biolo et al., 2008; Plazar & Pišot, 2009)

Examples of reference list*:*
The style of referencing should follow the examples below:

Books
Latash, M. L. (2008). Neurophysiologic basis of movement. Campaign (USA): Human Kinetic.

Journal articles
Marušič, U., Meeusen, R., Pišot, R., & Kavcic, V. (2014). The brain in micro- and hypergravity : the effects of changing gravity on the brain electrocortical activity. European journal of sport science, 14(8), 813–822. https://doi.org/10.1080/17461391.2014.908959

Šimunič, B., Koren, K., Rittweger, J., Lazzer, S., Reggiani, C., Rejc, E., … Degens, H. (2019). Tensiomyography detects early hallmarks of bed-rest-induced atrophy before changes in muscle architecture. Journal of applied physiology, 126(4), 815–822. https://doi.org/10.1152/japplphysiol.00880.2018

Book chapters

Šimunič, B., Pišot, R., Mekjavić, I. B., Kounalakis, S. N. & Eiken, O. (2008). Orthostatic intolerance after microgravity exposures. In R. Pišot, I. B. Mekjavić, & B. Šimunič (Eds.), The effects of simulated weightlessness on the human organism (pp. 71–78). Koper: University of Primorska, Scientific and research centre of Koper, Publishing house Annales.

Rossi, T., & Cassidy, T. (in press). Teachers' knowledge and knowledgeable teachers in physical education. In C. Hardy, & M. Mawer (Eds.), Learning and teaching in physical education. London (UK): Falmer Press.

Conference proceeding contributions

Volmut, T., Dolenc, P., Šetina, T., Pišot, R. & Šimunič, B. (2008). Objectively measures physical activity in girls and boys before and after long summer vacations. In V. Štemberger, R. Pišot, & K. Rupret (Eds.) Proceedings of 5th International Symposium A Child in Motion "The physical education related to the qualitative education" (pp. 496–501). Koper: University of Primorska, Faculty of Education Koper, Science and research centre of Koper; Ljubljana: University of Ljubljana, Faculty of Education.

Škof, B., Cecić Erpić, S., Zabukovec, V., & Boben, D. (2002). Pupils' attitudes toward endurance sports activities. In D. Prot, & F. Prot (Eds.), Kinesiology – new perspectives, 3rd International scientific conference (pp. 137–140), Opatija: University of Zagreb, Faculty of Kinesiology.

4. Manuscript submission

The article should be submitted via online Open Journal Systems application, which is open source journal management and publishing software at http://ojs.zrs-kp.si/index.php/AK/about/submissions. All the communication process with authors proceeds via Open Journal System and e-mail.

5. For additional information regarding article publication, please do not hesitate to contact the secretary of Annales Kinesiologiae.


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