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Articles and Statements

Technology of Computer-assisted Technical Actions Training in Team Sports

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Abstract

When computer-assisted training is used the content is provided in a certain order with relatively small portions (steps). When developing training programmes of the basic elements of a hockey stick or ball handling, the number of steps depends on the complexity of the techniques to be trained. Each step of the programme includes introductory, informational, operational and control frames. The introductory frame is a pedagogical task of creating a motivation and an overview of the competitive activity. The informational frame is transfer of theoretical knowledge when studying a particular method of action (explanation, demonstration, repeated and contrast demonstration, demonstration accompanied by simultaneous explanation). The operational frame includes practical drills – the exercises aimed at mastering the action trained. The control frame serves to perform a test to check the quality of the techniques proficiency and the effectiveness of training.

The test and drills are performed on the playing ground with computer-controlled light emitters, generating unallowed light dynamic areas to be evaded by an athlete and/or sports implement. These areas emulate counter-players' actions and while moving, put obstacles on the athlete's way. The zones are moving following the course of straight lines up to meeting with the boundaries of the training area or among themselves. After colliding, as absolutely elastic bodies, they are moving until colliding again according to the laws of mechanics.

The technique training programme is selected, for example, consisting of two basic elements – groundmoves with the subsequent handling of the sports implement. When at the first step, the trainee evaluates the emulated game situation, adjusts his/her speed and technical capacities to the dynamics of unallowed zones movement and then, at the second step, he/she performs the groundmoves. If there are no errors, the diameter and/or the speed of the unallowed zones is increased until the trainee fails to accurately perform the action being trained. Then, having mastered the groundmoves, the trainee learns to perform the second element – passing the implement to one of the fellow trainees.

When testing the skill of the action handling, the diameter, the movement speed and the number of the unallowed areas are assigned according to the athlete's proficiency level.

Keywords: sport, team sports, technical actions, basic technical elements, computer-assisted training.

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1. Introduction

Technical actions training is more typical of the first, so-called basic stage of athlete's technical training, where the main (basic) elements of a hockey stick or a ball handling are receiving, passing, groundmoves, dribbling, tackling, steal, throw and shooting (Rami, 2011; Plotnikov, 2012; Bykov, 2012).

According to V.V. Plotnikov (Plotnikov, 2012), the pass and dribbling effectiveness in hockey is to be higher than 46-47%. According to V.V. Suvorov (Suvorov, 2007), the effectiveness of short, medium and long ball passing forward, momentum passing and dribbling of youth footballers is approximately 60%. However, they are used in the competitions relatively seldom as a result of inadequate training of those play elements. This hampers the execution of group tactical actions done by at least the player holding the ball and doing dribbling and the player he interacts with through the ball passing.

It is noted in paper (Afonshin, Rozhentsov, 2016a) that to achieve good level of basic technical elements proficiency multiple drill repetitions are required, but the uniformity and monotony of training sessions result in an athlete's psychological tiredness, fatigue and loss of interest. Therefore, when choosing training tools it is necessary to make a wider use of techniques to create a positive emotional background. This will not only ensure high performance, but will also contribute to a faster athlete's recovery after an intense workout.

In this regard, the search and study of new methods and techniques for application of emotional and comprehensive training aids to teach youth athletes to perform technical actions to enhance their overall proficiency is a prerequisite to improve training programmes in many sports (Maslo, 2010).

The use of information technologies for technical and tactical training in team sports were examined by the authors earlier, the method of technical (Afon'shin et al., 2014; Polevshchikov et al., 2014; Afonshin, Rozhentsov, 2016b) and tactical actions training by simulating game situations in the virtual reality (Rozhentsov, Afon'shin, 2013), technical and tactical training in team sports having been proposed (Rozhentsov, Afon'shin, 2014).

One of the promising ways of teaching motor actions in team sports, according to A.V. Bykov (Bykov, 2012), is the application of computer-assisted learning.

The purpose of this paper is to develop the technology of computer-assisted instruction of technical actions in sports.

The technology of computer-assisted technical actions training

The technology of computer-assisted training, according to A.I. Uman (Uman, 2012) and V.A. Kaver (Kavera, 2013), appeared in the early 1950s. It is at that time when the American psychologist B.F. Skinner firstly proposed to enhance the effectiveness of learning, having constructed it as a consistent programme of information submission and control. The technology of computer-assisted training involves learning of study material supported by training devices (computers, programmed textbook, etc.). The main feature of the technology is that all the study material is submitted in a strictly algorithmic order in relatively small portions (steps).

When developing the basic elements training programmes of a ball or a hockey stick handling it is important to take into account the biomechanical features of the technique and the general principles of programmed instruction. The number of steps in the training programmes for each basic element depends on the complexity of the certain technique. Each step of the programme includes introductory, informational, operational and control frames. The introductory frame is a pedagogical task to create a motivation and an overview of the competitive activity. The informational frame is transfer of theoretical knowledge when studying a particular action (explanation, demonstration, repeated and contrast demonstration, and demonstration accompanied by simultaneous explanation). The operational frame includes practical assignments – drills aimed at mastering the action trained. The control frame is to perform a test to check the quality of the technical action mastery and the effectiveness of learning (Bykov, 2012).

A test and drills are executed on the playing ground where computer-controlled light emitters generate highlighted unallowed zones for an athlete and/or an implement. The zones emulate the counteractions of the opponent players and while moving, hamper the athlete's movement. The zones are moving following the course of straight lines up to meeting with the boundaries of the training area or among themselves. After colliding, as absolutely elastic bodies, they are moving until colliding again according to the laws of mechanics.

The technique training programme is selected, for example, consisting of two basic elements – groundmoves with the subsequent handling of the sports implement. When at the first step, the trainee evaluates the emulated game situation, adjusts his/her speed and technical capacities to the dynamics of unallowed zones movement and then, at the second step, he/she performs the groundmoves. If there are no errors, the diameter and/or the speed of the unallowed zones is increased until the trainee fails to accurately perform the action being trained. Then, having mastered the groundmoves, the trainee learns to perform the second element – passing the implement to one of the fellow trainees. The fragment of the drill to train groundmoves followed by ball passing is shown in Figure.

Fig. The fragment of the drill to train groundmoves followed by ball passing.

By the maximum moving speed and the diameter of the unallowed zones, the trainee's movement speed and the non-failure time while executing the drill they assess technical and tactical and physical fitness, the ability to see the playing ground, to foresee changes in the game situation and implement skills efficiently (Afon'shin, 2015).

When testing the mastery level the action trained, the diameter, the movement speed and the number of unallowed zones are assigned by the corresponding proficiency level.

2. Discussion

According to V.A. Kaver (Kavera, 2013), when developing the technology of computer-assisted training, N. Crowder developed so-called branching programmes, which depending on the learner's test results submitted different learning material for independent work. The domestic pedagogical school is represented by V.P. Bespalko who was engaged in the development of that technology and who outlined the main principles of training arrangement and identified the types of training programmes:

- linear programmes (consecutively changing small information units with test assignments);
- branching programmes (if the difficulty arises, more information is provided to the student to help him/her to do the test and give the correct answer);
- adaptive programmes (provide the learner with the opportunity to choose the difficulty level of the training material and to change it after it has been mastered);
- combined programmes (include fragments of previous programmes).

Computer-assisted training ensures actions acquisition under the strict requirements, according to V.N. Blednova et al. (Blednova et al., 2013), has several advantages:

- learning information capacity is increased;
- feedback is enhanced;
- every trainee works at his/her optimal pace;
- self-control and self-regulation skills are formed.

In sport programming is quite a strictly deterministic system of successive and acquired in practice operations and actions giving certain outcomes within the allotted time (Sakharova, 2004).

According to V.P. Filin and N.A. Fomina (Filin, Fomin, 1980), computer-assisted movement instruction involves such a teaching method, which reduces the unwanted effects of random exercise leading to the ultimate goal.

Compiling the learning process depends on the structural complexity of the actions trained, influenced by several factors (Bykov, 2012):

- a number of phases comprising an action;
- movement accuracy requirements in space and time;
- specifics of movement coordination in each action phase and in the action as a whole;
- simplicity and complexity of the rhythmic structure of the action.

When computer-assisted instruction is in place the mastery of next portion of knowledge and skills is examined after each step. This provides the possibility to adapt the pace of learning to the learner's individual characteristics. At the same time, it is necessary to clearly articulate learning goals and objectives for each class, each stage of the class, and ways of achieving them for some motor drills. In this way, the didactic principles of consciousness and activity are implemented (Bykov, 2012).

Computer-assisted instruction method used with training computer linear programmes is successfully applied for training practical skills in shooting and in the theoretical study of gunnery regulations followed by the practical study. The learner plunging into the atmosphere of the assignment falls into the conditions under which the instructor is technically facilitated to pay attention not only to the way the shooter on the whole performs the action, but also to analyze constantly the accuracy and speed of the action individual elements. Having identified the weaknesses and focusing on them, the instructor in this way contributes to learners' further skills development. This circumstance ensures not only automation of a skill as it takes place outside the computer-assisted instruction, but also working out the shooter's absolute proficiency, which in a quality manner differs from simple automaticity attained through higher productivity. At the same time, this productivity is the result of not only trainees' physical activity intensification but an increase in the proportion of creative mental operations (Aksenov, 2015).

However, it is not always possible to train complex movements through programmed training using a linear principle, since not every assignment can be divided into simple elements, which will not change the logical internal content of the assignment. This problem is solved while maintaining structural and biomechanical integrity of the exercise by means of branching programming. Provided by the programme, training errors and ways to correct them makes the learning process more effective and individualized than the linear method of learning material disposition (Sakharova, 2004).

For instance, in gymnastics they widely use the algorithm of linear-branching programming when training motor actions, both beginners and highly skilled athletes. Such programming provides for the distribution of the learning assignments when training motor actions into the basic and supplementary ones. The transition from one main task to the following one is possible only if the previous learning material has been well acquired. If there is a difficulty in performing the basic tasks there arises a possibility to perform supplementary assignments, and then doing the following main task is allowed (Pimakhin, Furmanov, 2014).

Training programmes compiled due to the complexity of technical actions acquisition in volleyball following the principle of linear-branching programming results in a better and faster skills development. Movement complexity in volleyball is conditioned by the playing technique composition consisting of two parts: an attack technique and a defense one. Each of these parts is subdivided into two subsections: relocation techniques and ball handling ones. Each subsection includes a number of techniques that are different from each other by the execution details. The training programme consists of a theoretical part and a practical one. The aim of the theoretical part is forming with the trainees a comprehensive and science-based knowledge of movement trained. First, a semantic meaning of the technique execution of the game technique accompanied by the record improving knowledge assimilation is given in a concise form. The process of drills learning in a programmed form takes place in the practical part. This facilitates to run effectively the learning process, taking into account the athlete's individual motor experience. In addition, training programmes form the skill to evaluate the movement in time and space, according to the degree of muscular effort, those programmes take into account the didactic requirements of learning (Pimakhin, Furmanov, 2014).

One of the approaches to develop the ideas of computer-assisted instruction, according to A.V. Bykov (Bykov, 2012), is using the principles of educational kinesiology, which increase the efficiency of the motor actions learning process and movements control in the course of a training session. This is achieved through high-level didactics (especially what concerns the principles of consciousness and performance), i.e. by means of focusing on self-learning or movements self-management.

Another approach to computer-assisted instruction is the technology of mastery learning (Kavera, 2013), proposed by the foreign authors: B. Bloom, J. Carroll, J. Block, L. Anderson. They hypothesised that the learner's abilities are found out mainly under the optimally selected for the certain individual conditions. Therefore, here an adaptive learning system that allows all the students to learn the programme material is required. Mastery learning technology sets the universal for all students mastery knowledge level, but at the same time makes for each learner the certain time, methods and forms of training variable. The main feature of this system is identifying the standard of mastery learning to be accomplished by all the learners. Mastery learning technology can be applied successfully at the beginner's stage of training technical actions to children and adolescents.

3. Conclusion

The technology of computer-assisted training of technical actions to children and adolescents will enhance the interest in the learning process, will optimise the training session structure and the training quality.

The training programmes compiled on the basis of linear-branching and adaptive programming, in our opinion, is the most effective way of training technical actions in team sports, where the toolkit of techniques and their combinations is almost unlimited. Such training contributes to start-up and improvement of technical skills, allows to effectively manage the learning process taking into account the learners' individual motor experience.

Литература

Аксенов, 2015 – *Аксенов К.В.* Применение компьютерных технологий обучения стрельбе из стрелкового оружия // Образовательные технологии и общество. 2015. № 1. С. 519-534.

Афоньшин и др., 2014 – *Афоньшин В.Е., Полевщиков М.М., Роженцов В.В.* Технология тренировки передач в спортивных играх // Ученые записки университета им. П.Ф. Лесгафта. 2014. № 1. С. 10-13. DOI: 10.5930/issn.1994-4683.2014.01.107.p10-13.

Афоньшин, 2015 – Патент РФ № 2014138070/12, 19.09.2014. *Афоньшин В.Е.* Способ тренировки технико-тактических действий спортсмена в игровых видах спорта // Патент России № 2557497. 2015. Бюл. № 20.

Бледнова и др., 2013 – *Бледнова В.Н., Трунин В.В., Кораблева Е.Н.* Интерактивные методы обучения в процессе преподавания дисциплины «Физическая культура» // Труды Санкт-Петербургского государственного университета культуры и искусств. 2013. Т. 200. С. 443-448.

Быков, 2012 – *Быков А.В.* Программированное обучение двигательным действиям в командных игровых видах спорта // Известия Пензенского государственного педагогического университета им. В.Г. Белинского. 2012. № 28. С. 707-710.
Кавера, 2013 – *Кавера В.А.* Современные педагогические технологии в системе дополнительного образования детей // Труды Санкт-Петербургского государственного университета культуры и искусств. 2013. Т. 195. С. 159-170.
Масло, 2010 – *Масло И.М.* Подвижные игры в системе подготовки спортсменов // Веснік Мазырскага дзяржаўнага педагагічнага ўніверсітэта імя І.П. Шамякіна. 2010. № 2(27). С. 72-75.
Пимахин, Фурманов, 2014 – *Пимахин Е.А., Фурманов А.Г.* Техника и методика программированного обучения юных волейболисток подаче мяча и нападающему удару // Веснік Мазырскага дзяржаўнага педагагічнага ўніверсітэта імя І.П Шамякіна. 2014. № 3(44). С. 71-78.
Плотников, 2012 – *Плотников В.В.* Технико-тактическая подготовка хоккеистов на этапе углубленной специализации // Омский научный вестник. 2012. № 5. С. 211-214.
Рами, 2011 – *Рами З.М.А.* Возрастная дифференцировка состава критериев отбора юных спортсменов к специализации в мини-футболе // Вестник Адыгейского государственного университета. Серия 3: Педагогика и психология. 2011. № 2. С. 232-236.
Роженцов, Афоньшин, 2013 – *Роженцов В.В., Афоньшин В.Е.* Тактическая подготовка в игровых видах спорта с использованием виртуальной реальности // Программные системы и вычислительные методы. 2013. № 3(4). С. 272-276. DOI: 10.7256/2305-6061.2013.3.8904.
Роженцов, Афоньшин, 2014 – *Роженцов В.В., Афоньшин В.Е.* Технология технико-тактической подготовки в игровых видах спорта // Кибернетика и программирование. 2014. № 3. С. 103-109. DOI: 10.7256/2306-4196.2014.3.12048.
Сахарова, 2004 – *Сахарова М.В.* Проектирование систем подготовки спортсменов (команды) в игровых видах спорта // Теория и практика физической культуры. 2004. № 5. С. 35–38.
Суворов, 2007 – *Суворов В.В.* Индивидуальные типологические показатели технико-тактических действий футболистов 12–15 лет // Ученые записки университета им. П.Ф. Лесгафта. 2007. № 6. С. 85-89.
Уман, 2012 – *Уман А.И.* Тенденции развития современной дидактики // Отечественная и зарубежная педагогика. 2012. № 5(8). С. 38-48.
Филин, Фомин, 1980 – *Филин В.П., Фомин Н.А.* Основы юношеского спорта. М.: Физкультура и спорт, 1980. 255 с.
Afonshin, Rozhentsov, 2016a – *Afonshin V.E., Rozhentsov V.V.* The Method of Team Sports Athletes' Motor Skills Development // European Journal of Physical Education and Sport. 2016. Vol. 12. Is. 2. pp. 34-40. DOI: 10.13187/ejpe.2016.12.34.
Afonshin, Rozhentsov, 2016b – Afonshin V.E., Rozhentsov V.V. The Technology to Train Techniques in Sports // European Journal of Physical Education and Sport. 2016. Vol. 11. Is. 1. pp. 4-9. DOI: 10.13187/ejpe.2016.11.4.
Polevshchikov et al., 2014 – *Polevshchikov M.M., Afonshin V.E., Rozhentsov V.V.* A Technology for Technical Preparation of Young Athletes in Team Sports // European Journal of Physical Education and Sport. 2014. V. 3. № 1. pp. 54-58. DOI: 10.13187/issn.2310-0133.

References

Aksenov, 2015 – *Aksenov K.V.* (2015). Primenenie komp'yuternykh tekhnologii obucheniya strel'be iz strelkovogo oruzhiya [The use of computer training technologies in shooting from small arms]. *Obrazovatel'nye tekhnologii i obshchestvo*. № 1. S. 519-534.
Afon'shin i dr., 2014 – *Afon'shin V.E., Polevshchikov M.M., Rozhentsov V.V.* (2014). Tekhnologiya trenirovki peredach v sportivnykh igrakh [The training technology of pass in sports games]. *Uchenye zapiski universiteta im. P.F. Lesgafta*. № 1. S. 10-13. DOI: 10.5930/issn.1994-4683.2014.01.107. p. 10-13.
Afon'shin, 2015 – Patent RF № 2014138070/12, 19.09.2014. Afon'shin V.E. Sposob trenirovki tekhniko-takticheskikh deistvii sportsmena v igrovykh vidakh sporta [The way of training of technical and tactical actions of athletes in playing sports]. Patent Rossii № 2557497. 2015. Byul. № 20.

Blednova i dr., 2013 – *Blednova V.N., Trunin V.V., Korableva E.N.* (2013). Interaktivnye metody obucheniya v protsesse prepodavaniya distsipliny «Fizicheskaya kul'tura» [The interactive training methods in the teaching of discipline "The physical culture"]. *Trudy Sankt-Peterburgskogo gosudarstvennogo universiteta kul'tury i iskusstv*. T. 200. S. 443-448.

Bykov, 2012 – *Bykov A.V.* (2012). Programmirovannoe obuchenie dvigatel'nym deistviyam v komandnykh igrovykh vidakh sporta [The programmed learning of motor actions in a team playing sports]. *Izvestiya Penzenskogo gosudarstvennogo pedagogicheskogo universiteta im. V.G. Belinskogo*. № 28. S. 707-710.

Kavera, 2013 – *Kavera V.A.* (2013). Sovremennye pedagogicheskie tekhnologii v sisteme dopolnitel'nogo obrazovaniya detei [The contemporary educational technologies in the system of additional children education]. *Trudy Sankt-Peterburgskogo gosudarstvennogo universiteta kul'tury i iskusstv*. T. 195. S. 159-170.

Maslo, 2010 – *Maslo I.M.* (2010). Podvizhnye igry v sisteme podgotovki sportsmenov [The motion games in the system of preparation of athletes]. V*esnik Mazyrskaga dzyarzhaўnaga pedagagichnaga ўniversiteta imya I.P. Shamyakina*. № 2(27). S. 72-75.

Pimakhin, Furmanov, 2014 – *Pimakhin E.A., Furmanov A.G.* (2014). Tekhnika i metodika programmirovannogo obucheniya yunykh voleibolistok podache myacha i napadayushchemu udaru [The technique and methodology of the programmed training of young volleyball players of the ball feed and striker blow]. *Vesnik Mazyrskaga dzyarzhaўnaga pedagagichnaga ўniversiteta imya I.P Shamyakina*. № 3(44). S. 71-78.

Plotnikov, 2012 – *Plotnikov V.V.* (2012). Tekhniko-takticheskaya podgotovka khokkeistov na etape uglublennoi spetsializatsii [The technical-tactical training of hockey players at the stage of advanced specialization]. *Omskii nauchnyi vestnik*. № 5. S. 211-214.

Rami, 2011 – *Rami Z.M.A.* (2011). Vozrastnaya differentsirovka sostava kriteriev otbora yunykh sportsmenov k spetsializatsii v mini-futbole [The age differentiation of criteria structure for selection of young sportsmen to specialization in minifootball]. *Vestnik Adygeiskogo gosudarstvennogo universiteta. Seriya 3: Pedagogika i psikhologiya*. № 2. S. 232-236.

Rozhentsov, Afon'shin, 2013 – *Rozhentsov V.V., Afon'shin V.E.* (2013). Takticheskaya podgotovka v igrovykh vidakh sporta s ispol'zovaniem virtual'noi real'nosti [The tactical training in team sports with the use of virtual reality]. *Programmnye sistemy i vychislitel'nye metody*. № 3(4). S. 272-276. DOI: 10.7256/2305-6061.2013.3.8904.

Rozhentsov, Afon'shin, 2014 – *Rozhentsov V.V., Afon'shin V.E.* (2014). Tekhnologiya tekhniko-takticheskoi podgotovki v igrovykh vidakh sporta [The technology of technical and tactical training in team sports]. *Kibernetika i programmirovanie*. № 3. S. 103-109. DOI: 10.7256/2306-4196.2014.3.12048.

Sakharova, 2004 – *Sakharova M.V.* (2004). Proektirovanie sistem podgotovki sportsmenov (komandy) v igrovykh vidakh sporta [The designing of training systems of athletes (team) in playing sports]. *Teoriya i praktika fizicheskoi kul'tury*. № 5. S. 35–38.

Suvorov, 2007 – *Suvorov V.V.* (2007). Individual'nye tipologicheskie pokazateli tekhniko-takticheskikh deistvii futbolistov 12–15 let [The individual typological indicators of technical and tactical actions of football players of 12-15 years]. *Uchenye zapiski universiteta im. P.F. Lesgafta*. № 6. S. 85-89.

Uman, 2012 – *Uman A.I.* (2012). Tendentsii razvitiya sovremennoi didaktiki [The development tendencies of modern didactics]. *Otechestvennaya i zarubezhnaya pedagogika*. № 5(8). S. 38-48.

Filin, Fomin, 1980 – *Filin V.P., Fomin N.A.* (1980). Osnovy yunosheskogo sporta [The fundamentals of youth sports]. M.: Fizkul'tura i sport, 255 s.

Afonshin, Rozhentsov, 2016a – *Afonshin V.E., Rozhentsov V.V.* (2016). The Method of Team Sports Athletes' Motor Skills Development. *European Journal of Physical Education and Sport*. Vol. 12. Is. 2. pp. 34-40. DOI: 10.13187/ejpe.2016.12.34.

Afonshin, Rozhentsov, 2016b – *Afonshin V.E., Rozhentsov V.V.* (2016). The Technology to Train Techniques in Sports. *European Journal of Physical Education and Sport*. Vol. 11. Is. 1. pp. 4-9. DOI: 10.13187/ejpe.2016.11.4.

Polevshchikov et al., 2014 – Polevshchikov M.M., Afonshin V.E., Rozhentsov V.V. (2014). A Technology for Technical Preparation of Young Athletes in Team Sports. *European Journal of Physical Education and Sport*. V. 3. № 1. pp. 54-58. DOI: 10.13187/issn.2310-0133.

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Enhancement of Brain Functions During Aging Through Various Exercises: a Review Study

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Abstract

Introduction: Decline of brain and mental functions with aging is a natural biological phenomenon. Scientists have engaged themselves to find out the different ways to protect degeneration and enhance brain functions. Regular exercise is one of the potential area. However, there are controversial and inconclusive results which create further interest of research. Aim: To review scientific literature related to exercise effect on brain and mental function during aging. Methods: Searches were conducted through electronic databases- PubMed, Medline, Springer link, Elsevier, and Google Scholar. The searching terms were: brain function (brain function or cognition or memory or processing speed or learning or executive function) and physical exercise (physical exercise or exercise or stretching exercise or strength exercise). Initial search were 11 review studies and 57 randomized control trials. The current study selected 03 review and 08 randomized control trials studies after fulfillment of its requirement. Findings: Long term (>24 weeks) combination exercise (aerobic, strength and stretching) training can improve memory functions and processing speed in elderly people. Aerobic exercise training and strength training together can contribute to the improvement of episodic memory, executive functions and processing speed in healthy elderly people. Memory can be enhanced through aerobic exercise training and also by doing strength exercise training in healthy older adults. Interpretations: Changes in different brain and mental functions may be occurred due to structural and functional variations. The structural changes may include change in the volume of hippocampus, neurogenesis, angiogenesis, and so on. The physiological variations can include brain plasticity, increase in brain-derived neurotrophic factor (BDNF), enhancement of Default Mode Network (DMN), increase the activity of proteasome and neprilysin. Conclusions: Aging brain and mental functions may be enhanced through regular aerobic exercise training but different exercise has different impact on brain structure and functions.

Keywords: Aging, Exercise, Brain structure, Brain function.

1. Introduction

Regular physical activity and exercise have a positive impact on health and well-being. Despite of this knowledge, human society has become an increasingly sedentary (Voss et al., 2011).

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Research shows an estimation that less than 50 % of children (6–11 yrs.) and 8 % of adolescents (12–19 yrs.) are actively engaged with the recommended 60 min. of exercise most days of the week, whereas only less than 5 % of adults (20–59 yrs.) and elderly (60+ yrs.) are active with the recommended 30 min./day for this age group (Troiano et al., 2008). This inactivity may cause different kind of risk factors such as type II diabetes (Laaksonen et al., 2005) cardiovascular-related disease (Shiroma and Lee, 2010), osteoporosis (Kelley, 1998), colon and breast cancer (Lee, 2003), and mental disorder (DHHS. Physical Activity Guidelines Advisory Committee Report 2008).

Mammalian brains process complex information including sensations, movements and complicated cognitive functions using sequences of action potentials in a large population of neurons. To process multiple signals simultaneously, brains take advantage of neural networks consisting of more than ten billion neurons connecting to one another. The individual neurons are known to have synaptic connections to hundreds or thousands of other neurons (Windhorst and Johansson, 1999). These intricate connections make it difficult to study functions of individual neurons or connections. Furthermore, some of the functional regions are located in the deep brain regions such as thalamus, hypothalamus, and hippocampus and so on (Holdefer et al., 2010; Belmonte et al., 2004).

Cognitive functions are in broad range which can be divisible into seven categories: executive functions, episodic memory, working memory, reading ability, attention and processing speed (Nouchi et al., 2014). Cognitive functions decline with age. Elderly people might experience a decline in several cognitive functions such as memory (Salthouse, 2003), attention (Yakhno et al., 2007), executive functions (Royall et al., 2004; Coppin et al., 2006), and processing speed (Salthouse, 1996). Maintaining or improving cognitive functions in older adults is drawing increasing attention (Colcombe and Kramer, 2003; Valenzuela and Sachdev, 2009; Fernandez-Prado et al., 2012; Tardif and Simard, 2011; Lovden et al., 2010; Kawashima et al., 2005; Uchida and Kawashima, 2008; Nouchi et al., 2012). Researcher observed that physical exercise training can improve cognitive functions in healthy older people (Colcombe and Kramer, 2003; Valenzuela and Sachdev, 2009; Hogan, 2005; Angevaren et al., 2008; vanUffelen et al., 2008; Chan et al., 2012; Snowden et al., 2011).

Combination exercise (aerobic, strength and stretching) training can improve executive functions, episodic memory and processing speed (Nouchi et al., 2014). Aerobic exercise training and strength training can contribute to the improvement of executive functions, episodic memory and processing speed in healthy elderly people (Colcombe and Kramer, 2003; Snowden et al., 2011). There is a direct correlation between increased levels of physical activity, increased hippocampal volume and enhanced spatial memory (Phillips et al., 2014). Exercise enhances Brain derived neurotrophic factor (BDNF), which plays a critical role in the learning process (Berchtold et al., 2005).

The objective of this study was to review scientific research related to exercise effect on brain function during aging.

2. Methods

Search Strategy

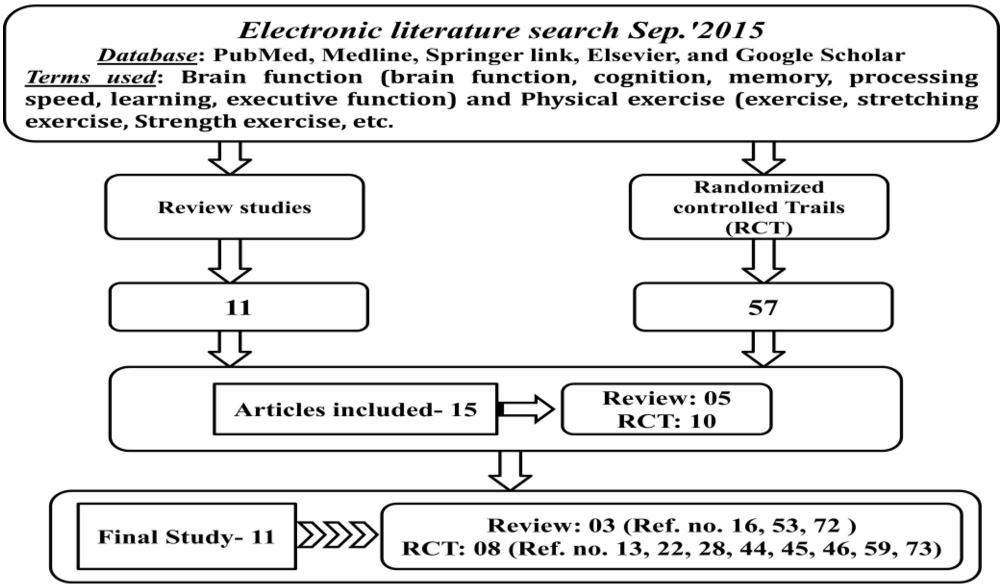
PubMed, Medline, Springer link, Elsevier and Google Scholar databases were systematically searched for Randomized Controlled Trials (RCTs) and Review work using terms related to brain function (brain function OR cognition OR memory OR processing speed OR learning OR executive function) and physical exercise (physical exercise OR exercise OR stretching exercise OR strength exercise). The search was performed in September' 2015 and repeated in April' 2016.

Inclusion and Exclusion criteria

The trials selected in this review had to meet the following inclusion criteria: RCTs; participants were involved in physical exercise with acute or chronic intervention period and reported the effect on brain functions. The review articles also involve the effect of different exercises on brain functions. The effect on brain functions included structural and functional changes.

Our initial search identified 11 review studies and 57 RCTs. Out of the total 68 studies, 23were excluded after reading the abstracts, and 30 studies were somehow unmatched the requirement of present study. The remaining 15 studies, 4 studies failed as insufficient information. The current study reported 03 review and 08 RCTs studies to complete its requirement.

The flow chart showing below for describing the method at a glance-



Findings from the final studies

i. Exercise enhances memory function

Brain-derived neurotrophic factor (BDNF) plays a critical role in memory functions (Berchtold et al. 2005). Exercise is associated with favourable changes in BDNF (Coelho et al., 2013; Erickson et al., 2013). Hippocampus is a brain region important in memory (Cotman and Engesser-Cesar 2002). One Randomized Controlled Trail (RCT) study using MRI (Magnetic resonance imaging) showed the increase of the brain volume in the hippocampus (Erickson et al., 2011). Enhanced Default Mode Network (DMN) was associated with better memory performance (Hampson et al., 2006). Aerobic exercise training led to increase the DMN (Voss et al., 2010).

Combination exercise training for 42 weeks improved memory (Williams and Lord 1997). Long term (>24 weeks) combination exercise training can improve memory functions in elderly people (Colcombe and Kramer 2003; Snowden et al., 2011; Williams and Lord, 1997; Smith et al., 2010; Tseng et al., 2011). Combination exercise training improved certain cognitive functions such as memory functions (Williams and Lord, 1997; Lautenschlager et al., 2008). RCT studies have revealed that aerobic exercise training alone and strength exercise training alone improved memory in healthy older people (Cassilhas et al., 2007; Perrig-Chiello et al., 1998; Hassmen and Koivula, 1997). Aerobic exercise training and strength training can contribute to the improvement of episodic memory in healthy elderly people (Colcombe and Kramer, 2003; Snowden et al., 2011). Functional MRI study reported that aerobic exercise training led to increase the DMN (Voss et al., 2010) which includes the posterior cingulate, ventral and superior frontal medial cortices, and bilateral lateral occipital, middle frontal, hippocampal and parahippocampal, and middle temporal cortices (Fox et al., 2005). There is a direct correlation between increased levels of physical activity, increased hippocampal volume and enhanced spatial memory (Phillips et al., 2014).

ii. Exercise enhances learning

Exercise enhances BDNF, which plays a critical role in the learning process (Berchtold et al., 2005). BDNF involves in increasing the volume of Hippocampus and it is a brain region important in learning (Cotman and Engesser-Cesar, 2002).

iii. Exercise enhances processing speed

Aerobic exercise training and strength training can contribute to the improvement of processing speed in healthy elderly people (Colcombe and Kramer, 2003; Snowden et al., 2011). Combination exercise training for 42 weeks improved processing speed (Williams and Lord, 1997).

One fMRI study demonstrated greater activity in the middle frontal gyrus after aerobic exercise training for 6 months. Middle frontal gyrus is associated with performance of processing speed (Colcombe et al., 2004).

iv. Exercise enhances executive functions

Enhanced DMN was associated with better performance of executive functions (Andrews-Hanna et al., 2007). A recent study using resting state fMRI has shown that aerobic exercise training led to increase the DMN (Default Mode Network) (Voss et al., 2010). Aerobic exercise training and strength training can contribute to the improvement of executive functions in healthy elderly people (Colcombe and Kramer, 2003; Snowden et al., 2011). One FMRI study demonstrated greater activity in the middle frontal gyrus, which is associated with performance of executive functions after aerobic exercise training for 6 months (Colcombe et al., 2004).

3. Discussion on the findings

1. Structural changes

Exercise is associated with maintenance or improvement in brain volume (Colcombe et al., 2006; Erickson et al., 2014). MRI of older adults has shown that a certain type of exercise training selectively changes the brain structure. One RCT study using MRI showed the increase of the brain volume in the hippocampus, which has an important role in memory functions, after walking exercise training for 1 year (Erickson et al., 2011). There is a direct correlation between increased levels of physical activity, increased hippocampal volume (Phillips et al., 2014).

2. Brain plasticity

Brain plasticity or neuroplasticity is the ability of the brain to functional change throughout the life. Human neuroimaging studies have revealed brain plasticity after exercise training (Erickson et al., 2011). Animal studies reported that some molecules such as BDNF, insulin-like growth factor (IGF-1), and vascular endothelial growth factor (VEGF) have a central role in brain plasticity, including neurogenesis, angiogenesis, and synaptic plasticity (Monteggia et al., 2004; Neeper et al., 1995; Ding et al., 2006; Chen et al., 2005). Exercise has the ability to enhance brain plasticity and encoding in a manner that may translate directly into structural change of neurons or synapses (Widenfalk et al., 1999).

3. Neurogenesis

Growth and development of neurons and formation of new neurons can be stated as neurogenesis. MRI has shown that a certain type of exercise training selectively changes the brain function, and brain connectivity in the older adults (Erickson et al., 2011). VEGF is also heavily involved in neurogenesis (Ding et al., 2006; Fabel et al., 2003). Exercise effects on VEGF content and messenger RNA (mRNA) expression seem to be dependent on the dose of exercise (Ding et al., 2006). IGF-1 is essential for nerve growth, as well as neurotransmitter synthesis and release (Anlar et al., 1999). Exercise increased the IGF-1 levels (Fabel et al., 2003; Cotman and Berchtold, 2002). IGF-1may protect from hyperglycemia-induced oxidative stress and neuronal injuries, by regulating mitochondrial inner membrane potential, possibly by the involvement of uncoupling protein 3 (Gustafsson et al., 2004). Various findings suggest that improved cognitive function during an exercise may be ascribed to the cerebral neural activation associated with the exercise (Ogoh et al., 2014). The effects of exercise appear to be very complex and could include neurogenesis via neurotrophic factors (Cotman and Engesser-Cesar, 2002; Neeper et al., 1995; Cotman and Berchtold, 2002; Adlard and Cotman, 2004; Adlard et al., 2005; Johnson and Mitchell, 2003; Molteni et al., 2004; Oliff et al., 1998; Lazarov et al., 2005). Exercise increases neurogenesis, and this one of the processes by which exercise benefits brain function (Van Praag et al., 1999). Resistance training may enhance brain function through several pathways which includes improvement in the structural integrity of the brain (growth of new neurons) and increased production of neurochemical promoting growth, differentiation, survival, and repair of brain cells (Voss et al., 2011). Exercise is associated with improved cerebral blood flow and neuronal connectivity (Ogonovszky et al., 2006) and neurogenesis (Coelho et al., 2013; Molteni et al., 2004)

4. Angiogenesis

Angiogenesis is the growth of capillary blood vessels from the existing vasculature. The effects of exercise appear to be very complex and could include increased capillarization (Cotman and Engesser-Cesar, 2002; Neeper et al., 1995; Cotman and Berchtold, 2002; Adlard and Cotman, 2004; Adlard et al., 2005; Johnson and Mitchell, 2003; Molteni et al., 2004; Oliff et al., 1998; Lazarov et al., 2005). Resistance training may enhance brain function through several pathways which includes improvement in the structural integrity of the brain (growth of new blood vessels) (Voss et al., 2011).

5. Brain-derived neurotrophic factor (BDNF)

BDNF is a neurotrophic factor which is important for nourishment of neurons and overall brain health. One study showed 20 % increase in the hippocampus abundance of BDNF mRNA from control levels after 2–7 nights of running (Salthouse, 2003; Neeper et al., 1996). Three weeks of exercise demonstrated that the effect of exercise on BDNF mRNA levels was not merely a short-term, transient effect. It is found that BDNF mRNA and its receptor; Tyrosine receptor kinase β (trkB) increased in the hippocampus after 6 weeks of voluntary wheel running (Widenfalk et al., 1999). Maintenance of cerebral BDNF level is important for effective neural function and longevity (Schinder and Poo, 2000). BDNF acts to increase levels of important synaptic proteins like - synaptobrevin, synaptophysin, and synaptotagmin. It has direct relationship with neuronal communication. Hippocampal BDNF mRNA level was increased with either exercise or the antidepressant tranylcypromine. BDNF plays a critical role in the learning process, memory, locomotion, behaviours, and a wide range of stress responses (Berchtold et al., 2005). The expression and protein content of BDNF have been shown to be upregulated by exercise and oxidative stress (Mattson et al., 2004). If exercise is terminated abruptly BDNF levels initially fall below normal before returning to control levels by 30 days and this is due to depression (Widenfalk et al., 1999). Exercise is associated with favourable changes in brain derived neurotrophic factor (Coelho et al., 2013; Erickson et al., 2013).

6. Default Mode Network (DMN)

DMN is a network of interacting brain regions which is helpful in remembering the past and planning for the future. Enhanced DMN was associated with better memory performance (Hampson et al., 2006) and better performance of executive functions (Andrew-Hanna et al., 2007). One study using resting state fMRI (Voss et al., 2010) have shown that aerobic exercise training led to increase the DMN, which includes the posterior cingulate, ventral and superior frontal medial cortices, and bilateral lateral occipital, middle frontal, hippocampal and parahippocampal, and middle temporal cortices (Fox et al., 2005).

7. cAMP response element binding protein (CREB)

CREB is a cellular transcription factor which has important role in neuronal plasticity and long-term memory formation in the brain and has been shown to be integral in the formation of spatial memory. When BDNF was blocked, the exercise-induced increases in CREB mRNA levels, as well as the phosphorylation of CREB, were prevented (Vaynman et al., 2003; Vaynman et al., 2004). Exercise does not simply upregulate the content and expression of BDNF in different brain regions, but also impacts downstream effectors of BDNF; namely, the transcription factor CREB. CREB DNA binding sites contribute to the activation of BDNF mRNA transcription, and this process can regulate by Reactive Oxygen Species (ROS). BDNF acts through trkB receptors that activate CREB, thus creating a positive loop for the cascades (Zou and Crew, 2006).

8. Gene Expression

Gene expression is the process by which information from a gene is used in the synthesis of a functional gene product. It has been discovered that in addition to BDNF, exercise induces changes in other genes known to be associated neuronal activity, synaptic structure, and neuronal plasticity (Tong et al., 2001).

9. Proteasome and Neprilysin

Proteasomes are protein complexes inside all eukaryotes and archaea, and in some bacteria while neprilysinis an enzyme that in humans is encoded by the metallo-endopeptidase (MME) gene. The effects of exercise appear to be very complex and could include decreased oxidative damage, and increased proteolytic degradation by proteasome and neprilysin (Cotman and Engesser-Cesar 2002; Neeper et al., 1995; Cotman and Berchtold, 2002; Adlard and Cotman, 2004; Adlard et al. 2005; Johnson and Mitchell, 2003; Molteni et al., 2004; Oliff et al., 1998; Lazarov et al., 2005). Regular exercise training also attenuated the age-related accumulation of Reactive carbonyl derivative (RCD) in the brain, increased the activity of the proteasome complex, and improved brain function (Radak et al., 2001b). Voluntary exercise decreases the accumulation of beta-amyloid in the brain. Exercise increases the activity of neprilysin, which is responsible for the degeneration of beta-amyloid (Tseng et al., 2011). Ogonovszky et al. (2005a) has given moderate training, very hard training, and overtraining to rats and found, even with hard training and overtraining, beneficial effects on brain function and lowered accumulation of RCD.

4. Conclusions

The combination exercise training would increase the BDNF, IGF-1, and VEGF levels. The increase BDNF, IGF-1, and VEGF levels might contribute to exercise induced neurogenesis and angiogenesis. Neurogenesis and angiogenesis would engender changes in the brain structure, brain function and brain connectivity, which are related to cognitive functions.

ROS and the changes in redox homeostasis could play a role in the very complex mechanism by which exercise training benefits the brain. The relationship between ROS concentration and brain function can be characterized by a bell-shaped curve, both low and high levels of ROS could impair brain cell function. Low levels of ROS might cause insufficient gene expression for redox homeostasis while high levels of ROS exceed the adaptive tolerance of cells, resulting in significant oxidative damage, apoptosis, and necrosis. Oxidizing enzyme, cytokines, and mitochondria are potent generators of ROS in the brain during exercise.

Finally, the improvements of executive functions, processing speed, and episodic memory can be expected to be enhanced by increasing the brain volume of hippocampus, which is related to memory. Greater activity in the middle frontal gyrus which is important for executive functions and processing speed and enhancing the DMN is associated with executive functions and memory could be improved through the combination exercise training. The phenomenon of exercise related to brain functions might be interpreted in a different way that exercise attenuates the inactivity-caused deteriorative effects on the CNS.

References

Adlard, P. A., & Cotman, C. W. (2004) Voluntary exercise protects against stress-induced decreases in brain-derived neurotrophic factor protein expression. *Neuroscience*, 124(4), 985-992. doi:10.1016/j.neuroscience.2003.12.039. PMID:15026138

Adlard, P. A., Perreau, V. M., Pop, V., & Cotman, C. W. (2005) Voluntary exercise decreases amyloid load in a transgenic model of Alzheimer’s disease. *J. Neurosci.,* 25(17), 4217-21. doi:10.1523/JNEUROSCI.0496-05.2005. PMID: 15858047

Andrews-Hanna, J. R., Snyder, A. Z., Vincent, J. L., Lustig, C., Head, D., Raichle, M. E., & Buckner, R. L. (2007) Disruption of large-scale brain systems in advanced aging. *Neuron,* 56(5), 924–35. doi:10.1016/j.neuron.2007.10.038. PMID: 18054866

Angevaren, M., Aufdemkampe, G., Verhaar, H.J., Aleman, A., & Vanhees, L. (2008) Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment. *Cochrane Database Syst Rev.*, doi: 10.1002/14651858.CD005381.pub2. PMID: 18425918

Anlar, B., Sullivan, K. A., & Feldman, E. L. (1999). Insulin-like growth factor-I and central nervous system development. *Horm. Metab. Res.,* 31(2-3), 120-5. DOI: 10.1055/s-2007-978708. PMID: 10226791

Belmonte, M. K., Allen, G., Beckel-Mitchener, A., Boulanger, L. M., Carper, R. A., & Webb, S. J. (2004) Autism and abnormal development of brain connectivity. *The Journal of Neuroscience,* 24(42), 9228-9231. doi: 10.1523/JNEUROSCI.3340-04.2004

Berchtold, N. C., Chinn, G., Chou, M., Kesslak, J. P., & Cotman, C. W. (2005) Exercise primes a molecular memory for brain-derived neurotrophic factor protein induction in the rat hippocampus. *Neuroscience*, 133(3), 853-61. doi:10.1016/j.neuroscience.2005.03.026. PMID:15896913

Cassilhas, R. C., Viana, V. A., Grassmann, V., Santos, R. T., Santos, R. F., Tufik, S., & Mello, M. T. (2007) The impact of resistance exercise on the cognitive function of the elderly. *Med Sci Sports Exerc.*, 39(8), 1401–7. DOI: 10.1249/mss.0b013e318060111f. PMID: 17762374

Chang, Y. K., Pan, C. Y., Chen, F. T., Tsai, C. L., & Huang, C. C. (2012) Effect of resistance-exercise training on cognitive function in healthy older adults: a review. *J Aging Phys Act.*, 20(4), 497–517. PMID: 22186664

Chen, J., Zhang, C., Jiang, H., Li, Y., Zhang, L., Robin, A., . . . Chopp, M. (2005) Atorvastatin induction of VEGF and BDNF promotes brain plasticity after stroke in mice. *J Cereb Blood Flow Metab.,* 25(2), 281–90. DOI:10.1038/sj. jcbfm.9600034. PMID: 15678129

Coelho, F. G., Gobbi, S., Andreatto, C. A., Corazza D. I., Pedroso, R. V., & Santos-Galduroz, R. F. (2013) Physical exercise modulates peripheral levels of brain-derived neurotrophic factor (BDNF): a systematic review of experimental studies in the elderly. *Arch Gerontol Geriatr.,* 56(1), 10-5. doi: 10.1016/j.archger.2012.06.003. PMID: 22749404

Colcombe, S., & Kramer, A. F. (2003) Fitness effects on the cognitive function of older adults: a meta-analytic study. *Psychol Sci.*, 14(2), 125–30. PMID: 12661673

Colcombe, S. J., Erickson, K. I., Scalf, P. E., Kim, J. S., Prakash, R., McAuley, E., . . . Kramer, A. F. (2006) Aerobic exercise training increases brain volume in aging humans. *J Gerontol A Biol Sci Med Sci.*, 61(11), 1166-70. PMID: 17167157

Colcombe, S. J., Kramer, A. F., Erickson, K. I., Scalf, P., McAuley, E., Cohen, N. J., . . . Elavsky, S. (2004) Cardiovascular fitness, cortical plasticity, and aging. *Proc Natl Acad Sci USA.,* 101(9), 3316–21. DOI:10.1073/ pnas.0400266101. PMID: 14978288

Coppin, A. K., Shumway-Cook, A., Saczynski, J. S., Patel, K. V., Ble, A., Ferrucci, L., & Guralnik, J. M. (2006) Association of executive function and performance of dual task physical tests among older adults: analyses from the InChianti study. *Age Ageing*, 35(6), 619–24. DOI: 10.1093/ageing/afl107. PMID: 17047008

Cotman, C. W., & Engesser-Cesar, C. (2002) Exercise enhances and protects brain function. *Exerc Sport Sci Rev.,* 30(2), 75-9. PMID:11991541

Cotman, C. W., & Berchtold, N. C. (2002) Exercise: a behavioural intervention to enhance brain health and plasticity. *Trends Neurosci.,* 25(6), 295–301. PMID: 12086747

DHHS. Physical Activity Guidelines Advisory Committee Report (2008) Washington, DC: US Department of Health and Human Services, edited by Services DoHaH.

Ding, Q., Vaynman, S., Akhavan, M., Ying, Z., & Gomez-Pinilla, F. (2006) Insulin-like growth factor I interfaces with brain-derived neurotrophic factor-mediated synaptic plasticity to modulate aspects of exercise-induced cognitive function. *Neuroscience,* 140(3), 823–33. DOI: 10.1016/j.neuroscience. 2006.02.084. PMID: 16650607

Erickson, K. I., Gildengers, A. G., & Butters, M. A. (2013) Physical activity and brain plasticity in late adulthood. *Dialogues Clin Neurosci.,* 15(1), 99-108. PMCID: PMC3622473

Erickson, K. I., Leckie, R. L., & Weinstein, A. M. (2014) Physical activity, fitness, and gray matter volume. *Neurobiol Aging.,* 35(suppl 2), S20-8. Doi: 10.1016/j.neurobiolaging. 2014.03.034. PMID: 24952993

Erickson, K. I., Voss, M. W., Prakash, R. S., Basak, C., Szabo, A., Chaddock, L., . . . Kramer, A. F. (2011) Exercise training increases size of hippocampus and improves memory. *Proceedings of National Academy of Science of the United States of America,* 108(7), 3017–3022. doi:10.1073/pnas.1015950108

Fabel, K., Fabel, K., Tam, B., Kaufer, D., Baiker, A., Simmons, N., . . . Palmer, T. D. (2003) VEGF is necessary for exercise-induced adult hippocampal neurogenesis. *Eur J Neurosci.,* 18(10), 2803–12. PMID: 146563229

Fernandez-Prado, S., Conlon, S., Mayan-Santos, J. M., & Gandoy-Crego, M. (2012) The influence of a cognitive stimulation program on the quality of life perception among the elderly. *Arch Gerontol Geriatr*, 54(1), 181–4. DOI: 10.1016/j.archger.2011.03.003. PMID: 21458869

Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., Van Essen, D. C., & Raichle, M. E. (2005) The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proceedings of National Academy of Science of the United States of America,* 102(27), 9673–9678. doi: 10.1073/pnas. 0504136102

Gustafsson, H., Soderdahl, T., Jonsson, G., Bratteng, J. O., & Forsby, A. (2004) Insuline-like growth factor type 1 prevents hyperglycemia-induced uncoupling protein 3 down-regulation and oxidative stress. *Journal of Neuroscience Research,* 77(2), 285-91. doi:10.1002/jnr.20142

Hampson, M., Driesen, N. R., Skudlarski, P., Gore, J. C., & Constable, R. T. (2006) Brain connectivity related to working memory performance. *J Neurosci.,* 26(51), 13338–43. doi:10.1523/ JNEUROSCI.3408-06.2006. PMID: 17182784. PMCID: PMC2677699

Hassmen, P., & Koivula, N. (1997) Mood, physical working capacity and cognitive performance in the elderly as related to physical activity. *Aging (Milano)*, 9(1-2), 136–42.

Hogan, M. (2005) Physical and cognitive activity and exercise for older adults: a review. *Int J Aging Hum Dev*., 60(2), 95–126. PMID: 15801385

Holdefer, R. N., Cohen, B. A., & Greene, K. A. (2010) Intraoperative local field recording for deep brain stimulation in parkinson's disease and essential tremor. *Mov Disord*., 25(13), 2067-75. DOI: 10.1002/mds.23232. PMID: 20721922

Johnson, R. A., & Mitchell, G. S. (2003) Exercise-induced changes in hippocampal brain-derived neurotrophic factor and neurotrophin-3: effects of rat strain. *Brain Res,*. 983(1-2), 108-14. PMID: 12914971

Kawashima, R., Okita, K., Yamazaki, R., Tajima, N., Yoshida, H., Taira, M., . . . Sugimoto, K. (2005) Reading aloud and arithmetic calculation improve frontal function of people with dementia. *J Gerontol A Biol Sci Med Sci.,* 60(3), 380–4. PMID: 15860478

Kelley, G. A. (1998) Exercise and regional bone mineral density in postmenopausal women: a meta-analytic review of randomized trials. *Am J Phys Med Rehabil*., 77(1), 76–87. PMID: 9482383

Laaksonen, D. E., Lindström, J., Lakka, T. A., Eriksson, J. G., Niskanen, L., Wikström, K., . . . and study Fdp. (2005) Physical activity in the prevention of type 2 diabetes: the Finnish diabetes prevention study. *Diabetes* 54(1), 158–65. PMID: 1566024

Lautenschlager, N. T., Cox, K. L., Flicker, L., Foster, J. K., van Bockxmeer, F. M., Xiao, J., . . . Almeida, O. P. (2008) Effect of physical activity on cognitive function in older adults at risk for Alzheimer disease: a randomized trial. *JAMA*, 300(9), 1027–37. Doi: 10.1001/jama.300.9.1027. PMID: 18768414

Lazarov, O., Robinson, J., Tang, Y. P., Hairston, I. S., Korade-Mirnics, Z., Lee, V. M., . . . Sisodia, S. S. (2005) Environmental enrichment reduces Abeta levels and amyloid deposition in transgenic mice. *Cell*, 120(5), 701-13. doi:10.1016/j.cell.2005.01.015. PMID: 15766532.

Lee, I. M. (2003) Physical activity and cancer prevention- -data from epidemiologic studies. *Med Sci Sports Exerc.,*35(11), 1823–7. DOI: 10.1249/01.MSS.0000093620.27893.23. PMID: 14600545

Lovden, M., Backman, L., Lindenberger, U., Schaefer, S., & Schmiedek, F. (2010) A theoretical framework for the study of adult cognitive plasticity. *Psychol Bull*, 136(4), 659–76. DOI: 10.1037/a0020080. PMID: 20565172

Mattson, M. P., Maudsley, S., & Martin, B. (2004) A neural singnaling triumvirate that influences ageing and age-related disease: insulin/IGF-1, BDNF and serotonin. *Ageing Res Rev*., 3(4): 445-64. DOI: 10.1016/j.arr.2004.08.001. PMID: 15541711.

Molteni, R., Zheng, J. Q., Ying, Z., Gomez-Pinilla, F., & Twiss, J. L. (2004) Voluntary exercise increases axonal regeneration from sensory neurons. *Proc. Natl Acad Sci* USA., 101(22), 8473-8. DOI: 10.1073/pnas.0401443101. PMID: 15159540

Monteggia, L. M., Barrot, M., Powell, C. M., Berton, O., Galanis, V., Gemelli, T., . . . Nestler, E. J. (2004) Essential role of brain-derived neurotrophic factor in adult, hippocampal function. *Proc Natl Acad Sci USA,* 101(29), 10827–32. doi:10.1073/pnas.0402141101. PMID: 15249684

Neeper, S. A., Gómez-Pinilla, F., Choi, J., & Cotman, C. W. (1996) Physical activity increases mRNA for brain-derived neurotrophic factor and nerve growth factor in rat brain. *Brain Res.,* 726(1-2), 49–56. PMID: 8836544

Neeper, S. A., Gomez-pinilla, F., Choi, J., & Cotman, C. (1995) Exercise and brain neurotrophins. *Nature,* 373(6510), 109. doi:10.1038/373109a0. PMID: 7816089

Nouchi, R., Taki, Y., Takeuchi, H., Hashizume, H., Akitsuki, Y., Shigemune, Y., . . . Kawashima, R. (2012) Brain training game improves executive functions and processing speed in the elderly: a randomized controlled trial. *PLoS One*, 7(1), e29676.

Nouchi, R., Taki, Y., Takeuchi, H., Hashizumes, H., Nozawa, T., Sekiguchi, A., & Kawashima (2012) Beneficial effects of short-term combination exercise training on diverse cognitive functions in healthy older people: study protocol for a randomized controlled trial. *Trials*, 13, 200. doi:10.1186/1745-6215-13-200. PMID: 23107038

Nouchi, R., Taki, Y., Takeuchi, H., Sekiguchi, A., Hashizume, H., Nozawa, T., . . . Kawashima, R. (2014) Four weeks of combination exercise training improved executive function, episodic memory, and processing speed in healthy elderly people: evidence from a randomized controlled trial. *Age (Dordr),* 36(2),787–99. doi. 10.1007/s11357-013-9588-x. PMID: 24065294

Ogoh, S., Tsukamoto, H., Hirasawa, A., Hasegawa, H., Hirose, N., & Hashimoto, T. (2014). The effect of changes in cerebral blood flow on cognitive function during exercise. *Physiol Rep.*, 2(9), doi: 10.14814/phy2.12163. PMID: 25263210

Ogonovszky, H., Berkes, I., Kumagai, S., Kaneko, T., Tahara, S., Goto, S., & Radek, Z. (2005). The effects of moderate-, strenuous- and over-training on oxidative stress markers, DNA repair, and memory, in rat brain. *Neurochem Int.*, 46(8), 635-40. doi:10.1016/j.neuint.2005.02.009. PMID: 15863241.

Oliff, H. S., Berchtold, N. C., Isackson, P., & Cotman, C. W. (1998) Exercise-induced regulation of brain-derived neurotrophic factor (BDNF) transcripts in the rat hippocampus. *Brain Res Mol Brain Res.,* 61(1-2), 147-53. PMID: 9795193

Perrig-Chiello, P., Perrig, W. J., Ehrsam, R., Staehelin, H. B., & Krings, F. (1998) The effects of resistance training on well-being and memory in elderly volunteers. *Age Ageing*, 27(4), 469–75. PMID: 9884004

Phillips, C., Baktir, M. A., Srivatsan, M., & Salehi, A. (2014) Neuroprotective effects of physical activity on the brain: a closer look at trophic factor signaling. *Front Cell Neurosci.*, 8, 170. doi: 10.3389/fncel.2014.00170. PMID: 2499318

Radak, Z., Kaneko, T., Tahara, S., Nakamoto, H., Pucsok, J., Sasvari, M., . . . Goto, S. (2001) Regular exercise improves cognitive function and decreases oxidative damage in rat brain. *Neurochem Int.,* 38(1), 17-23. PMID: 10913684.

Radak, Z., Kumagai, S., Taylor, A. W., Naito, H., & Goto, S. (2007) Effects of exercise on brain function: role of free radicals. *Appl Physiol Nutr Metab.,* 32(5), 942-6. doi:10.1139/H07-081. PMID: 18059620

Royall, D. R., Palmer, R., Chiodo, L. K., & Polk, M. J. (2004) Declining executive control in normal aging predicts change in functional status: the Freedom House Study. *J Am Geriatr Soc.*, 52(3), 346–52. PMID: 14962147

Salthouse, T. A. (1996) The processing-speed theory of adult age differences in cognition. *Psychol Rev.,* 103(3), 403–428. PMID: 8759042

Salthouse, T. A. (2003) Memory aging from 18 to 80. *Alzheimer Dis Assoc Disord.*, 17(3), 162–7. PMID: 14512830

Schinder, A. F., & Poo, M. (2000) The neurotrophin hypothesis for synaptic plasticity. *Trends Neurosci.*, 23(12), 639–45. PMID: 11137155

Shiroma, E. J., & Lee, I. M. (2010) Physical activity and cardiovascular health: lessons learned from epidemiological studies across age, gender, and race/ethnicity. *Circulation* 122(7), 743–52. PMID: 20713909

Skurvydas, A., Masiulis, N., Jurgelaitiene, G., & Drozdova-Statkeviciene, M. (2015) Different acute exercise effect on cognitive functions. A first pilot study. *International Scientific Symposium*, 54-55.

Smith, P. J., Blumenthal, J. A., Hoffman, B. M., Cooper, H., Strauman, T. A., Welsh-Bohmer, K., . . . Sherwood, A. (2010) Aerobic exercise and neurocognitive performance: a meta-analytic review of randomized controlled trials. *Psychosom Med.*, 72(3), 239–52. doi:10.1097/PSY.0b013e3181d14633. PMID: 20223924

Snowden, M., Steinman, L., Mochan, K., Grodstein, F., Prohaska, T. R., Thurman, D. J., . . . Anderson, L. A. (2011) Effect of exercise on cognitive performance in community-dwelling older adults: review of intervention trials and recommendations for public health practice and research. *J Am Geriatr Soc.,* 59(4), 704– 16. doi:10.1111/j.1532-5415.2011.03323.x. PMID: 21438861

Tardif, S., & Simard, M. (2011) Cognitive stimulation programs in healthy elderly: a review. *International Journal of Alzheimer's Disease*. Doi: 10.4061/2011/378934

Tong, L., Shen, H., Perreau, V., Balazs, R., & Cotman C. W. (2001) Effect of exercise on gene-expression profile in the rat hippocampus. *Neurobiol Dis.,* 8(6), 1046–56. DOI: 10.1006/nbdi.2001.0427. PMID: 11741400

Troiano, R. P., Berrigan, D., Dodd, K. W., Mâsse, L. C., Tilert, T., McDowell, M. (2008) Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc.* 40(1), 181–8. DOI: 10.1249/msss.0b013e31815a51b3. PMID: 18091006

Tseng, C. N., Gau, B. S., & Lou, M. F. (2011) The effectiveness of exercise on improving cognitive function in older people: a systematic review. *J Nurs Res.* 19(2), 119–31. doi:10.1097/JNR. 0b013e3182198837. PMID: 21586989

Uchida, S., & Kawashima, R. (2008) Reading and solving arithmetic problems improves cognitive functions of normal aged people: a randomized controlled study. *Age (Dordr)*, 30(1), 21–29. Doi: 10.1007/s11357-007-9044-x. PMCID: PMC2276592

Valenzuela, M., Sachdev, P. (2009) Can cognitive exercise prevent the onset of dementia? Systematic review of randomized clinical trials with longitudinal follow-up. *Am J Geriatr Psychiatry*, 17(3), 179–87. DOI: 10.1097/JGP.0b013e3181953b57. PMID: 19225276

Van Praag, H., Kempermann, G., & Gage, F. H. (1999) Running increases cell proliferation and neurogenesis in the adult mouse dentate gyrus. *Nature Neurosci*ence, 2, 266-270. doi: 10.1038/6368

vanUffelen, J. G., Chin A. P. M. J., Hopman-Rock, M., & van Mechelen, W. (2008) The effects of exercise on cognition in older adults with and without cognitive decline: a systematic review. *Clin J Sport Med.*, 18(6), 486–500. doi: 10.1097/JSM.0b013e3181845f0b

Vaynman, S., Ying, Z., & Gomez-Pinilla, F. (2003) Interplay between brain-derived neurotrophic factor and signal transduction modulator in the regulation of the effects of exercise on synaptic-plasticity. *Neuroscience*, 122(3), 647-57. PMID: 14622908

Vaynman, S., Ying, Z., & Gomez-Pinilla, F. (2004) Hippocampal BDNF mediates the efficacy of exercise on synaptic plasticity and cognition. *Eur J Neurosci.,* 20(10), 2580-90. doi:10.1111/j.1460-9568.2004.03720.x. PMID: 15548201

Voss, M. W., Nagamatsu, L. S., Liu-Ambrose, T., & Kramer, A. F. (2011) Exercise, brain, and cognition across the life span. *J Appl Physiol.,* 111(5), 1505-13. doi:10.1152/japplphysiol.00210.2011. PMID: 21527670

Voss, M. W., Prakash, R. S., Erickson, K. I., Basak, C., Chaddock, L., Kim, J. S., . . . Kramer, A. F. (2010) Plasticity of brain networks in a randomized intervention trial of exercise training in older adults. *Front Aging Neurosci.,* 2, 32. doi:10.3389/fnagi.2010.00032. PMID: 20890449

Widenfalk, J., Olson, L., & Thoren, P. (1999) Deprived of habitual running, rats downregulate BDNF and TrkB messages in the brain. *Neurosci Res.,* 34(3), 125–32. PMID: 10515254

Williams, P., & Lord, S. R. (1997) Effects of group exercise on cognitive functioning and mood in older women. *Aust N Z J Public Health*, 21(1), 45–52. PMID: 9141729

Windhorst, U., & Johansson, H. (1999) Modern techniques in neuroscience research. Springer, New York, NY. DOI: 10.1007/978-3-642-58552-4

Yakhno, N. N., Zakharov, V. V., & Lokshina, A. B. (2007) Impairment of memory and attention in the elderly. *Neurosci Behav Physiol.*, 37(3), 203–8. doi:10.1007/s11055-007-0002-y. PMID: 1724094

Zou, J., & Crews, F. (2006) CREB and NF-kappaB transcription factors regulate sensitivity to exicitotoxic and oxidative stress induced neuronal cell death. *Cell Mol Neurobiol.,* 26(4-6), 385-405. DOI: 10.1007/s1057-006-9045-9. PMID: 16633891.

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Improvement of Brain Function through Combined Yogic Intervention, Meditation and Pranayama: A Critical Analysis

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Abstract

Background: The practice of yoga includes static and dynamic postures (asanas), breathing manipulations (pranayama) and meditation (dhyana). Yoga is a tool which works in the gross body level to the shuttle mind level. Yoga is a simple and inexpensive health regimen that can be incorporated as an effective adjuvant therapy for the improvement of brain and mental activity.

Aim: To review scientific literatures related to yoga practice and brain function.

Method: Researchers collected scientific evidences through electronic databases; Pubmed, Embase, Medline, Google Scholar, Google Advance Search, PsycINFO, ROAJ, DOAJR, Web of Science and critically analyzed the entire relevant article according to the nature of this study.

Findings: Combined yogic practices improve memory which can influence the academic performance of the students. Meditation practices improve higher level of concentration and consciousness which may reduce the psychic disorder. Pranayama practice may be applied as alternative therapy for reducing stress related diseases

Conclusions: Regular yogic practices may improve brain and others neuro cognitive functions.

Keywords: Yoga, Meditation, Pranayama, Brain function, Neuro psychology.

1. Introduction

Brain is the sites of mind and mental function. Brain has three specific areas, lower brain, mid brain and fore brain. This three parts control different types of mental function. Brain is a vast area and lakhs of specialized neurons engage themselves for different types of mental activities. Some area stores the memory where as the other control intelligence level. The development of brain function started from the early childhood and it continuous up to the starting point of ageing. Obviously there is an individual difference in brain function. The improvement of brain function is related with educational development, job performance, professional achievement and sports performance. Ageing and injury may decline the brain function. Scientist are trying to improve brain function by different modes and methods and to delay the decling of brain function.

For the improvement of brain function pharmacological drugs, natural products, different types of chemical has been used in different civilization from the ancient time. Indian is the only ancient civilization who identified vyamaya (physical exercise) and yoga (mental exercise) for the

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development of brain function and especially the mental function. By definition yoga is a practice to control and develop the mental function. In yoga techniques they used different types of asanas, pranayama and meditation as a whole or in a part. In this article, the present researcher reported improvement of brain function related literatures with the intervention of pranayama, meditation and combined yoga intervention. It is interesting to note that there is no such literature found till date on asanas effect on brain function.

2. Objective of the Study

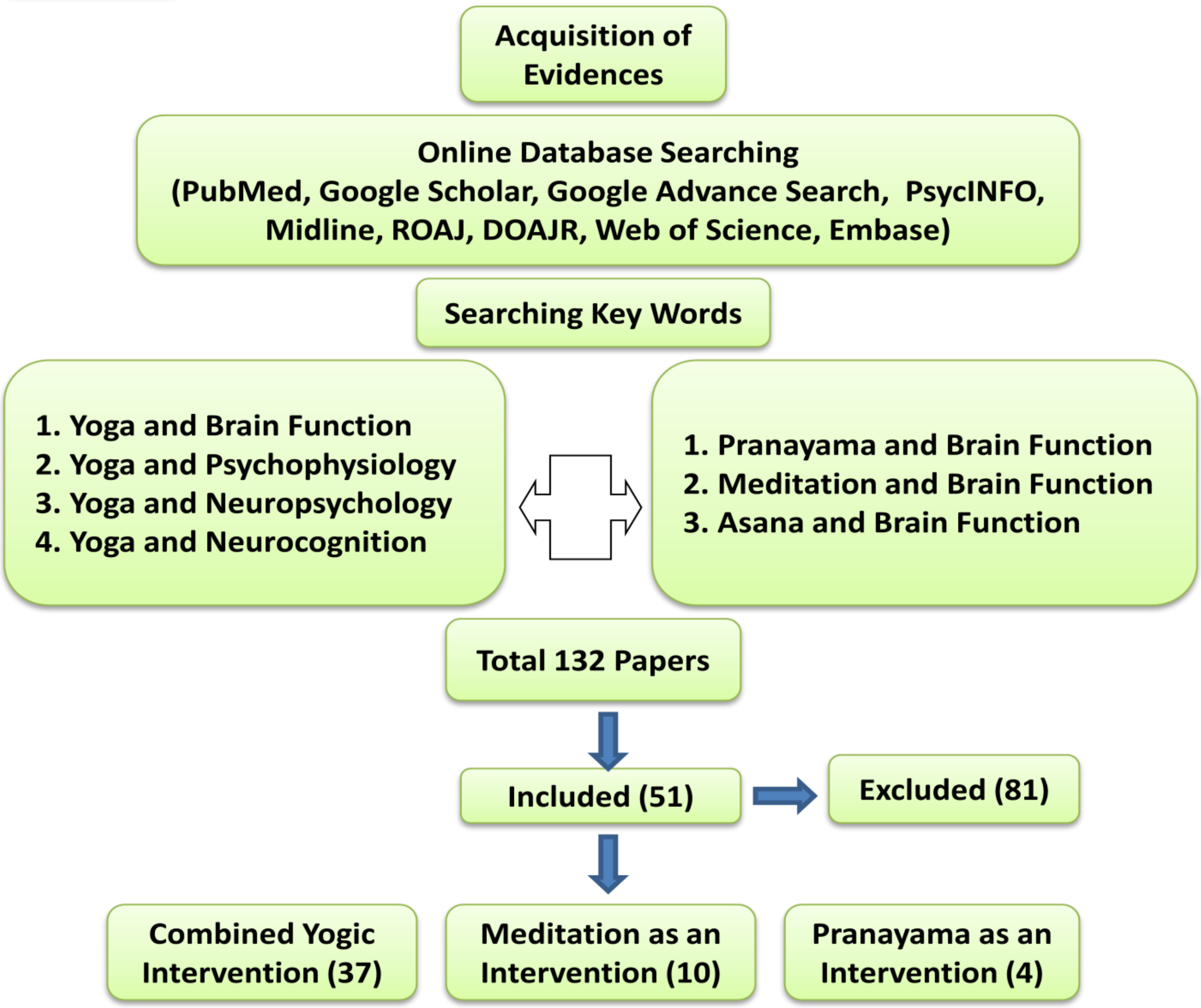
The specific objective of this systematic review study was to explore the improvement of brain function through meditation, pranayama and combined yogic intervention.

3. Methods

3.1 Acquisition of Evidence:

In this systematic review study a thorough online searching procedure was applied for acquisition of evidence. The electronic databases: PubMed, Embase, Medline, Google Scholar, Google Advance Search, PsycINFO, ROAJ, DOAJR and Web of Science were carefully searched for the purpose of reviewing the literatures.

Figure-1



3.2 Inclusion and Exclusion Criteria:

Studies related to the objective of this paper were included in this project whereas studies which were not directly matched with the concept of analysis were excluded from the process.

3.3 Selection Procedure of Review Articles:

In the first attempt, a total 132 article with full text were assessed on the basis of eligibility criteria. Out of which only 51 papers were fulfill the objective of this study. Detail selection procedure adopted for this study is presented in the Figure-1.

A growing body of scientific evidence indicates that yoga has a positive influence on brain function. In this systematic review, the studies related with the yoga and brain function are summarized under the following heads.

4. Improvement of brain functions through combined yogic intervention:

Long term combined yoga practice improves primary cognitive processes such as attention, perception, reaction time, accuracy, and observation (Verma, 2015; Banerjee, 2014; Gothe, 2013). Short term yoga practice for 10 days in school children lead to significant improvement in cognitive function (Reddy, 2015). Short term integrated yoga practices can improve memory scores of diabetics and play a vital role in managing the mental health of diabetics patient (Bhanu, 2015). The effect of eight-week yoga exercise improve balance with intellectual disability (Parisa, 2015). Combination of regular yoga practice with orel hypoglycemic agents improve better cognitive abilities in type 2 diabetic population rather than administration of oral hypoglycemic agents alone (Nagothu, 2015). Yoga module can improve attention and remembrance which may positively affect on academic performance of students (Ramkumar, 2014). Yoga practices are correlated to neurophysiological system that increases in associative attention and positive affective valence (Mackenzie, 2014). Regular practiced of yoga module yielded higher concentration levels and exhibited better short term memory (Kauts, 2012). Yoga has a beneficial effect on P300 wave and thus can be incorporated along with the conventional medical therapy for improving cognitive brain functions in diabetes (Kyizom, 2010). 8 weeks sahaj yoga practice improve neurocognitive function and it can lead to additional improvement in executive functions like manipulation of information in the verbal working memory and added improvement in attention span and visuo-motor speed of the depressives (Sharma, 2006). Pranayama and yoga-asana practice on P300 wave latency and amplitude in type 2 Alzheimer patients have beneficial effect on reduction of Alzheimer and thus can be incorporated along with the conventional medical therapy for improving cognitive brain functions (Tripathi). Yoga practice supported by a common paralimbic brain network which linked to awareness, attention and emotion in order to support memory dependent self reference (Lou, 2011). Combined yoga practice reduces the comorbid anxiety and depression (Forbes, 2008). Yogic education system enhances visual and verbal memory scores (Rangan, 2009).

Yoga based stress management programme on brain wave coherence recorded with brain master EEG 2 channel and found that the delta, theta, alpha gamma wave coherence increases 19.31 %, 5.04 %, 15.40 %, 18.68 % respectively and 1.67 % decrease in beta wave coherence between pre and post intervention measurements (Ganpat, 2011). Yogic intervention improve alpha-EEG level of working women which causes brain come in relax and cool state (Bharadwaj, 2013). 40 days pranakarshan pranayama and yoga nidra practice improve the pranic energy level and change alpha dominance in the brain which influences the mental relaxation, reduce anxiety and stress (Kumar, 2009). Regular yogic intervention improves delta, theta, alpha and beta brain waves which improve overall brain function with emphasis on attention and concentration (Boonjaksilp). Combined yoga practice improve various cognitive behavior in terms of physiological parameters by using EEG and ECG analysis, where indicates improvement in parasympathetic activity and decrease in sympathetic activity. Yoga modifies the sympathovagal balance towards parasympathetic activation, improved the heart rate variability, and enhanced sense of wellbeing (Nagendra, 2015). Five weeks of brain waves vibration training, Iyengar yoga and mindfulness programme improve sleep latency, absorption, memory, salivery cortisol, mood, mindfulness and reduce overall stress (Bowden, 2012). Breathing, meditation, and posture-based yoga progamme increased overall brain wave activity, increases gray matter along with amygdala and activate the frontal cortex (Desai, 2015).

MRI and voxel-based morphometry analysis observed three years combined yoga meditation practice improve gray matter volume in frontal, limbic, temporal, occipital, and cerebellar regions of the brain of 18–55 years people (Froeliger, 2012). Combined yoga meditation practice may be associated with the promotion of neuroplastic changes in executive brain systems and using by fMRI, which may confer therapeutic benefits that accrue with repeated practice (Froeliger, 2012). Fluid intelligence declined with age as a natural process and it have a negative impact on brain function. Fluid intelligence declined slowly than the natural process with combination yoga and meditation practice (Gard, 2014). 12 weeks yogic intervention increase serum brain-derived neuro-trophic factor (BDNF) and maintenance of serum serotonin level in premenopausal women (Lee, 2014). Yoga stimulate the parasympathetic nervous system and increase the inhibitory action of a hypoactive GABA system in brain pathways and structures that are critical for threat perception, emotion regulation, and stress reactivity (Streeter, 2012). 12 weeks yoga practices improve y-aminobutyric acid (GABA) which also helps to reduce the mood and anxiety disorder (Streeter, 2010). Regular 60 minutes yogasana and breathing exercise practices improve 27 % brain GABA level (Streeter, 2007).

Regular practices of yoga have beneficial effects on both phases of parasympatho-dominance and psychological well-being probably by balancing neuro-endocrinal axis (Kanojia, 2013). Yoga and meditation should be recommended as an adjuvant therapy along with medication to tilt the autonomic balance to parasympathetic dominance to get relieved from hypertensive symptoms (Sharma, 2013). Yoga practice decreases sympathetic activity and causes a shift in the autonomic balance towards parasympathetic dominance and indicates helps to reduce stress by optimizing the autonomic functions (Patil, 2012). 12 weeks yoga training program can changes in the brain's baseline and activated cerebral blood flow, dorsal medial cortex, and right sensorimotor area and greater impact found in right hemispheric function, particularly in the frontal lobes (Cohen, 2009). Yoga enhanced the vagal activity and reduced cortisol in turn may contribute to positive effects such as enhanced immune function and lower prematurity rate (Field, 2011).

5. Improvement of brain functions through meditation

Effect of yoga meditation practice and EEG wave was analyzed and it was observed that immediate yoga meditators have greater source of activity in low frequencies particularly theta and alpha wave during mental calculation. Advance yoga meditators showed greater activity in high frequencies (beta and gamma) in all conditions (Thomas, 2014). Other researcher reported that EEG based improvements in cognitive abilities like attention and working memory with meditation practice (Singh, 2014).

Two years meditation experience activates the bilateral hippocampi which are related to memory consolidation (Engstrom, 2009). Long term meditation practices positively improve in gray matter atrophy (Luders, 2014). Regular meditation practice positively affect on frontal region, anterior cingulated, limbic system and parietal lobes of the brain. Strong correlation was found between depth of meditation and neural activity in the left inferior forebrain areas including the insula, inferior frontal cortex and temporal lobe (Wang, 2011).

Long term meditation practice improves over all cognitive functions (memory, attention, perception, observation ability, processing speed, neural activity, intelligence executive function etc.) which energies brain to focus on its task (Singh, 2012; Khalsa, 2004; Prakash, 2011). Meditation technique may be able to offset age related cognitive decline and perhaps even increase cognitive capabilities (Gard, 2014). Meditative practices can be used as leveraged in the prevention and intervention of mental illness (Rubia, 2009).

6. Improvement of brain functions through Pranayama

Two months Sheetali and Sheethkari pranayama practice improve in the delta and alpha band power in the frontal and occipital regions and an increase in theta band power in the frontal region with a marked decrease in beta band power almost throughout the entire hemisphere which keeps brain calm and quiet with less anxiety (Thanalakshmi, (2014). Bhramari pranayama practice can generate controlled high-frequency gamma waves by using EEG signals which is contributed to improve the active thought (Vialatte, 2008). 20 minutes Nadi-Shodhana pranayama practice advocated improving cardio-respiratory efficiency as well as higher functions of brain in healthy individuals. Pranayama practice may be applied as alternative therapy or as adjunct to conventional therapy in stress related diseases (Gupta, 2014). If a person is breathing predominately with the left nostril, that person's right hemisphere of the brain will be more active and putting out a greater electrical signal than the left hemisphere (Srinivasan, 1991).

7. Conclusion

Brain and neuro psychological profile decreases with age is a natural process and it have a negative impact on brain function. Yoga could be considered as a precious tool in the path of mind body medicine. Yoga have a potential benefits on brain health because this ancient Indian technique particularly trained the psycho-physical system. Combined yogic practices improve memory which can influence the academic performance of the students. Meditation practices improve higher level of concentration and consciousness which may reduce the psychic disorder. Pranayama practice may be applied as alternative therapy for reducing stress related diseases such as essential hypertension, neuro degenerative and Parkinson diseases. So the yogic practices improve brain function in multiple pathways.

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References

Banerjee S. (2014) Effect of Yoga on the Memory of Middle School Level Students: IOSR Journal of Research & Method in Education (IOSR-JRME) e-ISSN: 2320–7388, p-ISSN: 2320–737X Volume 4, Issue 1 Ver. IV (Feb. 2014), P 49-52

Bhanu R, Shankar V, Kutty K. (2015) Effect of Short Term Integrated Approach of Yoga Therapy on Memory Scores in type 2 Diabetes Mellitus Patients: Indian Journal of Clinical Anatomy and Physiology 2015;2(4):174-176

Bharadwaj I, Kulshrestha A, Anuja (2013) Effect of Yogic Intervention on Blood pressure and Alpha- EEG level of working women: Indian Journal of Traditional Knowledge Vol. 12 (3), July 2013, pp. 542-546

Bhavanani A B, Ramanathan M, Balaji R, Pushpa D. (2014) Comparative immediate effect of different yoga asanas on heart rate and blood pressure in healthy young volunteers: International Journal of Yoga, Vol. 7, Jul-Dec-2014

Bowden D, Gaudry C, Chan S, Gruzelier J. (2012) A Comparative Randomized Controlled Trial of the Effects of Brain Wave Vibration Training, Iyengar Yoga, and Mindfulness on Mood, Well-Being, and Salivary Cortisol: Evidence-Based Complementary and Alternative Medicine, Volume 2012, Article ID 234713, 13 pages

Cohen D L, Wintering N, Tolles V, Raymond R T, John T F, Galantino M L, Newberg A B. (2009) Cerebral Blood Flow Effects of Yoga Training: Preliminary Evaluation of 4 Cases: The Journal of Alternative and Complementary Medicine, Volume 15, Number 1, 2009, pp. 9–14

David S, Khalsa S. (2004) An Introduction to Kundalini Yoga Meditation Techniques that are Specific for the Treatment of Psychiatric Disorders: The Journal of Alternative and Complementary Medicine, Volume 10, Number 1, 2004, pp. 91–101

Desai R, Tailor A, Bhatt T. (2015) Effects of yoga on brain waves and structural activation: A review: Complementary Therapies in Clinical Practice, 21 (2015) 112e 118

Engstrom M, Pihlsgard J, Lundberg P, Soderfeldt B. (2010) Functional Magnetic Resonance Imaging of Hippocampal Activation During Silent Mantra Meditation: The Journal of Alternative and Complementary Medicine, Volume 16, Number 12, 2010, pp. 1253–1258

Field T. (2011) Yoga clinical research review, Complementary Therapies in Clinical Practice, 17 (2011) 1e8

Froeliger B E, EricL G, Leslie A. Joseph M F. (2012) Neuro cognitive correlates of the effects of yoga meditation practice on emotion and cognition: a pilot study: Frontiers in Integrative Neuroscience, July 2012 , Volume 6 , Article 48

Froeliger B, Eric L. G, McClernon F. J. (2012), Yoga Meditation Practitioners Exhibit Greater Gray Matter Volume and Fewer Reported Cognitive Failures: Results of a Preliminary Voxel-Based Morphometric Analysis, Evid Based Complement Alternat Med. 2012; 2012: 821307.

Ganpat T S, Nagendra H. R. and Muralidhar K. (2011) Effects of Yoga on Brain Wave Coherence in Executives: Indian Journal of Physiology and Pharmacology, 2011; 55 (4) : 304–308

Gard T, Hölzel B K, Lazar S W. (2014) The potential effects of meditation on age-related cognitive decline: a systematic Review: **Annals of the New York Academy of Sciences**. 2014 Jan; 1307: 89–103. PMCID: PMC4024457

Gard T, Taquet M, Dixit R, Hölzel B K, Montjoye Y D, Brach N, Salat D H, Dickerson B C, Gray J R, Lazar S W. (2014) Fluid intelligence and brain functional organization in aging yoga and meditation Practitioners: Front Aging Neurosci. 2014;6: 76. Published online 2014 Apr 22. doi: 10.3389/fnagi.2014.00076

Gothe N, Pontifex M B, Hillman C, McAuley E. (2013) The Acute Effects of Yoga on Executive Function: Journal of Physical Activity and Health, 2013, 10, 488-495 © 2013 Human Kinetics, Inc.

Gupta V, Singh Y, Vikramaditya, Singh H. (2014) Immediate Effect of "Nadi-Shodhana Pranayam" on Some Selected Parameters of Cardio respiratory and Mental Efficiency: Journal of Current trends in Clinical Medicine & Laboratory Biochemistry, Volume 2, Issue 3, July-Sep 2014

Kanojia S, Sharma V K, Gandhi A, Kapoor R, Kukreja A, Subramanian S K. (2013) Effect of Yoga on Autonomic Functions and Psychological Status in Menstrual Cycle in young healthy females: Journal of Clinical and Diagnostic Research. 2013 Oct, Vol-7(10): 2133-2139

Kauts A, Sharma N. (2012), Effect of yoga on concentration and memory in relation to stress: International journal of multidisciplinary research, vol.2 issue 5, May 2012, ISSN 2231 5780

Kumar K, Joshi B. (2009) Study on the effect of Pranakarshan pranayama and yoga nidra on alpha EEG & GSR: Indian Journal of Traditional Knowledge, Vol.8 (3), July 2009, pp. 453-454

Kyizom T, Singh S, Singh K.P., Tandon & Kumar R. (2010) Effect of pranayama & yoga-asana on cognitive brain functions in type 2 diabetes-P3 event related evoked potential (ERP): Indian J Med Res 131, May 2010, pp 636-640

Lee M, Moon W, and Kim J. (2014) Effect of Yoga on Pain, Brain-Derived Neurotrophic Factor, and Serotonin in Premenopausal Women with Chronic Low Back Pain, Evidence-Based Complementary and Alternative Medicine: Volume 2014, Article ID 203173, 7 pages

Luders E, Cherbuin N, Kurth F. (2015) Forever Young(er): potential age-defying effects of long-term meditation on gray matter atrophy: Journal of Frontiers in Psychology, Published online 2015 Jan 21. doi: 10.3389/fpsyg.2014.01551

Mackenzie M J, Carlson L E, Paskevich D M, Ekkekakis P, Wurz A J, Wytsma K, Krenz K A, McAuley E, Culos S N. (2014) Associations between attention, affect and cardiac activity in a single yoga session for female cancer survivors: An enactive neuro phenomenology-based approach: Consciousness and Cognition, 27 (2014) 129–146

Nagendra H, Kumar V, Mukherjee S. (2014) Cognitive Behavior Evaluation Based on Physiological Parameters among Young Healthy Subjects with Yoga as Intervention: Computational and Mathematical Methods in Medicine, Volume 2015, Article ID 821061, 13 pages

Nagothu R S, Reddy I Y, Archana R, Rajesh P. (2015) Role of yoga on cardic autonomic function tests and cognition in type 2 diabetes: Int.J. Res. Ayurveda Pharm. 6(6), Nov-Dec 2015

Parisa S, Yahya S, Reza S. (2015) The Effect of Eight-week Yoga Exercise on Balance and Gait in Girls with Intellectual Disability: Biological Forum – An International Journal 7(1): 1295-1300(2015), ISSN No. (Print): 0975-1130

Patil S G, Mullur L M, Khodnapur J P, Dhanakshirur G B, Aithala M R. (2013) Effect of Yoga on Short Term Heart Rate Variability Measure as a Stress Index in Sub junior Cyclists : A Pilot Study: Indian J Physiol Pharmacol 2013; 57(2): 153–158

Prakash R, Rastogi P , Dubey I, Abhishek P, Chaudhury S B, Small J. (2012) Long-term concentrative meditation and cognitive performance among older adults: Aging, Neuropsychology, and Cognition, 2012, 19 (4), 479–494

Ramkumar N R. (2014) Effect of Yoga on Attention and Remembrance in Relation to Anxiety: Asia Pacific Journal of Research, Vol: I Issue XVI, August 2014 ISSN: 2320-5504, E-ISSN-2347-4793

Reddy G.K, Kumari S (2015) Effect of Short Term Yoga Practices on Cognitive Function and Attitude Towards Violence in School Children- A Randomized Control Study: Yoga and Attitude Towards Violence, Voice of Research, Volume 3, Issue 4 March 2015 ISSN 2277-7733

Sharma M, Meena M, Sharma R, Chauhan N. (2013) Study on the Effect of Yoga (Yogasans, Pranayam and Meditation) Training on Hypertension: Ind. J. Sci. Res. and Tech. 2013 1(2):89-95/ISSN:-2321-9262 (Online)

Sharma V K, Das S, Mondal S, Goswami U, Gandhi A. (2005) Effect of Sahaj Yoga on Neuro-Cognitive Functions in Patients Suffering From Major Depression: Indian J Physiol Pharmacol 2006; 50(4)

Singh M, Narang M. (2014) Cognitive Enhancement using meditation as Intervention: International Journal of IT & Knowledge Management, Volume 7, Number 2, Jan– June 2014 pp. 62-70 (ISSN 0973-4414)

Singh Y, Sharma R, Talwar A. (2012) Immediate and Long-term Effects of Meditation on Acute Stress Reactivity, Cognitive Functions, and Intelligence: Alternative Therapies, NOV/DEC 2012, VOL. 18, NO.6

Srinivasan T M. (1991) Pranayama and Brain Correlates: Ancient Science of Life, Vol No. XI No.1 & 2, July & October 1991, Pages 1 – 6

Streeter C C, Gerbarg PL, Saper RB, Ciraulo D A, Brown R P. (2012) Effects of yoga on the autonomic nervous system, gamma-aminobutyric-acid, and allostasis in epilepsy, depression, and post-traumatic stress disorder: Medical Hypotheses xxx (2012) xxx–xxx

Streeter C C, Jensen J E, Perlmutter R M, Howard B S, Cabral J, Tian H, Devin B. Terhune, Domenic A. Ciraulo, Perry F. Renshaw (2007) Yoga Asana Sessions Increase Brain GABA Levels: A Pilot Study, The Journal of Alternative and Complementary Medicine, Volume 13, Number 4, 2007, pp. 419–426

Tenzin K, Singh S, Singh K P, Tandon O P, Kumar Rahul. (2010) Effect of pranayama & yoga-asana on cognitive brain functions in type 2 diabetes-P3 event related evoked potential (ERP),:Indian J Med Res 131, May 2010, pp 636-640

Thanalakshmi J, Ravindran R, Sembulingam K, Sembulingam P. (2014) Impact of Sheetali and Sheetkari Pranayama on the Topographic Mapping of the Brain Waves: IOSR Journal of Pharmacy (e)-ISSN: 2250-3013, (p)-ISSN: 2319-4219 www.iosrphr.org Volume 4, Issue 10 (October 2014), PP. 51-57 51

Thomas J, Jamieson G, Cohen M. (2014) Low and then high frequency oscillations of distinct right cortical networks are progressively enhanced by medium and long term Satyananda Yoga meditation practice: Front Hum Neurosci. 2014; 8: 197. Published online 2014 Jun 10. doi: 10.3389/fnhum.2014.00197

Verma A, Shete S U, Thakur G S, Kulkarni D D, Bhogal R S (2014) The Effect of Yoga Practices on Cognitive Development in Rural Residential School Children in India: National Journal of Laboratory Medicine. 2014 Sep, Vol 3(3): 15-19

Vialatte F B, Bakardjian H, Prasad R, Cichocki A. (2008) EEG paroxysmal gamma waves during Bhramari Pranayama: A yoga breathing technique: Consciousness and Cognition (2008)

Wanga D J, Raob H, Korczykowskib M, Wintering N, Pluta, Khalsa D S, Newberg A B. (2011) Cerebral blood flow changes associated with different meditation practices and perceived depth of meditation: Psychiatry Research: Neuroimaging 191 (2011) 60–67

Cramer H, Lauche R and Dobos G. (2014) Characteristics of randomized controlled trials of yoga: A bibliometric analysis: BMC Complement Altern Med. 2014; 14: 328. Published online 2014 Sep 2. doi: 10.1186/1472-6882-14-328

Telles S, Singh N, Joshi M, Balkrishna A. (2010) Post traumatic stress symptoms and heart rate variability in Bihar flood survivors following yoga: a randomized controlled study: BMC Psychiatry. 2010; 10: 18. Published online 2010 Mar 2. doi: 10.1186/1471-244X-10-18

Colgrove Y S, Sharma N, Kluding P, Potter D, Imming K, Stanhope J, Hoffman K, White K. (2012) Effect of Yoga on Motor Function in People with Parkinson's Disease: A Randomized, Controlled Pilot Study: Yoga & Physical Therapy, 2012, 2:2 http://dx.doi.org/10.4172/2157-7595.1000112

Rubia K. (2009) The neurobiology of Meditation and its clinical effectiveness in psychiatric disorders: Biological Psychology 82 (2009) 1–11

Kavuri V, Raghuram N, Malamud A, Selvan S R. (2015) Irritable Bowel Syndrome: Yoga as Remedial Therapy: Evid Based Complement Alternat Med. 2015; 2015: 398156.

Forbes B, Nacco C, Gotz J, Hartsell K (2008) Using Integrative Yoga Therapeutics in the Treatment of Comorbid Anxiety and Depression: International Journal of Yoga Therapy – No. 18 (2008)

Rangan R, Nagendra HR, Bhat GR (2009) Effect of yogic education system and modern education system on memory: International Journal of Yoga. 2009 Jul–Dec; 2(2): 55–61. doi: 10.4103/0973-6131.60045. PMCID: PMC2934577

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The Intervention Movement Programme for Rhythmical Gymnastics and Dance in Practice

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Abstract

In this contribution the authors present partial results of their research relating to the influence of an intervention movement programme for rhythmical gymnastics and dance on the physical fitness of younger students as well as the verification of physical methods with respect to their appropriateness in practice. This experiment was conducted with fourth grade primary school students. The authors used the Sporttester diagnostics to determine the load intensity on a randomly chosen sample from the experimental group. The results showed that the methods chosen for physical fitness development of younger students were appropriate. The movement programme being tested in practice can be applied at schools.

Keywords: rhythmical gymnastics and dance, load intensity, younger students.

1. Introduction

The Government Policy Statement of the Slovak Republic 2016 – 2020 includes an aim for the continuous improvement of Slovak citizens' quality of life connected with the growth of their living standards. The school policy specified within this section involves, among other things, sport and healthy lifestyle of children and youth. In the near future, the school policy will be focused on increasing the physical activity performed by children and youth, an improvement in the quality of physical education and support of leisure time activities for children and students.

It follows from the above that the content of educational activities should be directed towards a healthy lifestyle and therefore, when drawing up school educational programmes at all school levels this fact should be taken into consideration.

The Slovak National Educational Programme for Primary Education (ISCED 1) which is the source for school educational programmes, is targeted at the content of physical education majoring in physical, functional and physical improvement thereby contributing to health improvements, physical fitness and physical performance. Physical education should provide elementary theoretical and practical knowledge of movement and sport as well as contribute to the mental, social and moral development of students and to the formation of a positive attitude towards physical activity. Physical education utilizes a wide spectrum of physical methods which contribute to personality development with an emphasis on fine and gross motor activity and also with positive impact on students' state of health (ISCED 1).

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In general, physical fitness is an important condition for effective functioning of the human organism at an optimal efficiency and is conditioned mainly by the physiological functions of the body. The physical fitness of children and youth was and remains a main topic for the ranks of experts. An optimal level of physical fitness demonstrably contributes to the quality of life. It enables a person to perform common and more demanding activities as well as decreasing health risks connected with hypokinesis (Frömel et al., 1999; Malina et al., 2004; Plowman, 2005; Bunc, 2008; Sigmund et al., 2009; Kyröläinen, 2010; Bendíková, 2011; Cepero et al., 2011, Bendíková, Kostencka, 2013; Miklánková, 2013, Smoleňáková, 2015).

Rhythmical gymnastics and dance are currently less utilized for students' physical activities at the primary education level. In reference to their focus, they belong to the thematic programme of Music-movement and dance activities with an aim of giving competence in age-appropriate basic sensory, motor (movement), intellectual, cultural-artistic and creative capacities and an ability to be able to apply them during life and in sport by means of cultivating natural movement (ISCED 1).

They are also an important motivational factor in physical activity with the influence on physical and functional development, the still developing music-movement sense, movement coordination, spatial orientation and movement memory.

After several years of research, Trunečková (2005) has confirmed the positive impact of dance on the functional state of the human body. In Croatia, Vujovič (2012) undertook a study of rhythmical gymnastics methods and their influence on the movement capacities of younger girls. He has confirmed in the research that this type of exercise has a positive impact on movement capacities. Werner, Williams and Hall (2012) also confirmed the development of affective and cognitive abilities caused by the performance of different types of dance within a teaching programme. Palmer Heater (2003), who focused his interventional movement programme on the development of creativity, fantasy, physical condition, and natural performance, pointed out the great importance of the connection between music and a gymnast's movement with respect to age-related distinctiveness. All the above mentioned experts emphasize the importance of instrumental accompaniment whilst undertaking movement activities.

These findings are partially included in the grant VEGA 1/0377/08"The Intervention Motion Program BUBO and development of physical abilities of basic school pupils.

Aim. The goal of the research was to verify the effectiveness of a physical intervention programme for rhythmical gymnastics and dance on the subjects' physical fitness. We tried to make the diagnostics of load intensity more objective whilst remaining in school teaching and at the same time we verified the appropriateness of the chosen physical methods for rhythmical gymnastics and dance within the experimental group.

2. Materials and methods

The research focused on the verification of the effectiveness of an intervention movement programme for rhythmical gymnastics and dance with two classes of fourth grade students (n= 67 students), i.e. 36 girls at the decimal age of 10.28 and 31 boys at the decimal age of 10.23. The lessons were taught by a qualified teacher for primary teaching with twenty – years experience. In reference to the goal we used a pedagogical experiment within natural conditions. An experimental factor representing the intervention movement programme for rhythmical gymnastics and dance was established on the basis of Tunečková's long-time experience and her publication *Hudobno-tanečné hry: metodická príručka k MGK s nahrávkami hudobných predlôh tanečných hier (1996)*. This publication was approved by the Ministry of Education of the Slovak Republic under the number 680/2001-41 as an auxiliary didactic teaching material. To make the diagnostics of the students' load intensity objective we monitored pulse rate on randomly chosen students using Sporttester during the school teaching. According to Olšák (1997) and Rychtecký – Fialová (2004), whilst monitoring pulse rate we are able to find out not only load intensity but also its volume. Following scientifically based empirical research, the above mentioned authors consider the method of watching the pulse rate changes as the most accurate, yet the most simple. The analysis of the load intensity within the experimental group represents only a partial result of the whole experiment focused on the increase of the primary school students' movement capacities.

3. Results

While assessing the effectiveness of the intervention movement programme for rhythmical gymnastics and dance, we reviewed the diagnostics of the load intensity observed on the sample of students during school teaching and thereby verified the appropriateness of the chosen physical methods. The main criterion for the effectiveness assessment of physical education is its content, i.e. physiological exercise character reflected in the heart rate. According to Židiš (1994), physical means are effective only in those cases when the values of the pulse rate among tested students range between aerobic and anaerobic threshold during 60% of training time. Figure 1 shows a physiological curve of a randomly chosen student A.K. from the experimental group during one lesson. An ideal load intensity in a span of 130-180 pulses/min. represented 58.5 % of training time. This is characteristic for the aerobic activity zone of the body. The tested student spent 33.6 % of the time in a zone of weak load and 7.9% of training time in a zone of maximum load, as it is showed in the Table 1.

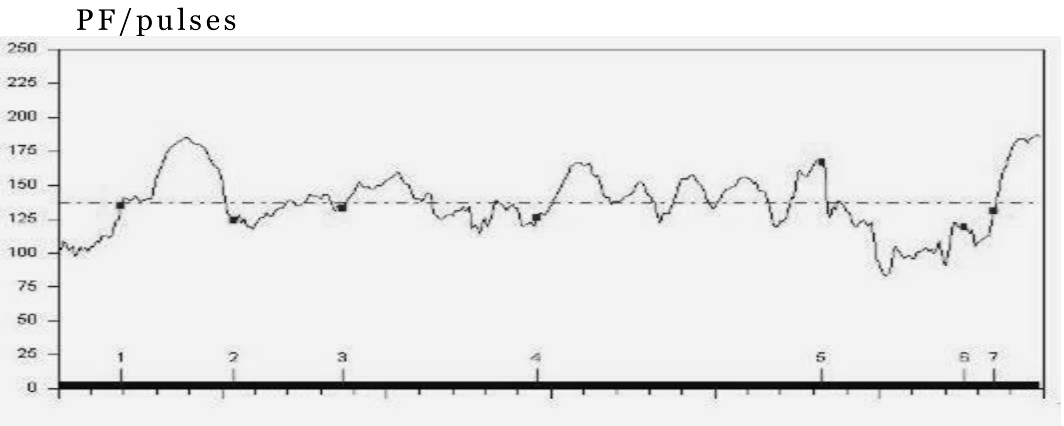

Figure 1. Student A.K.: graphical representation of heart rate curve during the lesson

Table 1. Student A.K. showing training time by zone, expressed as a percentage

PF	Within 130 pulse/min	From 130 to 180 pulse/min	Over 180 pulse/min
Training time	33.6 %	58.5 %	7.9 %

Figure 2 shows the physiological load of student D.T. during physical education. Table 2 represents their training time in the defined zones expressed as a percentage. The student D.T. spent 33.6 % of training time in a zone of weak load, 61 % in aerobic zone and 5.4 % in a zone of maximum load during the lesson modified by the experimental factor.

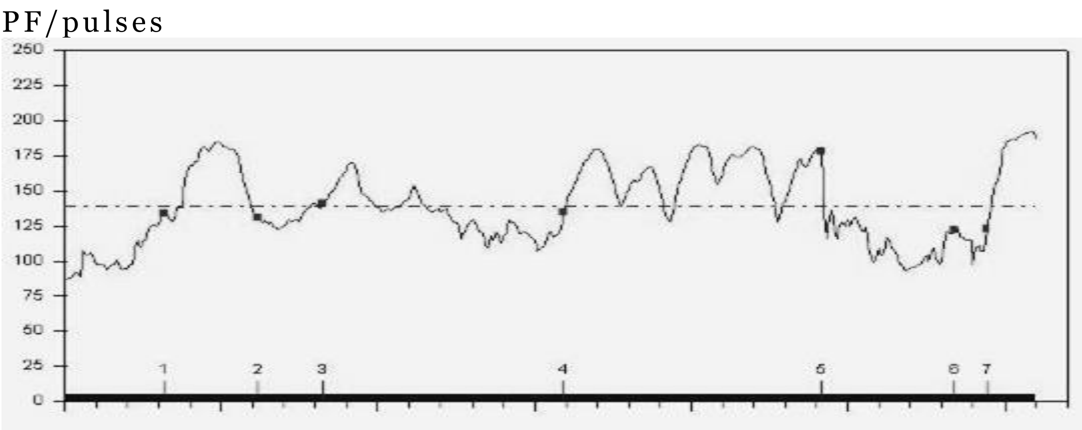

Figure 2. Student D.T. graphical representation of heart rate curve during the lesson

Table 2. Student D.T. showing training time by zone, expressed as a percentage

PF	Within 130 pulse/min	From 130 to 180 pulse/min	Over 180 pulse/min
Training time	33.6%	61%	5.4%

In Figure 3, there is a record from Sporttester relating to the student M.S. Their pulse frequency curve shows training time during physical education in a zone from 130 to 180 pulse/min-52.7 %. An experimental programme during physical education was applied.

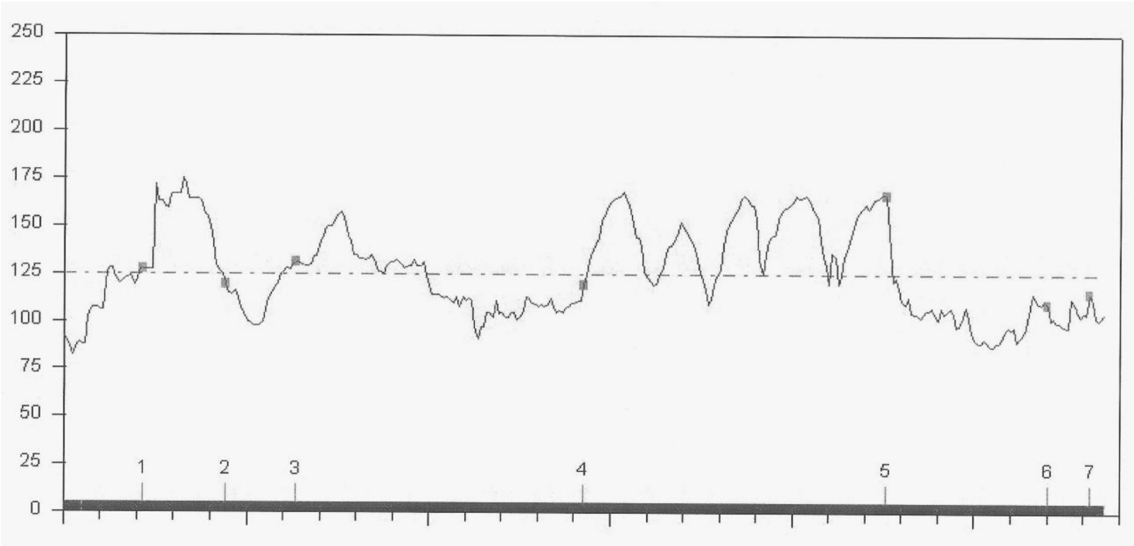

Figure .3. Student M.S.: graphical representation of heart rate curve during the lesson.

Table 3. Student M.S. showing training time by zone, expressed as a percentage

PF	Within 130 pulse/min	From 130 to 180 pulse/min	Over 180 pulse/min
Training time	47.3%	52.7%	-

In the three of randomly chosen students, we found that their heart rate ranged between 130–180 pulses/min., 57.4 % of training time on average. Therefore, we can consider the methods used during the experiment appropriate.

4. Conclusion

Physical education provides more space for teaching methods, mainly the physical activity which plays not only an important role in primary education but also is irreplaceable when teaching a child in individual or group form. It also offers conditions in which a child can behave naturally and without stress.

According to our results, we can agree with non-traditional and varied types of physical education undertaken using rhythmical gymnastics and dance and mainly by the use of games. They are one of the most natural activities typical for this age group. A child fulfils its desire for physical activity. When they are properly adjusted they can offer many options to increase the level of physical activity during physical education whilst respecting individual students' needs and contribute to their personal and intellectual development at humanistic school.

Provided a teacher chooses proper methods during physical education, the programme is applicable not only while warming up and limbering up but also as the main content of the lesson and last but not least at the end of the lesson for loosening and compensation exercises.

The results of the Sporttester measurement technique confirm the above mentioned statement and cover not only load intensity but also its volume. Exploring the load intensity we came to the conclusion that the time spent in the various zones of load intensity is only approximate because the experiment was conducted on general population and therefore a teacher has to take the student's age and individual peculiarities into consideration. We have to be aware of the fact, that nowadays some people do exercise regularly, others randomly and some people do not do exercise at all. The same situation is true for the intensity of exercise.

In reference to the above mentioned conclusions, the experts recommend changing levels of load intensity during the physical education lessons. It is also recommended to change the maximum load with active relaxation when the heart rate approximates the initial values.

Taking this fact into consideration, we found that the load intensity values of randomly chosen students are adequate and the physical methods as applied to younger students are optimal.

References

Bendíková, E. (2011) Hľadajme príčiny poklesu záujmu žiakov o školskú telesnú a športovú výchovu! *Těl. Vých. Sport Mlád.*, vol. 77, no. 2, p. 18–20.

Bendíková, E. & Kostencka, A. (2013). Exercise routine as a conditions of early school age pupils´ health : [scientific monograph] / Bydgoszcz : Oficyna Wydawnicza Mirosław Wrocławski, 2013, 149 p.

Bunc, V. (2008) Aktivní životní styl dětí a mládeže jako determinant jejich zdatnosti a tělesného složení. *Studia Kinanthropologica*, vol. 9, no. 1, p. 19–23.

Cepero, M. et al. (2011) Fitness test profiles in children aged 8–12 years old in Granada (Spain). *Journal of Human Sport and Exercise*, vol. 6, no. 1, p. 135–145.

FrömeL, K., Novosad, J. & Svozil, Z. (1999) *Pohybová aktivita a sportovní zájmy mládeže*. 1.vyd. Olomouc: UP. 173 p.

ISCED 1 – Telesná a športová výchova, Štátny pedagogický ústav, 2015. [citované 2016 08.20]. Available on internet: http://www.statpedu.sk/clanky/inovovany-statny-vzdelavaci-program-inovovany-svp-pre-1stupen-zs/zdravie-pohyb.

Kyröläinen, H. et al. (2010) Physical fitness profiles of young men: associations between physical fitness, obesity and health. *Sport Medicine*, vol. 40, no. 11, p. 907–920.

Malina, R. M., Bouchard, C. & Bar-Or, O. (2004) *Growth, maturation and physical activity*. 2nd ed. Champaign, IL: Human Kinetics.

Miklánková, L. (2013). Výchova *dětí ke zdravému životnímu stylu – strategie, intervence, prevence.* Studia Kinathropologica, 14 (1):33-42.

Olšák, S. (1997). *Srdce Zdravie Šport*. Moravany nad Váhom: Raval, 1997.

Palmer, H. (2003). Teaching Rhythmic Gymnastics: Developmentally Appropriate Approach. Human Kinetics 2003, p.131. ISBN07 36042423.

Plowman, S. A. (2005) Physical activity and physical fitness: weighing the relative importance of each. *Journal of Physical Activity and Health*, vol. 2, no. 2, p. 143–158.

Rychtecký, A., Fialová, L. (2004). *Didaktika školní tělesné výchovy*. Praha, Karolinum, 2004, 171 p.

Sigmund, E. et al. (2009) Odlišnosti v pohybové aktivitě předškolních dětí ve srovnání s pohybovou aktivitou adolescentů a mladých dospělých. *Česká kinantropologie*, vol. 13, no. 4, p. 50–62.

Smoleňáková, N. (2015). *Zmeny úrovne vedomostí a pohybového režimu stredoškolákov vplyvom výučby modulu zdravý životný štýl*. Dizertačná práca FTVŠ UK v Bratislave 146 s.

Trunečková, E. (1996). *Hudobno-tanečné hry: metodická príručka k MGK s nahrávkami hudobných predlôh tanečných hier*. 1996, 88 p.

Trunečková, E. (2005). *Hudobno – pohybová edukácia na základných školách*. Banská Bystrica: PF UMB, 2005, 76 p.

Vujović (2012). The influence of Rhythmic gymnastics teaching contents upon development of some motor skills among the school girls of the fifth grade of primary school. In.Sport Montsep. 2012, Issue 34-36, p 482, 6 p.

Werner, et al. (2012). Teaching Children gymnastics, third edition. Copyright 2012, 264 p.
Židišin, M. (1994). *Pedagogická diagnostika ako metóda poznávania javov v športovej činnosti.* In.XV. Zborník Telovýchovnej školy SZTK Bratislava, 1994.

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Models in Estimating Fat Percentage in Active Male

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Abstract

This study was undertaken to develop different predictive models for the active college males in the age range of 18–24 years. The reference variable was the fat percentage measured with bio-electrical impendence. Five sets of independent models were generated with girth alone, skinfold alone, girth with demographic, skinfold with demographic and all together. Step-wise multiple regression was carried out in each category of variables and the best model from each category was identifies and compared. The analysis revealed that the best model evolved when all the variables were used with a R^2 value of 0.797. The model with girth and demographic variables resulted in R^2 of 0.793. Since girth is easier to measure, the second model may be used for the estimation in field situation. However, the model demands validation in a larger population.

Keywords: Fat percentage, Estimation, Regression.

1. Introduction

Fat is an essential component of human body that supplies energy and nutrients for proper functioning of different body parts. This also acts as a source of essential fatty acids required by the body (Ainala et al., 2015). However, excess fat is also harmful for the body. Excessive fat leads to the condition of 'Obesity' which is associated with a variety of metabolic disturbances and long-term cardiovascular complications. The global obesity epidemic has become a menace to the society (Chan and Nelson, 2009; Lohman, et al., 2000). Thus for the implementation of curative and preventive health measures, the assessment of fat percentage is very essential (Ranasinghe et al., 2013).

Hydrostatic weighing has long been considered the "gold standard" for estimating body fat. The requirement of specialised equipment and trained technicians has resisted its use in field situation and alternative methods were developed using body anthropometry (Kujawa et al., 2002). Valid determinations of body fat percentage is possible using skinfold callipers in men (Jackson and Pollock, 1978) and women (Jackson et al., 1980) with multiple correlations, to underwater weighing, exceeding 0.90 in men and ranging from 0.842 to 0.867 in women. Jackson et al (1980) reported that body composition determined using skinfolds was strongly correlated (r=0.82) with body fat determined using underwater weighing. Skinfold determination can be made using several different equations, including a three-site, four-site, or seven-site skinfold formula (Jackson and Pollock, 1978). However, this also requires expertise and availability of calibrated callipers. So, in order to make the measurements more practical and field oriented several other measures have also been formulated using girths such as BMI, waist to hip ratio, etc. (Howley and Thompson, 1943).

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Ballor and Katch (1989) mentioned that the accuracy of anthropometric prediction equations dependents on many factors including age, gender, body composition status, and statistical considerations (Katch and McArdle, 1973; Katch and Katch, 1980; Lohman, 1981; Pollock et al., 1975). The present study aimed at developing several regression equations for predicting the fat % of Indian active population and compares the effectiveness of the models in the age range of 18 to 24 years on the basis of skinfold, girth, skinfold with demographics, girth with demographics and all types of combined variables.

2. Materials and Methods

In developing regression equations the fat percentage was considered as the dependent variable and bodily measurements were the independent variables. Thirty eight healthy adult male subjects were randomly chosen from the Lakshmibai National Institute of Physical Education Gwalior in the age range 18–24 years with sporting background as a sample for the study. The consent from the individuals was obtained before proceeding for measurements.

Seven bodily circumferences namely, Neck, Biceps, Chest, Waist, Hip, Thigh, Calves and Forearms were measured with tape and the data was recorded in centimetres. Further, seven skinfolds namely, Triceps, Suprailiac, Thigh, chest, Abdomen, Axilla and Subscapular was measured with Harpender calibrator (British Indicators Ltd, Luton, UK) with 0.1 mm precision and constant pressure of approximately 10 g/mm²was used for the measurement of the skinfolds. All measurements were taken three times on the right side of the body and the mean values were used for the calculations.

Weight and Height of the subjects were also recorded with a calibrated weighing scale and stadiometer respectively using standard methods. The Fat percentage was obtained from the TANITA BC-420MA Leg-to-Leg Bio Impedance Machine. The instrument has reliability greater than 0.80 and is also considered valid in the medical community (Tanita, 2015; Kutac et al., 2008; Jebb et al., 2007).

3. Results

The stepwise multiple regression was applied separately on the data of Demographic variables, Girths, skinfolds, girths & demographic, skinfold & demographics and all together using SPSS® 20. Except “skinfolds alone” group, in all other categories more than one model could be developed. Table 1 show different models developed in each combination of variables.

Table 1. Summary of all the derived models

	R	R^2	Adj. R^2	SEE	Variables in the model
Skinfold and Demographic	**0.868**	**0.754**	**0.732**	**2.508**	**(Constant), Axilla Skinfold, Weight, Height**
Skinfold and Demographic	0.836	0.699	0.682	2.733	(Constant), **Axilla** Skinfold, Weight
Skinfold and Demographic	0.798	0.637	0.627	2.961	(Constant), **Axilla** Skinfold
Skinfold	**0.798**	**0.637**	**0.627**	**2.961**	**(Constant), Axilla Skinfold**
Girth and Demographic	**0.890**	**0.793**	**0.774**	**2.302**	**(Constant), Hip Circumference, Weight, Height**
Girth and Demographic	0.860	0.74	0.725	2.543	(Constant), Hip Circumference, Weight
Girth and Demographic	0.785	0.616	0.606	3.044	(Constant), Hip Circumference
Girth	**0.854**	**0.729**	**0.714**	**2.594**	**(Constant), Hip Circumference, Thigh Circumference**
Girth	0.785	0.616	0.606	3.044	(Constant), Hip Circumference
All Together	**0.893**	**0.797**	**0.779**	**2.280**	**(Constant), Axilla Skinfold, Hip Circumference, Neck Circumference**
All Together	0.873	0.762	0.749	2.430	(Constant), Axilla Skinfold, Hip Circumference
All Together	0.798	0.637	0.627	2.961	(Constant), Axilla Skinfold

NB: The model with highest R^2 value in each category has been marked in bold.

The best model was obtained when all the variables were taken in the analysis, with R^2 value of 0.797 having predictors as axilla skinfold, hip circumference and neck circumference. The second best model was obtained in the 'Girth and demographic' variable with R^2 of 0.793 and the predictor variables as Constant, Hip circumference, Weight and height. There exists a very marginal difference in the percentage variance explained (R^2) by the top two consecutive models. The least variance is explained by the model in skinfold alone group with a R^2 of 0.637.

Table 2. Coefficients of the predictor variables included in the best model of each combination

Model		**Unstandardized Coefficients**		**Standardized Coefficients**	**t**	**Sig.**
		B	**Std. Error**	**Beta**		
All Together	**(Constant)**	-31.318	7.906		-3.961	0.000
	Axilla skinfold	0.458	0.109	0.438	4.2	0.000
	Hip circumference	0.609	0.182	0.365	3.339	0.002
	Neck circumference	1.409	0.587	0.236	2.398	0.022
Girth and Demographic	**(Constant)**	5.151	12.657		0.407	0.687
	Hip circumference	0.636	0.182	0.381	3.498	0.001
	Weight	0.355	0.066	0.675	5.378	0.000
	Height	-0.209	0.071	-0.282	-2.952	0.006
Skinfold and Demographic	**(Constant)**	26.392	11.431		2.309	0.027
	Axilla skinfold	0.344	0.155	0.329	2.223	0.033
	Weight	0.354	0.089	0.674	3.989	0.000
	Height	-0.218	0.079	-0.294	-2.746	0.010
Girth	**(Constant)**	-39.652	5.606		-7.073	0.000
	Hip circumference	1.197	0.15	0.717	7.982	0.000
	Thigh circumference	0.527	0.138	0.343	3.814	0.001
Skinfold	**(Constant)**	7.186	1.041		6.904	0.000
	Axilla Skinfold	0.834	0.105	0.798	7.946	0.000

The following equations were derived using the unstandardized coefficients for selected combination of variables:

Equation 1 (R^2= 0.893):

Fat % = - 31.318 + 0.458(Axilla skinfold) + 0.609(Hip circumference) + 1.409(Neck circumference)

Equation 2 (R^2= 0.890):

Fat % = 5.151 + 0.636(Hip circumference) + 0.355(Weight) – 0.209(Height)

Equation 3(R^2= 0.868):

Fat % = 26.392 + 0.344(Axilla skinfold) + 0.354(Weight) – 0.218(Height)

Equation 4 (R^2= 0.854):

Fat % = -39.652 + 1.197(Hip circumference) – 0.527(Thigh circumference)

Equation 5 (R^2= 0.798):

Fat % = 7/186 + 0.834(Axilla skinfold)

As equation 5 holds the lowest R^2, it should be avoided for estimating fat percentage.

4. Discussion

Fat estimation methods based on anthropometric variables aims at finding valid representative of fat and in this process, the present study ended up with five equations using girth measurements, skinfold measurement, girth with demographic variables, skinfold with demographic variables and all the variables together. The best equation evolved from the model developed by exploring all the variables together with a R^2 of 0.797 and a standard error of 2.280. Out of all 17 variables only three variables namely axilla skinfold, hip circumference and neck circumference were retained. The second best model with R^2 of 0.793 and a standard error of 2.594 was derived from the girth (Hip circumference) and demographic variables (Height & Weight). According to Kujawa et al. (2002) one of the major source of error in measurement of fat is the technical error made during the measurement of anthropometric segments. The circumferences can be measured more precisely than skinfolds (Roche, 1996), which has the effect of decreasing the proportion of error in predicting body fat percentage due to measurement of the anthropometric variables. It has also been shown that individuals can learn to measure circumferences accurately, more quickly and more easily than skinfolds (Heaney, 1998). Thus, the second model can be best utilised for the prediction of fat percentage. Jackson et al. (1980) gave four predictive models with Sum 4SF, Sum 4SF+C, Sum 3SF, Sum 3SF+C with a R^2 value of 0.85, 0.86, 0.84 & 0.85 respectively. These equations had higher R^2 value but they were constructed on children and youths of normal population. The lower R^2 value in the present study indicates the inclusion of some other factors than those of selected in the present study.

The study found the existing fat percentage estimation models inadequate for active population as it retained only axilla skinfold during the development of model using skinfolds only. The principle of fat percentage estimation through anthropometric measurements lies in the measurement of subcutaneous fat. Since active youths are regularly engaged in exercise the accumulation of subcutaneous fat vary from the normal sedentary population. Further, the earlier equations are composed of sum of skinfold and individual skinfolds have been seldom evaluated for their significance. Also axilla skinfold which has been identified in the model as a significant predictor does not figure in many popular models (Ballor and Katch, 1989)

It is quite significant to note that demographic variables (Height and Weight) were included in the model when it was developed using variables in the Girth and Skinfold group, but were excluded when the model was developed using all the variables. Thus, it prompts for the inclusion of height and weight in the predictive models for the calculation of fat percentage using skinfolds measurements but all the popular models mentioned by Jackson et al. (1980) lacks these two parameters. The exclusion of age as predictor in all the models demonstrates the stabilization of the effect of age and the directive for the usage of the equations throughout the age range of 18–24 years. Out of all the included variables the height holds a negative coefficient, indicating a decrease in fat % with increase in height for a given value of other predictor variables.

5. Conclusion and recommendations

In the absence of any prediction model for the active population, any of the first four models developed in the study can be used for the fat percentage estimation. The second model i.e. Fat % = 5.151 + 0.636(Hip circumference) + 0.335(Weight) – 0.209(Height) is the best suitable in field situations as it includes only one girth measurement along with Height and Weight. These variables can be measured with less competency and error and would enhance the reliability in the study. However, these models need to be validated in large population before any clinical evaluation.

References

Ainala, S. S., Aljohani, N., Roy, K., Yuan, X., & Yu, H. A. (2015). Study on body fat density prediction based on anthropometric variables. International Journal of Data Mining & Knowledge Management Process, 5(3), 1-8. doi:10.5121/ijdkp.2015.5301

Aniteli, T., Florindo, A., Pereira, R., & Martini, L. (2006). Development of an equation for measurement of bodyfat mass of elderly women with osteoporosis or osteopenia through skinfold thickness using dual energy X-ray absorptiometry as a reference. Rev Bras Med Esporte, 326-330. Retrieved June 20, 2015, from http://www.scielo.br/pdf/rbme/v12n6/en_a13v12n6.pdf

April, J., Chambers, E., Parise, J., Mccrory, L., & Cham, R. (2014). A comparison of prediction equations for the estimation of body fat percentage in non-obese and obese older Caucasian adults in the United States. The journal of nutrition, health & aging, 18(6), 586-590. Retrieved May 24, 2015, from http://link.springer.com/article/10.1007%2Fs12603-014-0017-3

Ballor, D. L., & Katch, V. L. (1989). Validity of Anthropometric Regression Equations for Predicting Changes in Body Fat of Obese Females. American Journal Of Human Biology, 1, 97-101.

Ballor, D. L., & Victor, L. K. (1989). Validity of Anthropometric Regression Equations for Predicting Changes in Body Fat of Obese Females. American Journal Of Human Biology, 1, 97-101.

Cameron, N., Griffiths, P., Wright, M., Blencowe, C., Davis, N., Pettifor, J., & Norris, S. (2004). Regression equations to estimate percentage body fat in African prepubertal children aged 9 y. Am J Clin Nutr, 80(1), 70-75. Retrieved May 11, 2015, from http://www.ncbi.nlm.nih.gov/pubmed/15213030

Chan, D., Li, A., So, H., Yin, J., & Nelson, E. (2009). New Skinfold-thickness Equation for Predicting Percentage Body Fat in Chinese Obese Children. HK J Paediatr, 14, 96-102. Retrieved July 01, 2015, from http://www.hkjpaed.org/pdf/2009;14;96-102.pdf

Fuster-Parra, P., Bennasar-Veny, M., Tauler, P., Yañez, A., López-González, A. A., & Aguiló, A. (2015). A Comparison between Multiple Regression Models and CUN-BAE Equation to Predict Body Fat in Adults. PLOS. doi:10.1371/journal.pone.0122291

Howley, E. T., & Thompson, L. D. (1943). Fitness Professional's Handboook (6th ed.). Human Kinetics.

Jebb, S. A., Siervo, M., Murgatroyd, P. R., Evans, S., Frühbeck, G., & Prentice, A. M. (2007). Validity of the leg-to-leg bioimpedance to estimate changes in body fat during weight loss and regain in overweight women: a comparison with multi-compartment models. International Journal of Obesity (31), 756–762. doi:doi:10.1038/sj.ijo.0803475

Johnson, R. W. (1996). Fitting Percentage of Body Fat to Simple Body Measurements. Journal of Statistics Education, 4(1).

Kujawa, KI, Loan, MV, Conway, JM, Stewart, WL, and Hodgdon, JA. (2002). Validity of Navy circumference body fat equation in women of African-American, Asian, Hispanic and Filipina descent. Med Sci Sports Exerc 34: S238

Kutac, P., Gajda, V., Pridalova, M., & Smajstrla, V. (2008). Validity of Measuring Body Composition by Means of the BIA Method. New Medicine, 89-93. Retrieved September 28, 2015, from http://www.czytelniamedyczna.pl/1067,validity-of-measuring-body-composition-by-means-of-the-bia-method.html

Lohman T. G., Caballero B., Himes J.H., Davis C.E., Stewart D., Houtkooper L., Going S.B., Hunsberger S., Weber J.L., Reid R., Stephenson L. (2000). Estimation of body fat from anthropometry and bioelectrical impedance in Native American children. Int J Obes Relat Metab Disord. 2000 Aug;24(8):982-8.

Ranasinghe, C., Gamage, P., Katulanda, P., Andraweera, N., Thilakarathne, S., & Tharanga, P. (2013). Relationship between Body mass index (BMI) and body fat percentage, estimated by bioelectrical impedance, in a group of Sri Lankan adults: a cross sectional study. BMC Public Health, 1-8.

Sen, B., Bose, K., Shaikh, S., & Mahalanabis, D. (2010). Prediction Equations for Body-fat Percentage in Indian Infants and Young Children Using Skinfold Thickness and Mid-arm Circumference. J HEALTH POPUL NUTR, 28(3), 211-229. Retrieved July 04, 2015, from http://www.bioline.org.br/pdf?hn10029

Tanita. (2015). Retrieved from Scalesmart: https://www.scalesmart.com/body-composition-analysers-tanita

Visser, M., Heuvel, E. V., and Deurenberg, P. (1994). Prediction equations for the estimation of body composition in the elderly using anthropometric data. British Journal of Nutrition, 71, 823-833.

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The Benefits of Physical Activity for Health and Well-being Case Menopausal Women

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Abstract

Obesity is a global public health issue. Having a BMI over 25 kg/m2 at the start of menopause is a significant risk factor for fatal morbidity. The objectives of this study is to determine the benefits of physical activity on maintaining Body mass index components for health and well-being case menopause. For the propose, a total of 32 menopausal women 16 from them are engaged in planned physical activity, in the opposite of the second group present in this comparative study. Body mass index (BMI) was calculated from weight and height. Blood was withdrawn after an overnight fast from the antecubital vein. Triacylglycerols, total cholesterol and HDL-cholesterol levels in plasma were determined using colorimetric methods and Randox commercial kits. Plasma LDL-cholesterol concentrations were calculated according to the Friedewald formula.

Based on them results and the statistical analysis applied, we confirm:

- There is Strong and significant positive associations between physical fitness and BMI.
- There is Strong and significant positive associations between BMI and health well-being in benefits of the practice physical activity

Keywords: physical activity, health and well-being, menopausal women.

1. Introduction

Menopause is a natural phenomenon that occurs in all women as they age and enter their sixth decade of life (Margaret Rees, Sally Louise Hope, Veronica A. Ravnikar, 2005). The average age at the last menstrual period is 51 years for women in industrialized countries, with most women reaching menopause between ages 45 and 55 and the normal range spanning ages 40 to 60 (Irving B. Weiner, W. Edward Craighead, 2010). In Western biomedical literature, menopause is defined as an estrogen deficiency disease or as an ovarian dysfunction producing (Paul Van Look, Kristian Heggenhougen, Stella R. Quah, 2011). According to (Alice J. Dan, Linda L. Lewis, 1992) as a result, 21 % of the physicians saw menopause as a major health problem (Grace Baruch, 2012). Whereas (Dora Kohen, 2014) Two major health problems associated with the menopause include osteoporosis and cardiovascular disease. While (Alka Pandey, Navneet Magon, 2015) confirm that

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Menopausal transition brings about anomalies in total body composition characterized by an increased body fat mass. For this propose, our research sample was consisted by 32 menopausal women 16 from them are engaged in planned physical activity, in the opposite of the second group present in this comparative study. Where our background indicate that the Menopause is usually a most challenging transition (J.M. Swartz M.D., Y.L. Wright M.A., 2015) comprises the changes in Body Weight, Body Fat Distribution, and Hormonal due to diet, exercise, and many other factors (Rodolfo Paoletti, P.G. Crosignani, P. Kenemans, G. Samsioe, Maurizio Soma, Ann S. Jackson, 2012).

2. Methodology

Subjects

We studied a sample of 32 menopausal women. They were selected from 48 volunteers because they agreed to venous blood withdrawal under fasting conditions. All participants were healthy non-smokers and not taking any medication on a regular basis, 16 from them are engaged in planned physical activity (aerobic and swimming programs) for 3 hours' pre-week in the opposite of the second group which preferred stay at home. They were informed about procedures and all provided their written consent. The study protocol was accepted by our physiologist professor institute Physical Education and sport university of Mostaganem for the academic years 2015–2016.

Testing Protocol

Anthropometric measurements

Body mass was measured to the nearest 0.1 kg and body height to the nearest 0.5 cm using standard medical equipment in subjects wearing light indoor clothing without shoes, jackets and sweaters. Body mass index (BMI) was calculated as body mass (kg) divided by height (m) squared. The subjects' adiposity was classified according to WHO standards: underweight was defined as BMI < 18.5, normal weight as BMI ≥ 18.5 and <25, overweight as BMI ≥ 25 to BMI <30, and obesity as a BMI ≥30 (Marzena Malara, Anna Kęska, Joanna Tkaczyk and Grażyna Lutosławska, 2015) (W H O, 2010).

Blood tests

Our intervention in this study is limited in the analysis of medical assessments:

Triacylglycerol's (TG), total cholesterol (TC), and cholesterol were assayed calorimetrically. All variables were determined using commercial kits (laboratory of Dr. Bajaj Committee Zhana). All analyses were run in duplicate for the two groups. All results used in this research are derived from medical assessment of passions.

Statistical Analyses

Data analysis was performed using SPSS 22.0 for Windows (32BIT). Data obtained from the tests showed a normal distribution and were presented as mean ± standard deviation. Independent T sample t-test was conducted to combine the results obtained from the two groups where the relationship between the two groups was analysed by Pearson correlations (r).

3. Results

The characteristics of the study sample is presented in Table 1. Where all comparisons with the Shapiro-Wilk test as the normality and Levene Statistic as the homogeneity where p values are greater than ≤ 0.05. whereas all the comparisons with independent t-test are significant in the opposite of Age.

Table 1. shows the Anthropometric characteristics and biochemical variables in Sample

variables		means	SD	Shapiro-Wilk test			Levene Statistic	Sig.	T	Sig.
				Statistic	df1	Sig.				
weight	Inactive	80,44	2,75	0,92	16	0,151	2,70	0,11	7,28	0,00
	Sport	71,40	4,13	0, 96	16	0,659				

BMI	Inactive	29,63	1,23	0,94	16	0,343	1,59	0,22	7,52	0,00
	Sport	26,70	0,95	0,95	16	0,465				
TC (g/l)	Inactive	1,35	0,11	0,93	16	0,248	2,87	0,10	7,65	0,00
	Sport	1,12	0,07	0,94	16	0,349				
TG	Inactive	1,37	0,07	0,91	16	0,110	1,08	0,31	4,77	0,00
	Sport	1,26	0,058	0,94	16	0,332				
AGE	Inactive	50,06	2,08	0,93	16	0,228	0,03	0,86	1,47	0,15
	Sport	49,00	2,00	0,92	16	0,153				

According to the Pearson Correlation through the table 2 all the correlations are strong positive between the variables chosen to study.

Table 2. shows the correlations between the variables Weight, BMI, Triacylglycerol's (TG), and total cholesterol (TC) chosen to study

		weight	BMI	TC	TG
weight	Pearson Correlation	1	0,896**	0,906**	0,837**
	Sig. (2-tailed)		,000	,000	,000
BMI	Pearson Correlation	0,896**	1	0,941**	0,922**
	Sig. (2-tailed)	0,000		0,000	0,000
TC	Pearson Correlation	0,906**	0,941**	1	0,868**
	Sig. (2-tailed)	0,000	0,000		0,000
TG	Pearson Correlation	0,837**	0,922**	0,868**	1
	Sig. (2-tailed)	0,000	0,000	0,000	
	N	32	32	32	32
**. Correlation is significant at the 0.01 level (2-tailed).					

4. Discussion

According to the weight our menopausal sportive women have less body gain than the menopausal women which does not practice sport Though that we agree (Kathryn R. Simpson, Dale E. Bredesen, 2006) that weight gain is just one symptom of hormonal imbalance, it's a problem that plagues many women, particularly after menopause. While (Leigh Bivens, 2014) confirm that the Risks of Weight gain during menopause involves more than just how we look, as major health issues. Where (Mickey Harpaz, Robert Wolff, 2012) reported that their gravities return to women dieters do not exercise the case of our study. Based on BMI values we agree (Stanley P. Brown, Wayne C. Miller, Jane M. Eason, 2006) that Women's percent body fat increases after menopause, due to a decline in lean body mass and an increase in body fat. From the proof we accept that During menopause transition estrogen decrease affects metabolism and body fat distribution (Caroline J. Hollins Martin, Ronald Ross Watson, Victor R. Preedy , 2013).where our background confirm that Menopause is associated with an increase in concentration of triacylglycerol (TG), total cholesterol (TC) (Danik M. Martirosyan, 2008). In conclusion we agree (Marc A. Fritz, Leon Speroff, 2012) that body fat distribution in women is positively correlated with increases in total cholesterol, triglycerides, and LDL-cholesterol . Whereas in our case study we agreed that the risk begin if the serum cholesterol is greater than 200 mg/dL and serum triglycerides greater than 150 mg/dL (Pothuri Radha Krishna Murthy , 2013). From the proof as the results we confirm by (Liane Deligdisch, Nathan G. Kase, Carmel J. Cohen , 2013) that the menopause transition is also characterized by significant changes in body composition, including increments in weight and fat mass, and a higher prevalence of metabolic syndrome and the coronary heart disease risk (Courtney Dianne Perry, 2007) due to lifestyle chosen by women (Barbara Hoffman, John Schorge, Joseph Schaffer , 2012) where our find confirm that increased BMI is associated more with aging and low physical activity than stage of menopause (Paola S. Timiras , 2007).

5. Conclusion

Our baseline study consists on the benefits of physical activity for health and well-being case menopausal women (Barbara Sternfeld, Sheila Dugan, 2011). Where this current research leads us to the fact of the habitual participation in physical activity results in many healths benefits, including decreased risk of changes in body composition (increased fat mass and decreased lean mass) and less risk cardiorespiratory due to estrogen decrease (Joyce J. Fitzpatrick, PhD, MBA, RN, FAAN, Meredith Kazer, PhD, APRN, A/GNP-BC, 2011) which influences metabolic diseases during the menopausal transition (Duru Shah, Sudeshna Ray, 2013). whereas the risk returns to the weight gain, which increases the levels of blood lipids, including total cholesterol, triglycerides, and low- density lipoprotein cholesterol (Wener W.K. Hoeger, Sharon A. Hoeger , 2016). From the proofs we recommend our menopausal women to practice physical fitness (W.H. Utian, 2012). Where (Kate Bracy, 2008) confirms that Exercise for Life is a wonderful start for preparing women to meet menopause with open arms. From the above the Health status at the menopause is largely determined by prior life experiences including the physical activity (W H O, 1996) explained by higher BMI (Tseng LA, El Khoudary SR, Young EA, Farhat GN, Sowers M, Sutton-Tyrrell K, Newman AB., 2012) and the changes in hormone secretion (Sarah E. Romans, Mary Violette Seeman, 2006).

References

Rodolfo Paoletti, P.G. Crosignani, P. Kenemans, G. Samsioe, Maurizio Soma, Ann S. Jackson. (2012). Women's Health and Menopause: Risk Reduction Strategies. UK: Springer Shop.

Alice J. Dan, Linda L. Lewis. (1992). *Menstrual Health in Women's Lives*. US: University of Illinois Press.

Alka Pandey, Navneet Magon. (2015). *Screening in Obstetrics & Gynecology*. New Delhi: A Fogsi Publication.

Barbara Hoffman, John Schorge, Joseph Schaffer. (2012). *Williams Gynecology, Second Edition*. US: McGraw Hill Professional.

Barbara Sternfeld, Sheila Dugan. (2011). Physical Activity and Health During the Menopausal Transition. *Obstet Gynecol Clin North Am, 38*(3), 537–566. doi:10.1016/j.ogc.2011.05.008

Caroline J. Hollins Martin, Ronald Ross Watson, Victor R. Preedy. (2013). *Nutrition and Diet in Menopause*. UK: Springer Shop.

Courtney Dianne Perry. (2007). *Relationship of Centrally-located Body Fat to Inflammatory Markers in postmenopausal*. US: ProQuest.

Danik M. Martirosyan. (2008). *Functional Foods for Chronic Diseases: Advances in the Development of*. US: D&A Inc.

Dora Kohen. (2014). *Women and Mental Health*. UK: Routledge.

Duru Shah, Sudeshna Ray. (2013). *Clinical Progress in Obstetrics & Gynecology*. India: Jaypee Brothers Medical Publishers.

Grace Baruch. (2012). *Women in Midlife*. UK: Springer Shop.

Irving B. Weiner, W. Edward Craighead. (2010). *The Corsini Encyclopedia of Psychology - Volume 3*. US: Wiley.com.

J.M. Swartz M.D., Y.L. Wright M.A. (2015). *The Wisdom of Bioidentical Hormones In Menopause, Perimenopause, and Permenopause*. US: Lulu.com.

Joyce J. Fitzpatrick, PhD, MBA, RN, FAAN, Meredith Kazer, PhD, APRN, A/GNP-BC. (2011). *Encyclopedia of Nursing Research, Third Edition*. UK: Springer Publishing Company.

Kate Bracy. (2008). *Your Guide to Health: Menopause: Practical Information and Advice to Keep*. US: Everything Books.

Kathryn R. Simpson, Dale E. Bredesen. (2006). *The Perimenopause & Menopause Workbook: A Comprehensive, Personalized Guide*. US: New Harbinger Publications.

Leigh Bivens. (2014). *I'm Not CrAzY, It's Ms. MenoPause!* US: Lulu.com.

Liane Deligdisch, Nathan G. Kase, Carmel J. Cohen. (2013). *Altchek's Diagnosis and Management of Ovarian Disorders*. UK: Cambridge University Press.

Marc A. Fritz, Leon Speroff. (2012). *Clinical Gynecologic Endocrinology and Infertility*. US: Wolters Kluwer Health.

Margaret Rees, Sally Louise Hope, Veronica A. Ravnikar. (2005). *The Abnormal Menstrual Cycle*. US: CRC Press.

Marzena Malara, Anna Kęska, Joanna Tkaczyk and Grażyna Lutosławska. (2015). Body shape index versus body mass index as correlates of health risk in young healthy sedentary men. *Journal of Translational Medicine, 13*(75), 1-6. doi:10.1186/s12967-015-0426-z

Mickey Harpaz, Robert Wolff. (2012). *Menopause Reset!: Reverse Weight Gain, Speed Fat Loss, and Get Your Body*. US: Rodale.

Paola S. Timiras. (2007). *Physiological Basis of Aging and Geriatrics, Fourth Edition*. US: CRC Press.

Paul Van Look, Kristian Heggenhougen, Stella R. Quah. (2011). *Sexual and Reproductive Health: A Public Health Perspective*. US: Elsevier.

Pothuri Radha Krishna Murthy. (2013). *Heart in Fours: Cardiology for Residents and Practitioners*. New Delhi: Japee Brothers Medical publishers.

Sarah E. Romans, Mary Violette Seeman. (2006). *Women's Mental Health: A Life-cycle Approach*. US: Wolters Kluwer Health.

Stanley P. Brown, Wayne C. Miller, Jane M. Eason. (2006). *Exercise Physiology: Basis of Human Movement in Health and Disease*. US: Wolters Kluwer Health.

Tseng LA, El Khoudary SR, Young EA, Farhat GN, Sowers M, Sutton-Tyrrell K, Newman AB. (2012). The association of menopause status with physical function: the Study of Women's Health Across the Nation. *Menopause, 19*(11), 1186-92. doi:10.1097/gme.0b013e3182565740.

W H O. (1996). *Research on the Menopause in the 1990s*. FR: World Health Organization.

W H O. (2010). *World Health Statistics*. FR: World Health Organization.

W.H. Utian. (2012). *The Menopause Manual: A woman's guide to the menopause*. UK: Springer Shop.

Wener W.K. Hoeger, Sharon A. Hoeger. (2016). *Fitness and Wellness*. US: CengageBrain.com.