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Systematic review

THE EFFECTS OF EXERCISE PROGRAMS ON VISUALLY IMPAIRED CHILDREN: A SYSTEMATIC REVIEW STUDY

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Abstract. *The objective of this study is to determine the effects of programs of physical exercise on visually-impaired children and to provide guidelines for further research and practice with the population in question. Nine electronic databases were searched to identify relevant articles. The search included papers published between 1990 and 2013. The following keywords were used for the searches: visual impairments, blindness, disability, amblyopia, children, physical activity, and sports activity. The retrieved study titles, abstracts and whole papers were read and analyzed. In order for a study to be included in the final analysis, it had to satisfy the following criteria: first, the study had to include both an experimental and a control group, and second, the participants had to be aged between 7 and 18 years. The four studies satisfied the criteria set. The small number of studies collected for analysis point to an unfortunate deficit in terms of information resulting from focused scientific research regarding the effects of exercise programs on the anthropological status of visually impaired children. This calls attention to the need for more future research in this area. The results of the analyzed studies indicate that exercise programs at least 8 weeks in duration with a weekly frequency of two or three practices each lasting 50 minutes (30 minutes of effective physical exercise) had a beneficial effect and led to an improvement in functional, motor and physiological characteristics in visually-impaired children.*

Key words: *physical exercise, visually-impaired, children, systematic review*

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INTRODUCTION

Physical activity has a positive effect on the quality of life, health, mental stability, motivation and self-confidence in persons with disability (Hinckson et al., 2013; Heller et al., 2014). The benefits of participating in sports and recreational activities for people with disability have been quoted in the literature as the cause of improved integration within the community, enhanced quality of life, feelings of contentment and wellbeing, trust in oneself and one's abilities, as well as the development of social skills like interaction and access to other social actors (Bačanac et al., 2014). However, various barriers make access to physical activities more difficult for children and adults with disability (Mulligan et al., 2012; Shields et al., 2012). Due to these barriers, participation in physical activities is lower in children with disability than in their typically-developing peers (Capio et al., 2012; Carlon et al., 2013), and the same holds for visually-impaired and blind children (Aslan et al., 2012). As a consequence, the habit of doing sports is not acquired, which further results in hypokinesia-related modern illnesses, such as obesity, diabetes, postural disorders, diminished aerobic capacity, muscle atrophy, and many others with a cause-and-effect relationship (Pitetti et al., 2013). A lack of physical activity puts visually impaired children at a high risk of not developing the locomotor skills necessary for preserving general health and maintaining the fitness levels needed for performing everyday activities (Houwen, Hartman, & Visscher, 2009).

Vision-impaired children should be provided with the opportunity to participate in activities with children without disability (Foley, Tindall, Lieberman, & Kim, 2007). Exercise programs require adaptation for children with visual impairment (Columna, Davis, Lieberman, & Lytle, 2010), even regarding specific physical activities in order for the child to become acquainted with his or her individual requirements during different periods of growth and development (Blessing, McCrimmin, Stovall & Williford, 1993; Lieberman, Robinson, & Rollheiser, 2006; Stuart, Lieberman & Hand, 2006).

Studies to date have not yet provided a concrete answer to the question of the minimal amount of physical activity (according to type, intensity and range) required in order to engender a positive transformation of the characteristics of visually-impaired children. Seeing as how physical exercise during childhood is critical for better health, habits and general anthropological status (American College of Sports Medicine, 2013; Wargo et al., 2013), the objective of this study is to determine the effects of programs of physical exercise on visually-impaired children and to provide guidelines for further research and practice with the population in question.

METHODOLOGY

The following electronic databases were searched with a view to collecting the studies conducted to date on the effects of applying programs of exercise in children with visual impairment: PubMed/ Medline, PEDro, DOAJ, SPONET, SCIndex, HRČAK, ScienceDirect, Google Scholar and ERIC. The search included papers published between 1990 and 2013. The following keywords were used for the searches: visual impairments, blindness, disability, amblyopia, children, physical activity, sports activity. The retrieved study titles, abstracts and whole papers were read and analyzed. In order for a study to be included in the final analysis, it had to satisfy two criteria: first, the study had to include both an experimental and a control group, and second, the participants had to be aged

between 7 and 18 years. The studies which satisfied these criteria were analyzed and represented according to the following parameters: reference (the first letter of the author's name and year of publishing, the participant sample, age, total number, and participant sub-groups), the physical exercise program, program duration and study results.

THE RESULTS OF THE STUDY

The process of collecting, analyzing and eliminating the retrieved papers is presented in Figure 1. The collecting of studies based on keywords identified 806 studies. The number of studies eliminated immediately based on title, duplicate papers, as well as papers excluded based on the period when they were published (i.e., pre-1990) was 797, whereas 9 studies were included in further analysis. The further analysis of these 9 papers resulted in the exclusion of another 5 papers based on several criteria, including: the abstract revealing them to be systematic review studies; the lack of a program being applied, and instead providing only a comparison between two or more groups based on appropriate tests; the lack of a control group in the study, or the age of the study participants falling outside the scope of this study (i.e., persons younger than 7 or older than 18 years of age).

The 4 remaining studies satisfied the criteria set, as follows: the papers were published between 1990 and 2013, the participants were children with visual impairment, aged between 7 and 18, and the study included both an experimental and a control group. The modest number of papers meeting the set criteria can be explained by the fact that organizing research that includes people with disability can be very difficult.

The studies that met the set criteria were then analyzed and presented according to the following parameters: reference (the first letter of the author's name and the year of publishing), the participant sample (age, total number, and participant sub-groups), the program of physical exercise, the duration and intensity of the program, the testing instruments used, the results of the study, and its contribution.

1. The objective of the study by Jazi, Purrajabi, Movahedi, & Jalali (2012) was to determine whether balance practice had an effect on the dynamic balance in visually impaired children (VIC), based on the assumption that maintaining balance while walking is crucial for visually impaired people because the deficit of dynamic balance is linked to increased risk of falling.

The results obtained indicated that including VIC in a program of balance practice significantly increased their dynamic balance compared to the control group. The study demonstrated that, if VIC are instructed to perform balance-enhancing exercises, the results in terms of improving their dynamic balance can be excellent. With enhanced balance, visually-impaired subjects can minimize the possibility of falling and thus experience a healthier way of life.

2. The study by Chao-Chien and Shih-Yen (2011) concluded that the exercise program did not have a significant effect on reducing the BMI of the participants, which was within the normal range for the age in question. In addition to the increase in the participants' aerobic physical activities, which this study did introduce, what also needs to be considered is the intake of foods of a specific caloric value, which could effect changes in the BMI of those tested. These results are in line with those obtained by other Chinese researchers. Rope-skipping practice for the duration of 10 weeks, applied in

visually-impaired children, can have a significant effect on increasing flexibility and aerobic capacity. Skipping rope can facilitate the overcoming of challenges such as reduced mobility and learning-related limitations in visually-impaired persons. The exercise equipment is easy to transport, one can exercise at any time of day, and organizing the practice does not require a lot of time or space.

3. Calıskan, Pehlivan, Erzeybek, Kayapınar, Agopyan, Yuksel & Dane (2011) demonstrate that activities including various movement skills for boys in particular and playing goalball for girls in particular can contribute to the enhancement of fitness and motor ability, although the authors believe that the reliability of the data obtained may have been compromised by maturation. Colak et al. (2004) write that visually-impaired children who did not play goalball performed poorly across all motor skills when compared against goalball-players. In this study, BMI was reduced in the entire goalball group. It was increased for the second group as a whole and for the boys from this group, but was decreased for the girls in this group. The authors conclude that this occurred due to a reduction in the percentage of fatty tissue, and that the BMI increase meant an increase in muscle mass.

4. The study by Colak et al. (2004) confirmed that practicing goalball can be viewed as an efficient option for improving motor skills in visually-impaired children, since the goalball-playing group's performance was superior in all motor tasks compared to the control group.

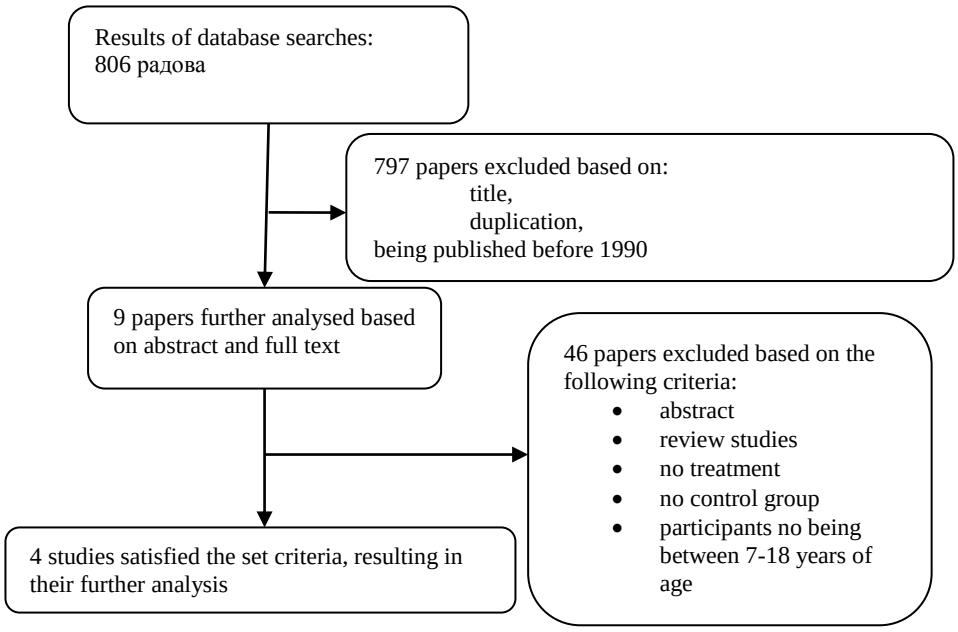

Fig. 1

Table 1 The statistics of studies to date in table form

Reference	Population	Group comparison	Treatment	Program duration and exercise intensity	Testing instruments	Study results
Jazi *et al.* (2012)	Visually impaired children; visual acuity in the more functional eye 20/70; excepting the VI they are in very good psycho-physical condition 8-14 years of age	1. EG (n= 9; 7 boys and 2 girls; 10.44 ± 1.59 years old) 2. CG (n=10; 5 boys and 5 girls; 10.10 ± 2.13 years old)	1. Balance training 2. Control group	60 minutes 2 pr./ week 8 weeks	MBTDB	EG: POT↑ CG: POT○
Chao-Chien & Shih-Yen (2011)	Visually impaired children 15-17 years of age (n = 16)	1. EG (n=8) 2. CG (n=8)	1. Skipping rope 2. Control group	50 minutes 3 pr./ week 10 weeks; BS - level 15 of RPE	BS RPE SART PACER test SU test BMI	EG: F↑ AC↑ SU○ BMI○ CG: all variables ○
Calıskan *et al.* (2011)	Seriously visually impaired children – blind 10-15 years of age (M-12.5; SD-1.5) (n=46, 26 boys and 20 girls)	1. GB (n = 22; 12 boys and 10 girls) 2.ME (n=24; 14 boys and 10 girls)	1. Goalball practice 2. Movement education	90 minutes 3 pr./ week 13 weeks	Holtain caliper BMI	GB: FTP↓ ME: FTP↓
Colak *et al.* (2004)	Sedentary children, volunteers, visually impaired, male, classified in 3 groups: B1, B2, B3 13-15 years of age (n= 103)	1. GP (n=51) 2. CG (n=52)	1 Goalball practice 2 Control group	6 hs/ week	Extremity flexibility Flamingo Balance Test (FBT) UICPT Jump-MD JamarDyna mometer HGS SART test	GP: F↑ UICPT↑ ESLE↑ HGS↑

VI – visual impairment; CG – control group; EG – experimental group; DB – dynamic balance; MBTDB – Modified Bass test of dynamic balance; PT (pre-test) – testing prior to treatment application; POT (post-test) – testing after treatment application; GP – goalball players; BS – the Borg scale of the Rating of Perceived Exertion (RPE) from 1962; SART – sit-and-reach test of flexibility; PACER test (Progressive Aerobic Cardiovascular Endurance Run) – aerobic capacity test; SU test (sit-up test) – repetitive abdominal muscle strength test; BMI - Body Mass Index; F – flexibility; AC – aerobic capacity; ME – movement education, exercise through movement; FTP – fatty tissue percentage; Visual impairment classification: B1 – no functional sight; B2 – reduced visual acuity – less than 20/400, or visual field reduced by 5 degrees; B3 – visual acuity 20/200-20/400, or field of vision reduced by 5 to 20 degrees; FBT - Flamingo Balance Test, standing as long as possible on one, preferred leg; BS3D - Biodex System-3 Dynamometer, instrument for measuring unilateral isokinetic concentric peak torque; JMD (Jump-MD)- instrument for measuring the explosive strength of lower extremities; HJD (Handle Jamar Dynamometer) – instrument for measuring hand-grip strength (HGS); UICPT – unilateral isokinetic concentric peak torque; ESLE – explosive strength of the lower extremities; HGS – hand grip strength, ↑ - statistically significant increase, ↓ - statistically significant decrease, ○ – no statistically significant changes

DISCUSSION

The studies included a total of 184 participants. The study by Colak et al. (2004) included the highest number of participants (n=103), while the lowest (n=16) was in the study by Chao-Chien & Shih-Yen (2011). The participant numbers in the two remaining studies, by Jazi et al. (2012) and Calıskan et al. (2011), were (n=19) and (n=46), respectively.

All four studies included participants with visual impairments, but with different levels or classifications thereof. In the first study (Jazi et al., 2012), participants' visual acuity in the better-functioning eye was 20/70; the second study (Chao-Chien, & Shih-Yen, 2011) did not provide a concrete classification or degree of impairment; participants in the third study (Calıskan et al., 2011) had serious visual impairment – total blindness; in the fourth (Colak et al., 2004), the participants were classified into three groups according to degree of impairment: B1 – no functional vision; B2 – reduced visual acuity of less than 20/400 or visual field less than 5 degrees; B3 – visual acuity of 20/200-20/400, or a reduced visual field of 5-20 degrees.

Participants in the four studies trained with a different range and frequency. In the first study (Jazi et al., 2012), participants practiced for a total of 8 weeks with a weekly frequency of 2 60-minute practices; in the second (Chao-Chien & Shih-Yen, 2011), participants practiced over 10 weeks with a weekly frequency of 3 practices of 50 minutes each; participants in the third study (Calıskan et al., 2011) trained for 3 months/13 weeks with a weekly frequency of 3 practices, each 90 minutes in duration; in the fourth study (Colak et al., 2004), participants trained for 6 hours every week (this was a group of goalball players who were in a systematic training regimen over an extended period of time not specified in the study.

Three of the studies (Jazi et al., 2012; Chao-Chien & Shih-Yen, 2011; Colak et al., 2004) included an experimental group undergoing the treatment and a control group which did not participate in any additional activities other than the usual everyday activities. The study by Calıskan et al. (2011) included two groups, each undergoing a specific physical activities treatment, of a different nature (but the same duration and frequency), which was followed by a comparison of the results obtained by testing at the beginning and end of the treatment.

Three of the four studies do not specify the stress intensity on the participants for the duration of the treatment. In the second study according to the numeration in the table presenting study statistics (Chao-Chien & Shih-Yen, 2011), stress intensity was measured by means of the 1962 Borg scale for the rating of perceived exertion, which classifies fatigue along a scale from 6 to 20. During the treatment, the intensity values varied across participants from 11 to 15, where level 11 was characterized as easy and level 15 as hard.

Two of the four studies describe the methods, instruments, as well as the duration and characteristic phases of the practice. In the first study (Jazi et al., 2012), the practice emphasized balance-enhancing exercises. It comprised movements such as standing still without rocking, standing while swaying arms back and forth simultaneously and rhythmically, and then accompanied with bending and extending the knee, games done standing up, crawling games (through a hoola-hoop, under a rope, over a rope, and finishing with a forward roll on a mat), rolling over, walking (along a straight line, forward and backward, along a curve, speed walking while changing direction, walking between two benches), hopping, skipping, galloping, jumping, jumping with feet together

from one side of a straight line to the other. The duration of the practice was 60 minutes. Each practice started with 10 minutes of warm-up and stretching exercises, followed by 45 minutes of balance exercises and ending with 5 minutes of cooling down exercises. In the second study (Chao-Chien, & Shih-Yen, 2011) the practice was 50 minutes long, with the following phases: 10 minutes of warm-up at the beginning of the practice, followed by 30 minutes of skipping rope (8 series of 2 minutes of activity alternating with 2 minutes of rest/ interval method), and 10-minute relaxation at the end of practice, with cooling down and stretching exercises.

In all four analyzed studies statistically significant changes occurred in the results of individual tests following the applied program. The studies emphasized the testing of functional abilities (different types of strength, speed, flexibility and balance) and morphological characteristics, that is, BMI (body mass index) and SFT (subcutaneous fatty tissue). The first study (Jazi et al., 2012) measured dynamic balance as a functional ability by means of the MBTDB (Modified Bass Test of Dynamic Balance). Both groups completed a balance test before and after the treatment. Pretest results showed no significant difference in balance abilities of the two groups. However, after the experimental group completed its training, the difference between the groups based on the completion of tasks in the post-test was significantly in favor of the experimental group 34.11 to 10.5; $t(18) = 4.095$, $p < 0.05$. Two studies (Chao-Chien, & Shih-Yen, 2011; Colak et al., 2004) measured hamstring, gluteal and lower back flexibility using SART (the sit-and-reach test). The results obtained indicated a statistical significance in the first study in favor of the experimental group ($p < .05$), while the analysis of the results obtained in the second study demonstrated a statistically significant difference in favor of the experimental group when comparing the two groups in classes B1 ($p < .02$) and B2 ($p < .04$), while no statistically significant differences were found in group B3 ($p < .06$). Only one study measured aerobic capacity (Chao-Chien, & Shih-Yen, 2011). The testing was done by means of the PACER (Progressive Aerobic Cardiovascular Endurance Run) method, where the comparison of the two groups revealed a statistically significant difference in favor of the experimental group ($p < .05$). In one of the four studies (Chao-Chien, & Shih-Yen, 2011) the repetitive strength of stomach muscles was measured by means of the SU (sit-up) test, with the result showing that there was no statistically significant difference between the tested groups, and the conclusion that this was the result of rope-skipping exercise having little influence on stomach muscle strength.

Two studies (Chao-Chien, & Shih-Yen, 2011; Calıskan et al., 2011) measured BMI. In the first, no statistically significant differences were found, with the authors noting that a more substantial BMI reduction could occur if a special diet was introduced along with increased physical activity. In the second study, all BMI-related measurements produced statistically significant results ($p < .05$). There was a reduction in BMI across the entire goalball group. BMI increased for the second group as a whole and for the boys from the second group, and decreased for the girls in this group. The study authors believed this was the result of a decrease in the percentage of fat tissue, and that the increased BMI in the men in the second group meant an increase in muscle mass. Only one of the four studies (Calıskan et al., 2011) measured the percentage of body fat (PBF) in the participants. Testing was done using the Holtain skinfold caliper, which showed a significant reduction in PBF in participants in both groups ($p < .05$; $p < 0.001$ – only for the male group); however, analysis of the results did not show statistically significant differences when comparing the two groups of participants. One of the four studies measured abilities such as static balance – using the Flamingo Balance Test (FBT); unilateral isokinetic concentric

peak torque - using the Biodex System-3 Dynamometer (BS3D); explosive strength of the lower extremities - using the Jump-MD (JMD); hand-grip strength – using the Jamar Hand Dynamometer (JHD), with all the results showing a statistically significant difference ($p < .05$) between the two groups tested, in favor of the experimental group.

CONCLUSION

The small number of studies collected for analysis points to an unfortunate deficit in terms of information resulting from focused scientific research regarding the effects of exercise programs on the anthropological status of visually impaired children. This calls attention to a need for more future research in this area. The results of the analyzed studies indicate that exercise programs at least 8 weeks in duration with a weekly frequency of two or three practices each lasting 50 minutes (30 minutes of effective physical exercise) had a beneficial effect and led to an improvement in functional, motor and physiological characteristics in visually-impaired children.

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EFEKTI PROGRAMA VEŽBANJA KOD SLABOVIDE DECE: SISTEMATSKO PREGLEDNO ISTRAŽIVANJE

Cilj ovog istraživanja je da se utvrde efekti programa fizičkog vežbanja na decu oštećenog vida i da se obezbede smernice za dalja istraživanja i praksu sa stanovništvom. Devet elektronskih baza podataka su pretražene da bi se identifikovali relevantni članci. Pretraživani su radovi objavljeni između 1990. i 2013. godine. Za pretraživanje korišćene su sledeće ključne reči: oštećenje vida, slepilo, invaliditet, ambliopija, deca, fizička aktivnost i sportske aktivnosti. Pronađena istraživanja, njihovi naslovi, apstrakti i čitavi radovi su pročitani i analizirani. Da bi istraživanje bilo uključeno u konačnu analizu, mora da zadovolji sledeće kriterijume: prvo, studija je morala da obuhvati i eksperimentalnu i kontrolnu grupu, i drugo, učesnici su morali da budu starosti između 7 i 18 godina. Četiri studije je zadovoljilo kriterijume. Mali broj studija prikupljenih za analizu, ukazuje na deficit rezultata naučnih istraživanja fokusiranih na efekte programa vežbanja na antropološki status dece oštećenog vida. To ukazuje na potrebu za većim brojem istraživanja u ovoj oblasti. Rezultati analiziranih studija ukazuju da programi vežbanja od najmanje 8 nedelja sa nedeljnom frekvencijiom od dva ili tri puta, koji traju 50 minuta (30 minuta efektivne fizičke vežbe) imaju pozitivan efekat i doveli su do poboljšanja u funkcionalnim, motoričkim i fizioloških sposobnostima dece oštećenog vida.

Ključne reči: *fizičke vežbe, oštećenje vida, deca, sistematsko pregledno istraživanje.*