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Effect of startup circuit exercise on derivatives reactive oxygen metabolites, biological antioxidant potential levels and physical fitness of adolescents boys with intellectual disabilities

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The purpose of this study was to examine the effect of starup circuit exercise program on derivatives reactive oxygen metabolite (d-ROM) and biological antioxidant potential (BAP) levels and physical fitness of adolescents with intellectual disabilities, and to sugesst exercise programs to promote the health and physical development of such adolescents. Twelve students with intellectual disabilities were divided into two groups; circuit exercise group (CE group: n=6; age, 14.83±0.98 years; height, 163.83±5.78 cm; body mass, 67.08±3.32 kg; %Fat, 25.68±2.42), control group (CON group: n=6; age: 15.00±0.63 years; height, 162.33±4.41 cm; body mass, 67.50±3.62 kg; %Fat, 26.96±2.06). The CE group performed the CE program 4 times a week over a 12-week period. The CON group maintained their activities of daily living. The following were measured before and after intervention: physical fitness by before and after the completion of the training programm, and were measured and blood samples were assessed. The results of the study indicate that the 12-week CE program increased significantly physical fitness ($P<0.05$). Furthermore, This study proved that the CE program improved physical fitness, and reduced the d-ROM levels, and increased the BAP levels of the adolescents with intellectual disabilities. Therefore, it may enhance the health and physical development of adolescents boys with intellectual disabilities.

Keywords: Intellectual disabilities, Circuit exercise, Derivatives reactive oxygen metabolite, Biological antioxidant potential, Physical fitness

INTRODUCTION

People with intellectual disabilities have lower-than-average intellectual levels, and in particular, adolescents with intellectual disabilities have higher risks for cardiovascular disease and obesity that lead to type 2 diabetes mellitus via hypoactivity (Sherrill, 2004; Takeuchi, 1994). They have slower walking speed because of their inability to control balance, coordination well, and perform physical activities efficiently with their weakened muscular strength, endurance, agility, and motor reaction (Pitetti et al., 1993).

Furthermore, people with intellectual disabilities tend to have high levels of reactive oxygen species (ROS) due to hypoactivity. More than 95% of ingested oxygen in the human body is combined with electrons produced from the energy metabolism of cells and reduced to water, but 2%–3% of oxygen is reduced incompletely and generates free radicals (Alessio, 1993; Halliwell and Gutteridge, 2007). Excessive physical activity causes formation of free radicals that leads to increases in oxidative stress and, finally, to negative effects (Gröger et al., 2005; Oter et al., 2005). However, the human body deals with ROS through its antioxidant capacity, which can be increased by regular physical activity (Jenkins et al., 1984; Miyazaki et al., 2001). Adolescents with intellectual disabilities lack physical activity, which not only inconvenience daily life but also confers potential health risks with the reduced physical fitness. Therefore, it is important for such adolescents to work out regularly to improve their performance in ac-

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tivities in daily life and general health.

Generally, regular aerobic exercise has positive effects on body composition; similarly, resistance exercise also improves body composition by improving oxidative energy metabolic capability (American College of Sports Medicine, 2009). Advanced research studies on exercise, which investigated the effects of aerobic exercise on ROS and antioxidant capacity (Ashton et al., 1998; Bloomer and Goldfarb, 2004; Sureda et al., 2009) and the effects of resistance exercise on oxidative stress levels and antioxidant capacity (Close et al., 2004; Groussard et al., 2003; Ramel et al., 2004), demonstrated the positive effects of aerobic and anaerobic exercises on ROS levels and antioxidant capacity. However, the subjects of these studies were people without disabilities, and data from research studies on the effects of regular exercise on ROS and antioxidant capacity in adolescents with intellectual disabilities are not sufficient to be conclusive.

When designing an exercise program for adolescents with intellectual disabilities, findings from studies on the effects of regular exercise on ROS, antioxidant capacity, and physical fitness should be considered. Adolescents with intellectual disabilities have weakened body coordination and movement ability as results from their inability to smoothly control muscle groups in each body part (Dixon-Ibarra et al., 2013), and they are easily distracted, making their attention span short. Therefore, continuous anaerobic exercise may be undesirable. A new exercise program should be developed for adolescents with intellectual disabilities that could enhance their body balance and that involves frequent changes in body movement to prevent them from being bored, with consideration of their features rather than just repeating simple exercises. Circuit exercise (CE) may a good starter program for children population who are overweight or obese because it includes only short bouts of cardiovascular components (2 min in length) coupled with strength training (Davis et al., 2011).

Thus, this study aimed to investigate an CE program for the health improvement and growth development of adolescents with intellectual disabilities by examining the effects of complex exercise program on physical fitness, derivatives reactive oxygen metabolite (d-ROM) level, and biological antioxidant potential (BAP) levels with consideration of the features of adolescents with intellectual disabilities.

MATERIALS AND METHODS

Participants

Twelve adolescents boys with intellectual disabilities between 14 and 16 years old who were from Incheon city participated in the study. The participants were judged to have class 1, 2, or 3 intellectual disabilities, and could be rehabilitated in society and profession by education. The participants were randomly classified into CE group (n=6; age, 14.83±0.98 years; height, 163.83±5.78 cm; body mass, 67.08±3.32 kg; %Fat, 25.68±2.42), and control group (n=6; age: 15.00±0.63 years; height, 162.33±4.41 cm; body mass, 67.50±3.62 kg; %Fat, 26.96±2.06). This study was approved by the Department of Sports Sciences, University of Gachon, and complied with the requirements for human experimentation. After medical screening to rule out any conditions that might have precluded their participation, all the subjects provided written informed consent.

Study design

To examine the effects of CE program on d-ROM, BAP levels and physical fitness, we conducted the participants in the exercise group to exercise 4 times per week for 12 weeks. The height (cm), body mass (kg), and body fat percent (%) were measured before and after the completion of the exercise program using an automatic height/weight measurement system (BSM340, Biospace Co., Seoul, Korea). The physical fitness were measured and resting blood samples were obtained before and after the completion of the exercise program.

CE program

The CE program was conducted for 40 min per session, 4 times every 12 weeks. The components of the exercise program are detailed in Table 1. The total exercise program consists of warming up for 5 min, exercising for 30–45 min, and cooling down for 5 min. The participants mainly did stretching for warm-up and cool-down, and used tools such as an elastic band and medicine ball in exercises for fitness development.

All exercises were fully explained and previously demonstrated by the researcher and instructor, and participants were asked to try them during a few minutes before strating the first session of the CE. The researcher and instructor gave positive feedback to motivate intellectual disabilities in chieving it (Badami et al., 2011).

Physical fitness

The physical fitness were measured before and after the completion of the exercise program. A basic fitness measurement system (THP2, Nurytec Co., Seoul, Korea) was used to assess the health-related fitness, and muscular strength (grip and back strengths), and measure muscular endurance (sit-up) and flexibility (sit and

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Table 1. The circuit exercise program

Level 1: Weeks 1–4 (35 min)
5-min warm-up; stretching
25-min 4 circuits: each consisted of three strength exercise (elastic-band exercise and medicine ball exercise) and two cardiovascular exercises (side-step, jumping jack) (each 30 sec)
5-min cooling-down: stretching
Exercise intensity:
Elastic band (yellow, 0.7–1 kg)
Medicine ball (1 kg)
Side-step, jumping jack (RPE, 9–11)
Level 2: Weeks 5–8 (40 min)
5-min warm-up; stretching
30-min 5 circuits: each consisted of three strength exercise (elastic-band exercise and medicine ball exercise) and two cardiovascular exercises (side-step, jumping jack) (each 1 min)
5-min cooling-down; stretching
Exercise intensity:
Elastic band (yellow, 0.7–1 kg)
Medicine ball (2 kg)
Side-step, jumping jack (RPE, 11–13)
Level 3: Weeks 9–12 (45 min)
5-min warm-up; stretching
35-min 6 circuits: each consisted of three strength exercise (elastic-band exercise and medicine ball exercise) and two cardiovascular exercises (side-step, jumping jack) (each 1 min)
5-min cooling-down; stretching
Exercise intensity:
Elastic band (red, 0.9–1.6 kg)
Medicine ball (2 kg)
Side-step, jumping jack (RPE, 13–15)

reach). To measure grip strength, the participants were trained to squeeze a dynamometer as hard as they could; measurement was performed twice for each hand, recording the higher value. In case of back strength, they were trained to pull utmost only with waist force while holding bars, with their backs straightened; measurement was performed twice, recording the higher value. For the sit-up measurements, beginning with a lying position, the participants were trained to lift their upper body up to the angle of a sensor, holding the position for 1 min to allow the sensor to record the movement and then the total number of sit-ups made. In the sit-and-reach measurement, the subject stretched the upper body and hands forward, seating with the feet stretched, soles fixed to the measurement stand, with one hand on the other hand. Measurement was performed twice, with the higher mark recorded. The grip and back strength were calculated by the relative value considering body mass. The body fat percent were measured before and after the completion of the exercise program using an automatic height/body mass measurement system (BSM340). All the measurements were conducted after the participants had sufficient training on the exercises.

Analysis of d-ROM and BAP levels

The blood samples were collected 7 days before and 3 days after completion exercise program. The participants remained in a hunger state for 8 hr and were forbidden to engage in extreme sports until blood sampling from the fingertip capillary. The d-ROM and BAP levels tests were used to assess oxidative stress and antioxidant capacity levels (Kim and Lee, 2013; Tamaki et al., 2008), using the International Scientific Community-certified oxidative stress analysis system (FRAS Evolvo, H&D srl, Parma, Italy). Measurement of the d-ROM levels were based on the ability of transition metals to catalyze, in the presence of peroxides, the formation of free radicals, which are trapped by an alchilamine. The d-ROM levels were expressed as CARR U. It has been established that 1 CARR U corresponds to 0.08-mg/dL hydrogen peroxide (Komatsu et al., 2006; Tamaki et al., 2008). From the manugacturer's instructions, the following classigication was made: very high oxidative stress, above 500 CARR U; high oxidative stress, from 401 to 500 CARR U; middle oxidative stress, from 341 to 400 CARR U; slight oxidative stress, from 321 to 340 CARR U; border-line, from 301 to 320 CARR U; and normal, from 250 to 300 CARR U. The BAP levels were expressed as μmol/L. The manufacturer's instruction shows the following classigication: optimum range, from 2,201 to 4,000 μmol/L; border line, from 2,001 to 2,200 μmol/L; moderate shortage from 1,801 to 2,000 μmol/L; shortage, from 1,601 to 1,800 μmol/L; severe shortage, from 1,401 to 1,600 μmol/L; and very severe shortage, less than 1,400 μmol/L.

Statistical analysis

A statistical analysis was performed using the IBM SPSS Statistics ver. 21.0 (IBM Co., Armonk, NY, USA), and mean and standard deviations were calculated as descriptive statistics. Two-way analysis of variance by repeated measure was used to analyze the differences between groups and time. Effect sizes were determined by the formula: (mean1–mean2)/pooled standard deviation for the differences in variables between groups. Statistical significance was set at $\alpha = 0.05$.

RESULTS

Changes in d-ROM and BAP levels after 12-week CE program

The changes in d-ROM and BAP levles after 12-week CE program were detailed in Table 2.

Table 2. The changes in d-ROM and BAP levels after the 12-week exercise program

Variable	Circuit exercise (n=6)		Control (n=6)		*P*-value			Effect size		
	Pre	Post	Pre	Post	Time[a]	Group[b]	Time × group	Time[a]	Group[b]	Time × group
d-ROMs (CARR U)	370.83 ± 48.65	319.67 ± 43.16	389.17 ± 37.92	392.00 ± 43.32	0.067	0.069	0.046	0.296	0.294	0.342
BAP (μmol/L)	2,300.83 ± 241.94	2,413.83 ± 289.19	2,205.33 ± 213.13	2,145.00 ± 182.99	0.202	0.318	0.006	0.157	0.100	0.545

Values are presented as mean ± standard deviation.
d-ROM, derivatives reactive oxygen metabolite; BAP, biological antioxidant potential.
[a]Pre vs. Post. [b]Circuit exercise vs. control.

Table 3. The changes in physical fitness after the 12-week exercise program

Variable	Circuit exercise (n=6)		CON (n=6)		P-value			Effect size		
	Pre	Post	Pre	Post	Time[a]	Group[b]	Time × group	Time[a]	Group[b]	Time × group
Left grip strength (kg/BM)	0.17 ± 0.09	0.21 ± 0.10	0.19 ± 0.06	0.18 ± 0.07	0.930	0.018	0.007	0.001	0.441	0.529
Right grip strength (kg/BM)	0.18 ± 0.87	0.23 ± 0.09	0.19 ± 0.05	0.19 ± 0.06	0.723	0.016	0.009	0.013	0.457	0.512
Back strength (kg/BM)	.028 ± .012	0.37 ± 0.18	0.28 ± .0.07	0.26 ± 0.05	0.457	0.055	0.006	0.056	0.320	0.548
Sit-up (count)	11.67 ± 5.35	14.67 ± 6.09	13.00 ± 6.23	13.17 ± 5.38	0.980	0.001	0.002	0.000	0.670	0.619
Sit and reach (cm)	-0.70 ± 4.88	2.88 ± 4.82	5.30 ± 7.18	5.07 ± 5.76	0.233	0.051	0.030	0.139	0.330	0.390
%Fat (%)	25.68 ± 2.42	25.27 ± 1.95	26.97 ± 2.06	27.18 ± 2.22	0.228	0.428	0.026	0.142	0.064	0.407

Values are presented as mean ± standard deviation.
BM, body mass.
[a]Pre vs. Post. [b]Circuit exercise vs. control.

The d-ROM and BAP levels were interaction effect between groups and times (respectively, $P<0.05$). The d-ROM levels significantly decreased after 12 weeks, and decreased more significantly in the CE group than in the control group (respectively, $P<0.05$). The BAP levels increased after completion of the exercise program in the CE group ($P<0.05$). These results mean that 12-week CE program had positive effects on oxidative stress and antioxidant capacity.

Changes in physical fitness after 12-week CE program

The changes in physical fitness after 12-week CE program were detailed in Table 3.

Among the physical fitness factors, right-left grip strength, back strength, muscular endurance, and flexibility, %fat were interaction effect between groups and times (respectively, $P<0.05$). In particular, right-left grip strength, back strength, muscular endurance, and flexibility more significantly increased in the CE group than in the control group (respectively, $P<0.05$), and %fat significantly decreased in the CE group than in the control group.

DISCUSSION

People with intellectual disabilities have more difficulty performing intense physical activities without faltering than people without disabilities; thus, they have a greater tendency to be sedentary (Rimmer et al., 2004). The weakened body coordination and movement ability in adolescents with intellectual disabilities result from their inability to smoothly control muscle groups in each body part (Dixon-Ibarra et al., 2013). In this study, the physical fitness of the CE group significantly improved after the 12-week CE program in terms of right-left grip strength, back strength, muscular endurance, and flexibility. This result indicates that the CE program conducted in this study induced improvement in muscular strength by stimulating different kinds of muscle groups through medicine ball exercises and improvement in coordination through strength and cardiovascular exercises. A decline in physical balance ability occurs owing to muscle weakness, proprioceptive function deficiency, and decrease in range of motion (Magee, 1992; Priplata et al., 2006; Wolfson et al., 1995). Many advanced studies reported that exercise using tools such as swiss balls and elastic bands stimulates proprioceptive function, improves movement sensation function, and effectively facilitates neuromuscular control (Carmeli et al., 2003; Lord et al., 1991; Marshall and Murphy, 2005). In addition, the CE programes in this study decreased the body fat. Most adolescents with intellectual disabilities are less movement. For this reason, the pro-

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nounced increase in body fat (Bertoli et al., 2006; Yamaki, 2005), and the adolescents with intellectual disability who are overweight or obese also present an elevated number of obesity-related secondary conditions such as high blood pressure, high blood cholesterol, diabetes, fatigue 10 compared to peers of a healthy weight (Rimmer et al., 2010). These results are consistent with studies which examine the effect of body fat following CE in Down syndrome (Rosety-Rodriguez et al., 2013).

Meanwhile, ROS has high reactivity and a short life compared with stable oxygen in the air; thus, it can facilitate the onset of many diseases by impairing biogenic substances during hypergenesis. When the oxydative stress levels exceeds that of the antioxidative system, it confers a negative effect on the human body (Gröger et al., 2005; Oter et al., 2005). However, advanced studies demonstrated that continuous physical activities increase adaptability that suppress accumulation of oxidative stress and decrease the active oxygen level in the blood by improving the oxidative defense of the body (Satoshi et al., 1989). In the present study, the d-ROM levels significantly decreased after 12-week CE group compared with that in the control group. This result is concurrent with those of advanced studies that reported improvement of cardiorespiratory function and oxydative stress levels in children who participated in an 8-week exercise program (Onur et al., 2011) and decreased oxidative stress in individuals who participated in regular exercise (Aoi and Sakuma, 2011). The previous studies reported that physical activities such as exercise could induce positive changes in active oxygen level (Aoi and Sakuma, 2011; Onur et al., 2011). Also, in the present study, the BAP levels significantly increased after 12-week CE group compared with that in the control group. In this regard, advanced research studies on exercise, which investigated the effects of aerobic exercise on ROS and antioxidant capacity (Ashton et al., 1998; Bloomer and Goldfarb, 2004; Sureda et al., 2009) and the effects of resistance exercise on oxidative stress levels and antioxidant capacity (Close et al., 2004; Groussard et al., 2003; Ramel et al., 2004). CE program in this study included the resistance and aerobic exercise. For this reason, it is considered that the similar result with the previous studies indicated.

In conclusion, this study proved that the CE program improved physical fitness, and reduced the d-ROM levels, and increased the BAP levels of the adolescents with intellectual disabilities. Therefore, it may enhance the health and physical development of adolescents boys with intellectual disabilities.

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

REFERENCES

Alessio HM. Exercise-induced oxidative stress. Med Sci Sports Exerc 1993;25:218-224.

American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 8th ed. Philadelphia (PA): Lippincott Williams & Wilkins; 2009.

Aoi W, Sakuma K. Oxidative stress and skeletal muscle dysfunction with aging. Curr Aging Sci 2011;4:101-109.

Ashton T, Rowlands CC, Jones E, Young IS, Jackson SK, Davies B, Peters JR. Electron spin resonance spectroscopic detection of oxygen-centred radicals in human serum following exhaustive exercise. Eur J Appl Physiol Occup Physiol 1998;77:498-502.

Badami R, VaezMousavi M, Wulf G, Namazizadeh M. Feedback after good versus poor trials affects intrinsic motivation. Res Q Exerc Sport 2011;82:360-364.

Bertoli S, Battezzati A, Merati G, Margonato V, Maggioni M, Testolin G, Veicsteinas A. Nutritional status and dietary patterns in disabled people. Nutr Metab Cardiovasc Dis 2006;16:100-112.

Bloomer RJ, Goldfarb AH. Anaerobic exercise and oxidative stress: a review. Can J Appl Physiol 2004;29:245-263.

Carmeli E, Bar-Chad S, Lotan M, Merrick J, Coleman R. Five clinical tests to assess balance following ball exercises and treadmill training in adult persons with intellectual disability. J Gerontol A Biol Sci Med Sci 2003;58:767-772.

Close GL, Ashton T, Cable T, Doran D, MacLaren DP. Eccentric exercise, isokinetic muscle torque and delayed onset muscle soreness: the role of reactive oxygen species. Eur J Appl Physiol 2004;91:615-621.

Davis JN, Gyllenhammer LE, Vanni AA, Meija M, Tung A, Schroeder ET, Spruijt-Metz D, Goran MI. Startup circuit training program reduces metabolic risk in Latino adolescents. Med Sci Sports Exerc 2011;43:2195-2203.

Dixon-Ibarra A, Lee M, Dugala A. Physical activity and sedentary behavior in older adults with intellectual disabilities: a comparative study. Adapt Phys Activ Q 2013;30:1-19.

Gröger M, Speit G, Radermacher P, Muth CM. Interaction of hyperbaric oxygen, nitric oxide, and heme oxygenase on DNA strand breaks in vivo. Mutat Res 2005;572:167-172.

Groussard C, Rannou-Bekono F, Machefer G, Chevanne M, Vincent S, Sergent O, Cillard J, Gratas-Delamarche A. Changes in blood lipid peroxidation markers and antioxidants after a single sprint anaerobic exercise. Eur J Appl Physiol 2003;89:14-20.

Halliwell B, Gutteridge JM. Free radicals in biology and medicine. 4th ed. Oxford: Clarendon Press Oxford; 2007.

Jenkins RR, Friedland R, Howald H. The relationship of oxygen uptake to superoxide dismutase and catalase activity in human skeletal muscle. Int J Sports Med 1984;5:11-14.

Kim CG, Lee JS. Differences of d-ROM, BAP, and metabolic variables with acute isokinetic strength and muscular endurance protocols. Korean J Sports Sci 2013;22:1357-1367.

Komatsu F, Kagawa Y, Sakuma M, Kawabata T, Kaneko Y, Otgontuya D, Chimedregzen U, Narantuya L, Purvee B. Investigation of oxidative stress and dietary habits in Mongolian people, compared to Japanese people. Nutr Metab (Lond) 2006;3:21.

Lord SR, Clark RD, Webster IW. Physiological factors associated with falls in an elderly population. J Am Geriatr Soc 1991;39:1194-1200.

Magee DJ. Orthopaedic physical assessment. St. Louis (MO): Saunders/Elsevier; 1992.

Marshall PW, Murphy BA. Core stability exercises on and off a Swiss ball. Arch Phys Med Rehabil 2005;86:242-249.

Miyazaki H, Oh-ishi S, Ookawara T, Kizaki T, Toshinai K, Ha S, Haga S, Ji LL, Ohno H. Strenuous endurance training in humans reduces oxidative stress following exhausting exercise. Eur J Appl Physiol 2001;84:1-6.

Onur E, Kabaroğlu C, Günay O, Var A, Yilmaz O, Dündar P, Tikiz C, Güvenç Y, Yüksel H. The beneficial effects of physical exercise on antioxidant status in asthmatic children. Allergol Immunopathol (Madr) 2011;39:90-95.

Oter S, Korkmaz A, Topal T, Ozcan O, Sadir S, Ozler M, Ogur R, Bilgic H. Correlation between hyperbaric oxygen exposure pressures and oxidative parameters in rat lung, brain, and erythrocytes. Clin Biochem 2005;38:706-711.

Pitetti KH, Rimmer JH, Fernhall B. Physical fitness and adults with mental retardation. An overview of current research and future directions. Sports Med 1993;16:23-56.

Priplata AA, Patritti BL, Niemi JB, Hughes R, Gravelle DC, Lipsitz LA, Veves A, Stein J, Bonato P, Collins JJ. Noise-enhanced balance control in patients with diabetes and patients with stroke. Ann Neurol 2006;59:4-12.

Ramel A, Wagner KH, Elmadfa I. Plasma antioxidants and lipid oxidation after submaximal resistance exercise in men. Eur J Nutr 2004;43:2-6.

Rimmer JH, Riley B, Wang E, Rauworth A, Jurkowski J. Physical activity participation among persons with disabilities: barriers and facilitators. Am J Prev Med 2004;26:419-425.

Rimmer JH, Yamaki K, Lowry BM, Wang E, Vogel LC. Obesity and obesity-related secondary conditions in adolescents with intellectual/developmental disabilities. J Intellect Disabil Res 2010;54:787-794.

Rosety-Rodriguez M, Camacho A, Rosety I, Fornieles G, Rosety MA, Diaz AJ, Rosety M, Ordonez FJ. Resistance circuit training reduced inflammatory cytokines in a cohort of male adults with Down syndrome. Med Sci Monit 2013;19:949-953.

Satoshi S, Kiyoji T, Hiroyo K, Fumio N. Exercise-induced lipid peroxidation and leakage of enzymes before and after vitamin E supplementation. Int J Biochem 1989;21:835-838.

Sherrill C. Adapted physical activity, recreation and sport: crossdisciplinary and lifespan. 6th ed. Boston: McGraw-Hill; 2004.

Sureda A, Ferrer MD, Tauler P, Romaguera D, Drobnic F, Pujol P, Tur JA, Pons A. Effects of exercise intensity on lymphocyte H2O2 production and antioxidant defences in soccer players. Br J Sports Med 2009;43:186-190.

Takeuchi E. Incidence of obesity among school children with mental retardation in Japan. Am J Ment Retard 1994;99:283-288.

Tamaki N, Tomofuji T, Maruyama T, Ekuni D, Yamanaka R, Takeuchi N, Yamamoto T. Relationship between periodontal condition and plasma reactive oxygen metabolites in patients in the maintenance phase of periodontal treatment. J Periodontol 2008;79:2136-2142.

Wolfson L, Judge J, Whipple R, King M. Strength is a major factor in balance, gait, and the occurrence of falls. J Gerontol A Biol Sci Med Sci 1995;50 Spec No:64-67.

Yamaki K. Body weight status among adults with intellectual disability in the community. Ment Retard 2005;43:1-10.

 https://doi.org/10.12965/jer.1632660.330