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Gross motor function and health fitness in adults with autistic spectrum disorder and intellectual disability: single-blind retrospective trial

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This study aimed at providing an exercise program for each type of disability after analyzing the exercise program performed by adults with intellectual disability (ID) or autistic spectrum disorder (ASD). Twenty-nine male adults voluntarily took part in this study, whose age ranged from 19 to 28 years and with an average body mass index of 23.98 ± 4.02 kg/m^2. The sample was divided into two groups as follows: ASD group (ASDG; n = 15) and ID group (IDG, n = 14). The selected tests used to measure gross motor function (GMF, locomotion and object control skills) and health fitness (body composition, flexibility, strength, muscle endurance, and cardiopulmonary endurance) were also used in previous studies. The GMF and health fitness between ASDG and IDG showed no significant differences. This study indicates that exercise programs could provide similar effects, even with other disorder types having similar symptoms.

Keywords: Autistic spectrum disorder, Intellectual disability, Gross motor function, Health fitness

INTRODUCTION

Intellectual disability (ID) and autism spectrum disorders (ASD) are neurodevelopmental disorders that affect daily living due to impaired adaptive and intellectual functions (Matson et al., 2008; Totsika et al., 2010). ASD and ID improve as the child grows older, but some entail impairments throughout life. Both ASD and ID are affected by heredity and males account for a higher percentage than females. Most research studies on ASD have shown prevalence figures using data from child cohorts. There has been a steady rise in the prevalence of ASD in children, with an estimated 5% of child subjects from studies conducted from the mid-1990s onward (Baird et al., 2006).

Until recently, no epidemiologic studies in adults, including ID, have been done. However, Brugha et al. (2011) looked into ASD in adults based on an adult psychiatric morbidity survey from the United Kingdom. From their study, prevalence rates were confirmed to be approximately 1%, but showed a higher prevalence rate in men (1.8%) than in women (0.2%). There was a higher likelihood for people with ASD and ID to be poorly educated, unmarried, and economically deprived compared to the general population (Howlin and Moss, 2012). In other words, adults who are mentally retarded are psychologically and socially vulnerable. The severity of both ID and ASD was determined by social awareness and communication. Generally, ASD is classified as mild, moderate, and severe, while the severity of ID is divided into four stages. Pedersen et al. (2017) reported that people who have ASD tend to exhibit a greater deficiency in nonverbal social behavior, which includes body language and the understanding of social cues. Matson and Dempsey (2008) found that subjects with ID displayed less repetitive behaviors. When compared to subjects with ID, those with ASD were reported to be more likely to self-isolate and

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to avoid eye contact. Several researchers reported a high likelihood of accompanying or overlapping ASD and ID (Matson and Shoemaker, 2009; Wilkins and Matson, 2009). Higashida et al. (2019) speculated that people with ID may go unnoticed in regards to co-occurring ASD. Actually, people with both ASD and ID have different needs compared to those with only either ASD or ID (Carminati et al., 2007; Gilchrist et al., 2001).

As such, ASD and ID share clinical characteristics which could result in confusion during diagnosis (Pedersen et al., 2017). It is possible that people with ASD that exhibit symptoms of ID may inadvertently be codiagnosed, which could result in receiving treatment for a nonexistent condition. Likewise, there is also the chance that people with ID may be misdiagnosed to have ASD and wrongly receive treatment for a condition they do not have. Clearly distinguishing the differences between ASD and ID will allow for the prescription of the appropriate treatments (Matson and Shoemaker, 2009).

Various treatment methods from several studies have been shown to improve symptoms (Bahrami et al., 2012). A growing body of evidence provides added support that regular physical activity has positive effects, such as improved respiratory function (Khalili and Elkins, 2009), reduced depression and anxiety, an enhanced sense of well-being, and better performance at work (Croce and Horvat, 1992). Several studies point to the importance of maintaining health and physical activity for people with ID and similar conditions (Chanias et al., 1998; Jansen et al., 2004). Among the outcome measures often used in early intervention programs are changes in the intelligence quotient (IQ). A lower IQ indicates a poorer prognosis for early intensive plans (Ben Itzchak et al., 2008; Matson and Smith, 2008). Verschuren et al. (2016) recently reported that engaging in physical activity can improve body image and help with treatment. Physical activity provides children with developmental disabilities with opportunities for physical development, reduces stress and anxiety, and improves muscle functions that helps for improved safety.

It is difficult to clearly distinguish between symptoms in individuals with ASD or ID. Although, major advances have been made in regards to the diagnosis, causes, and treatment for children with such conditions, there is a lack of research on the prognosis, results, and effective interventions for adults (Howlin and Moss, 2012). Even in Korea, physical activity programs for adults with ASD or ID were provided by various institutions, but no detailed program was provided depending on the type of disability. In addition, most play and exercise programs related to the disability were focused only on children, but programs that take into account the characteristics of adults were not provided. Therefore, this study aimed to provide an exercise program for each type of disability after analyzing the exercise program performed by an adult with ASD or ID in a developmental disability center. In other words, this study analyzed the differences in gross motor function (GMF) and health fitness in participants who took part in the same exercise program for one year among adults with ASD or ID.

MATERIALS AND METHODS

Subjects

The voluntary participants included male adults from 19 to 28 years of age. For inclusion, participants were required to enroll in the research center for motor development, have ASD or ID, and have regularly exercised for the past twelve months. All participants took part in a supervised physical activity program for 2 days (Tuesday and Friday) a week for a year. They began with warm-up conditioning for 5 min by a practitioner. Next, they performed up to five types of work-out sessions, which was composed of routine games (basic locomotion skill, catching a tail, playing tug-of-war), floorball games (routine exercise for passing and receiving a ball, passing practice, mini-short game), basketball (dribble a ball, pass a ball, shoot a ball), and inline skating (basic skating skill, walking, pushing, turning) for 40 to 45 min. Finally, they finished their program with 10 min of stretching.

Based on the criteria above, 32 subjects were screened to determine eligibility. Among them, three subjects refused to participate. In the end, 29 subjects took part in this study. Subjects with hearing, visual, and/or physical disabilities were excluded from the study. Furthermore, subjects unable to be measured or unable to continue, as well as those who have received medical treatment affecting physical condition, including any major surgery in the past year, were excluded from the study. Finally, all subjects were divided into autistic spectrum disorder group (ASDG, n = 15) and ID group (IDG, n = 14) as shown in Table 1.

Table 1. Physical characteristics of the subjects

Variable	ASD (n = 15)	ID (n = 14)	Z	*P*-value
Age (yr)	22.22 ± 2.31	21.93 ± 2.87	-0.595	0.561
Height (cm)	171.36 ± 5.47	169.55 ± 7.79	-0.372	0.715
Weight (kg)	71.21 ± 13.05	69.31 ± 12.25	-0.393	0.713
Body mass index (kg/m^2)	24.02 ± 4.52	23.95 ± 3.58	-0.240	0.813
Symptom	1.60 ± 0.51	1.43 ± 0.51	-0.907	0.451

Values are expressed as mean ± standard deviation.
ASD, autism spectrum disorder; ID, intellectual disability.

Experimental protocol

This was a single-blind, retrospective trial, which used the exercise program as the independent variable, and GMF and health fitness as the dependent variables. The assessment was conducted from February 13 to 14, 2020. The participants, including their parents, were continuously given motivation and encouragement to complete all the tests. Advertisements were used to recruit the subjects who signed an informed consent before the start of the study, which was approved by the ethics committee and done according to the Declaration of Helsinki (2-7001793-AB-N-0120-19113HR).

Test of gross motor development

This study used the test of gross motor development scale-2 (TGMD-2), which is a standardized criterion that measures GMF changes in disabled persons according to Yoon et al. (2019). Reliability of this test was found to be Cronbach a = 0.894. Twelve patterns of major muscle movements were divided into two parts: locomotion skills and object control skills. Horizontal jumping, hopping, galloping, leaping, running, and sliding comprised the locomotion section. Hitting a fixed ball, kicking a ball, catching a ball, stationary dribbling a ball, underhand rolling a ball, and overhand throwing a ball comprised of the object control skills. After examining the TGMD-2, one point was given if they were able to complete the task, while no point was given if they were unable to do the task. The total score, using subscales, was obtained from adding the results of the two parts (Allen et al., 2017). The locomotion and object control sections each had a maximum score of 48 points from the six subscales. Using the TGMD-2 is simple and useful for finding areas of improvement in exercise programs. Physical education experts often use it to create individualized training programs (Bittner, 2018).

Test of health physical fitness

Bioelectrical impedance analysis method assessed by Body Composition Analyzer (InBody 230, BioSpace, Seoul, Korea) was used to measure body composition and a height tester was used to measure height (Analogue height tester, Samwha, Seoul, Korea). The body composition analyzer is a segmental impedance device that has electrodes made of stainless steel interfaces. The subjects stood on the foot electrodes as they stood upright, without holding the handles. Analysis of height and body weight was measured prior to dinner and after emptying (Cha et al., 2014). The variables from body composition were body mass index (BMI), muscle mass, fat mass, waist/hip ratio (WHR), and basal metabolic rate (BMR).

The sit and reach flexion test was used to measure flexibility with a measuring device (TKK1859, Takei Inc., Tokyo, Japan). A ruler (25 cm outwards, 40 cm inwards) was attached to the surface perpendicularly. The heels of the subjects were placed against the platform at a distance of 5 cm apart. After taking a deep breath, the subjects bent forward and extended their fingertips to the furthest possible point as they exhaled. Subjects were told to refrain from bouncing their waist while bending forward. Their legs were kept straight with their heads between their arms as they reached forward. Two measurements were taken with the greatest distance being recorded.

Strength was measured using a digital hand dynamometer (TKK-5401, Takei Inc.) that measures grip strength. Participants sat in a chair with their shoulder positioned at 0° flexion and elbow at 90° flexion. Their wrist was between supination and pronation and the hand positioned vertically. The subjects placed the middle phalanges on the handle of the dynamometer and squeezed 3 times with maximum force with a minute of rest between each attempt. The greatest amount of force produced from 6 attempts was recorded and converted to kilograms. In order to ensure that the subjects exerted their greatest effort, the test examiner took into account the muscles contractions of the arm and hand, color changes in the phalanges, changes in facial expressions, and consistency of each trial. The grip strength of the left and right sides was summed and recorded as the average value.

A customized sit-up test was used to measure muscle endurance. The subjects lied on a mat, locked their hands behind their heads, and positioned their feet 30 cm apart with their knees bent at 90° as their ankles were held down by an assistant. When the signal was given, the subjects moved their upper body forward and touched their knees with their elbows. To count as one sit-up, the back had to touch the floor after both elbows touched the knees. The highest count during one minute was recorded.

A 15-m shuttle run test was used to measure cardiopulmonary endurance, which is commonly used as an aerobic fitness test. This is also referred to as a bleep test or multi-stage fitness test (Yoon et al., 2019). Before beginning the test, the subjects were explained the test procedures by an expert and instructed to complete warm-ups. The subjects were positioned behind a line that faced a second line 15 m apart. At each beep, the subjects ran toward the other line. The beep intervals were long in the beginning, but became shorter after about one min, which increased the pace. This increase in pace continued on for each following minute (level). In the case that the subject reached the line before the next beep, they waited until the beep before running again. For those who did not reach

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the line before the beep, they were issued a warning as they continued to run and attempt to catch up within the next 2 beeps. The first warning was given for failing to reach the line (within 2 m) and were eliminated after being given a second warning. The recorded score was calculated as the total number of shuttles completed before being eliminated.

Statistical analysis

The results obtained through the experiment were input using Microsoft Excel (Microsoft, Redmond, WA, USA), and calculated using technical statistics (mean±standard deviation). The IBM SPSS ver. 18.0 (IBM Co., Armonk, NY, USA) was used to calculate statistics for this study. Based on the results of the Shapiro–Wilk test, an independent *t*-test was performed to compare the differences of variables between ASDG and IDG. At this time, Mann–Whitney *U*-test, which is a nonparametric statistic, was used for data for which the normality of distribution for the examined variables was not confirmed, and the statistical significance level of this study was set at 0.05.

RESULTS

Comparison of demographic factors

All subjects were aged 19 to 28 years, their mean age was 22.07±2.55 years old, and mean BMI was 23.98±4.02 kg/m^2 as shown in Table 1. Symptom degrees between groups were not significantly different. The mild symptom and severe symptom of ASDG were 11 and 4, respectively. The mild symptom and severe symptom of IDG were 9 and 5, respectively.

Differences of GMF between groups

As shown in Table 2, the six variables of locomotion skill were not significantly different between ASDG and IDG. There were no significant differences in the sum of locomotion skills between groups. Similarly, these results from the six variables and sum score of object control skills were not significantly different between both groups.

Difference of body composition between groups

As Table 3 shows, there was no significant difference in muscle mass between ASDG and IDG. Although the value of IDG was shown to have a higher tendency, there was no significant difference in fat mass between both groups. WHR was not significantly different between ASDG and IDG after completing the physical activity program. Finally, there was no significant difference in BMR between both groups, although the value of ASD group was shown to have a higher tendency.

Differences of physical fitness between groups

As shown in Table 4, flexibility ($P=0.310$), strength ($P=0.681$), muscle endurance ($P=0.441$), and cardiopulmonary endurance ($P=0.123$) showed no significant differences between ASDG and IDG after completing the physical activity program.

Table 2. Comparative results of gross motor function between groups

Variable	ASD (n=15)	ID (n=14)	*Z*	*P*-value
Run	5.40±2.44	4.64±2.98	-0.668	0.533
Gallop	6.60±1.24	6.07±1.33	-0.985	0.354
Hop	6.27±1.75	6.14±2.57	-0.112	0.914
Leap	5.80±0.86	5.29±1.38	-0.829	0.505
Horizontal Jump	3.40±3.00	4.36±2.65	-1.075	0.310
Slide	7.13±0.99	7.21±1.19	-0.506	0.652
Locomotion skill	34.73±7.44	33.86±10.11	-0.175	0.880
Striking a ball	3.73±1.33	3.64±0.93	-0.056	0.983
Dribbling a ball	6.40±2.35	6.07±2.56	-0.217	0.847
Catching a ball	4.87±1.41	4.86±1.66	-0.185	0.880
Kicking a ball	5.40±1.68	5.14±1.79	-0.269	0.813
Over-throwing a ball	0.07±0.26	0.14±0.36	-0.662	0.747
Under-rolling a ball	3.60±2.13	3.79±2.12	-0.380	0.715
Object control skill	24.07±5.87	23.64±6.82	0.001	1.000

Values are expressed as mean±standard deviation.
ASD, autism spectrum disorder; ID, intellectual disability.

Table 3. Comparative results of body composition between groups

Variable	ASD (n=15)	ID (n=14)	*Z*	*P*-value
Muscle mass (kg)	50.05±6.87	47.41±8.2	-0.722	0.477
Fat mass (kg)	22.31±7.96	23.79±7.39	-0.131	0.914
WHR	0.8±0.09	0.8±0.07	-0.220	0.847
BMR (kcal/day)	1,533.53±151.6	1,481.57±181.38	-0.721	0.477

Values are expressed as mean±standard deviation.
ASD, autism spectrum disorder; ID, intellectual disability; WHR, waist/hip ratio; BMR, basal metabolic rate.

Table 4. Comparative results of physical fitness between groups

Variable	ASD (n=15)	ID (n=14)	*Z*	*P*-value
Flexibility (cm)	-5.83±4.05	-3.18±6.33	-1.072	0.310
Strength (kg)	17.57±4.24	18.09±4.79	-0.415	0.683
Muscle endurance (reps)	13.86±5.21	13.24±5.31	-0.603	0.441
Cardiopulmonary endurance (reps)	7.86±4.35	7.24±2.17	-1.586	0.123

Values are expressed as mean±standard deviation.
ASD, autism spectrum disorder; ID, intellectual disability.

DISCUSSION

This study analyzed the differences in GMF and health fitness in participants who took part in the same exercise program for a year among adults with ID or ASD. From the results of this study, no significant differences existed in GMF and health fitness between ASDG and IDG. In other words, a year-long exercise program did not provide a difference in disability type. The result showed that exercise programs could provide similar results, even with other disorder types with similar symptoms. In fact, this study was a retrospective study comparing variables between two groups with postvalue only after a year of exercise without prevalue. Therefore, it was not known whether health fitness and GMF increased or decreased.

Many researchers have reported that adults with mental retardation have lesser adaptive, cognitive, and social skills. Individuals with developmental disability also have more limited physical abilities compared to those who do not. Moreover, they are often accompanied by stereotype and challenging behavior such as depression, anxiety, and schizophrenia (Downs et al., 2008; Holden and Gitlesen, 2008; Lee et al., 2008; Lifshitz et al., 2008; Matson et al., 2005; McGillivray et al., 2008; Myrbakk and von Tetzchner, 2008; Thirion-Marissiaux and Nader-Grosbois, 2008; Yalon-Chamovitz and Weiss, 2008; Zayac and Johnston, 2008). All of these problems could be problematic for patients, their family, and even society. Specifically, individuals with developmental disability, on average, score 25% less on developmental tests than those without (Wood et al., 2000). In other words, there is no physical fitness test for the disabled and only exercise programs are provided. According to several previous studies, there are many reports that people with disabilities who have good physical fitness or enjoy sports have increased psychological stability and improved sociality. However, as described above, if the program was provided after the physical examination was performed, it may provide better results. In other words, a lot of researchers reported that a physical activity or an exercise program provided to adults with mental retardation has been reported to promote psychological health as well as physical health of persons with disabilities and play a role in society (Chanias et al., 1998; Croce and Horvat, 1992; Jansen et al., 2004; Rimmer, 1999; Verschuren et al., 2016). A review on studies involving the mental health and physical fitness of both able and disabled populations showed that physical activity led to improved psychological states in children with ID (Folkins and Sime, 1981). Gabler-Halle et al. (1993) found that aerobic exercise led to many improvements in psychological variables such as behavior, self-concept, and intellectual functioning.

Especially, a variety of programs are offered to help children with mental retardation grow into members of society. Among them are physical activity programs that could improve the health of children with disabilities, promote psychological stability, and increase the chances of social adjustment (Ahn and Fedewa, 2011; Janssen and LeBlanc, 2010; Latorre Román et al., 2015). The effects of physical activity in children with developmental disabilities include improved physical development and muscle function necessary to protect the body (Verschuren et al., 2016). Body fat distribution and physical fitness in childhood are highly correlated with cardiovascular health in adulthood. Bürgi et al. (2011) indicated that preschoolers who are physically active tend to have improved aerobic capacity and heart function. These findings show that childhood fitness levels have important long-term effects on health. (Ortega et al., 2008; Ortega et al., 2015). For adults with ASD or ID, physical activity not only provides available movement, but also improves physical function and mental pleasure. In other words, since physical activity itself is learning and living, it is essential for the education of adults with mental disabilities.

Lower levels of muscular strength and cardiovascular fitness and higher levels of obesity were found in individuals with ID compared to those without. (Pitetti and Yarmer, 2002; Pitetti et al., 2001). For people with ID, Frey et al. (2008) showed that physical fitness performance is significantly lower, while Frey et al. (2008) reported less physical activity than those without ID (Van den Berg-Emons et al., 1998). Similarly, a meta-analysis was conducted by Chanias et al. (1998) to analyze the effects of physical activity on fitness levels in people with ID. Data was gathered from 21 studies yielding an effect size of 100. Significant effects were shown in areas of cardiovascular and muscular endurance, moderate effects for muscular strength, less notable effects for flexibility, and insignificant effects for body composition. In addition, they reported that program type influenced strength and program frequency influenced flexibility.

In conclusion, no significant differences were found in the GMF and health fitness between ASDG and IDG in this study. In other words, a year-long exercise program did not provide a difference in disability type, but the BMR of ASDG was higher tendency than that of IDG. The result showed that exercise programs could provide similar results, even with other disorder types with similar symptoms. Specifically, this study includes some limitations as follows. First, the experiment was conducted by selecting a special education institute, as such, it was difficult to generalize the research results to all adults with disabilities. Second, the adults were

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not able to control the physical other activities and eating methods. Revising the standards of reporting relevant data related to samples and exercise prescription components would be beneficial for future research studies.

CONFLICT OF INTEREST

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

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