วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 20 ฉบับที่ 1, ธันวาคม 2563

Journal of Sports Science and Technology Volume 20, No. 1, 2020

COMPARISON OF MOVEMENT PATTERNS AND MOTIVATION LEVEL WHILE PLAYING ACTIVE VIDEOGAMES IN CHILDREN WITH CHRONIC ANKLE INSTABILITY

Janya CHUADTHONG[1], Raweewan LEKSKULCHAI[2]*

[1]*School of Integrative Medicine, Mae Fah Luang University, Chiang Rai, THAILAND 57100*

[2]*Faculty of Physical Therapy, Mahidol University, Nakhon Pathom, THAILAND 73170*

ABSTRACT

Active video games (AVGs) are accepted as enjoyable exercising tools for rehabilitation. It offers a potential solution to improve adherence by increasing motivation levels in patients who require long-term rehabilitation sessions such as those with chronic ankle instability (CAI). The prevalence of CAI is high in children, but no evidences reporting movement patterns while playing AVGs in children. Therefore, this study aimed to compare movement patterns and intrinsic motivation levels while playing AVGs between children with CAI and typical children. Thirty children aged between 8 and 14 years old were recruited. They were divided into two groups including children with CAI (n=15) and typical children (n=15). Each child performed 4 AVGs including running, dancing, catching fish, and Russian block for 5 minutes per game. Percentage of movement patterns and intrinsic motivation levels were measured. The results revealed that there were no significant differences ($p>0.05$) between groups except the percentage of double leg stance (DLS) while playing catching fish ($p<0.05$). In addition, there was significant difference between groups for perceived competence in Russian block; effort/importance in catching fish; and value/usefulness in dancing ($p<0.05$). In conclusion, this study showed similar movement patterns among the 4 AVGs in both groups. However, the findings suggested that catching fish, dancing, and Russian block showed greater movement patterns than running including single leg stance, double leg stance and reaching direction. In addition, this study found that dancing could cause higher pressure to the players than comparing with others. Therefore, catching fish and Russian block may help to encourage the single leg standing patterns of children with CAI. These game are inexpensive tool, high motivation level and simply to apply both in clinic and home. Further studies are highly recommended to investigate the effectiveness of the AVGs for improving common deficits in children with CAI.

(Journal of Sports Science and Technology 2020; 20(1): 7-19)

(Received: 4 December 2019, Revised: 12 April 2020, Accepted: 13 April 2020)

Keywords: Active videogame, Children/ Chronic Ankle Instability/ Motivation/ Movement pattern

*Corresponding Author: Raweewan LEKSKULCHAI

Faculty of Physical Therapy, Mahidol University, Nakhon Pathom, THAILAND 73170

E-mail: raweewan.lek@mahidol.ac.th

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 20 ฉบับที่ 1, กรกฎาคม 2563
Journal of Sports Science and Technology Volume 20, No. 1, 2020

INTRODUCTION

Chronic ankle instability (CAI) is a long-term condition often encountered after ankle injuries. Three main components of CAI include perceived instability, mechanical instability and recurrent sprain[1]. Currently, the prevalence of CAI in children was reported as higher than that of adults[2]. Moreover, children commonly showed signs and symptoms of the multiple components of CAI[3]. A systematic review reported that 71% of children with a history of ankle sprain had perceived instability and 47% had mechanical instability[2]. Moreover, a previous study shown the high prevalence rate of residual symptoms of CAI in Thai children after initial injury and becoming of great concern[4]. Patients with CAI reported of having diminished neuromuscular control, decreased strength and range of motion (ROM), impaired proprioception, pain, recurrent ankle sprains, impaired performance during functional tasks, and perceived difficulties with activities of daily living (ADLs) or sport-specific skills[5]. Due to the long lasting impacts of CAI on activity levels and quality of life, it is important to prevent the symptoms in children as they are growing and developing more advanced skills[2].

Treatment of CAI often consists of conservative rehabilitation programs that are designed to improve neuromuscular control, proprioception, strength and ROM[6,7]. Previous research explored treatment interventions in isolation to investigate the efficacy of each specific program such as joint mobilization[8, 9], strengthening exercise[10,11], balance training[12-15], proprioceptive training[16]. Due to the multifaceted components of CAI, a more comprehensive treatment applies combining intervention concepts such stretching, strengthening, balance training may be more effective in improving functional and preventing recurrent sprain[17,18]. Hale et al studied a comprehensive rehabilitation program in combination with ROM, muscle performance, and neuromuscular control. The results showed improved postural control and functional activities[19]. Despite the traditional therapeutic exercises could improve postural control after injury, high levels of motivation and adherence are often lacking due to the repetitive nature of the exercises. Fitzgerald suggested that this may be particularly problematic in the case of preventative exercises or long-term rehabilitation program[20].

A wide range of traditional interventions has been shown in previous studies[6-16]. Emerging technology such as virtual reality and video game intervention shown the increasing volume of research in recent research for child population. These interventions can be provided to improve physical activities to interact with a virtual environment. Thus, the potential benefits may be greater than traditional methods, such as increased engagement, motivation, and repetition of more challenging and varied activities with instantaneous visual or auditory feedback[21]. A recent study examined the exercise program with therapeutic exergaming for balance training on dynamic postural stability and intrinsic motivation levels. This study showed similar improvements in dynamic postural stability, whereas this result showed a greater level of interest and enjoyment when compared with conservative rehabilitation program[20]. However, the program in the study included non-specific task and movement patterns required for children with CAI.

Furthermore, research to date has been heavily focused on adults and lack of evidence to recommend the appropriate game to improve standing balance and intrinsic motivation level in children population especially children with CAI. Poor exercise technique and lack of adherence during long-term rehabilitation program are important issue in preventing a full recovery in children with CAI. It is widely believed that therapeutic exergaming has the potential to solve these issues. AVG Thus, the present study aimed to focus on inexpensive active video games with safety, simplicity and efficacy, such as the step mania active video games (AVGs). This device can provide many task repetitions, real-time feedback, safe environment, and a high level of motivation, which are among the key factors for successful rehabilitation[22]. Therefore, the objective of this study was to compare movement patterns and intrinsic motivation levels while playing the active video games between children with CAI and typical children.

METHODS

Study design

This study was conducted using a cross-sectional design.

Subjects

Fifteen children with chronic ankle instability and fifteen children with typical children were recruited. The inclusion criteria for typical children were 1) age between 8 and14 years old, 2) without a history of unilateral or bilateral ankle sprain. The inclusion criteria for children with CAI were 1) age between 8 and 14 years old, 2) with a history of unilateral ankle sprain, 3) self-report sensations of “giving way” of at least twice a year, 4) Cumberland Ankle Instability Tool-Youth (CAITY) score of less than 24. The exclusion criteria for both groups were a history of previous surgeries to the musculoskeletal structures such as bones, joint structure, nerves in lower extremity, injury to musculoskeletal structures of other joints of the lower extremities, history of balance deficits, visual deficits, uncontrolled seizure, physical anomalies or deformity of lower extremity and current participation in supervised physical rehabilitation.

Prior to the study, all subjects provided written informed consent according to the protocol approved by the Human Research Ethics Committee of Mahidol University.

Measurements

Demographic data were interviewed then the Cumberland Ankle Instability Tool-Youth score (CAITY) was recorded. Then the single leg stance test (SLST) for both sides was assessed. The children were instructed to stand on one leg as long as possible for each trial. They were barefoot with hands on hips. The test was performed 3 times with eyes open (SLS EO) and three times with eyes closed (SLS EC) and with a testing trial before collecting the data. A digital stopwatch was used to measure the stance duration (seconds). The maximum time was set to 30 seconds. The measurement was stopped if there were any changes in position of the weight-bearing foot, or any body parts except the weight-bearing foot touched the floor, or open eyes during eyes closed condition. The durations of the 3 trials were averaged to obtain the scores for SLS-EO and SLS-EC conditions. The SLST was assessed by a physical therapist who have experiences in pediatric physical therapy for more than 5 years. The test-retest reliability in performing the test was acceptable at the Intraclass Correlation Coefficient (ICC (3,1)) between 0.602 and 0.822, $p<0.05$.

After the interview and assessments, children were asked to perform 4 AVGs (running, dancing, catching fish, and Russian block) for 5 minutes per game. Movement patterns of the lower extremities were recorded by using 2 video cameras. The numbers of movement pattern of the 4 games were analyzed by two assessors who have been defined patterns of movement, and has been practicing observation and correctly. The movement patterns included single leg stance, double leg stance, sideways hopping, anteroposterior hopping, and foot reaching (anterior, posteromedial, and posterolateral directions). The number of movement patterns was calculated to percentage for each movement pattern.

After playing the 4 AVGs, all children were asked to rate the self-report questionnaire for intrinsic motivation level. There were 5 dimensions of the intrinsic motivation level, including (1) interest/enjoyment, (2) perceived competence, (3) effort/importance, (4) pressure/tension and (5) value/usefulness[6]. Each dimension is rated using 1-10 level scores, where 0 is minimal and 10 is the maximum score.

Procedures

All children performed the 4 AVGs on the StepMania gaming device with a floor mat. The 4 games were chosen because they emphasize on the movements of the lower extremities and easy to apply in children. The video cameras began to record when the child pressed the “start” on the floor mat, and stop recording at the end of each game. The video (that was recorded as movement pattern for 5 minutes during play game with Olympus OM-D, E-M10 Mark II camera) was recorded in two dimensions, including sagittal and frontal planes of motion. Before starting each game, children were allowed to practice to ensure that they understood the procedure of the game and could play the game correctly. The details of each game are as follows;

1. **Running**: child stands on the central of the mat before playing games, and then keep running to the mat for 5 minutes continuously.

2. **Dancing**: child stands on the central of the mat before dancing, and then keep one leg stance on the central and move another leg to press the corresponding arrows with 6 key directions on the mat for 5 minutes continuously.

3. **Catch fish**: child stands on the central of the mat before playing games, and then move their feet to the left or right direction and press the corresponding arrows for catching the yellow or red fish for 5 minutes continuously.

4. **Russian blocks**: child stands on the central of the mat before playing games, and then move their feet to left and right direction or change the shape of the piece for 5 minutes continuously. A random sequence of Tetriminos fall down the playing field. The objective of the game is to manipulate these Tetriminos, by moving each one sideways and/or rotating by quarter-turns, so that they form a solid horizontal line without gaps.

Statistical analysis

This study analyzed by using SPSS Statistics version 18.0. The normality of the distributions was determined with the Shapiro-Wilk test. Demographic characteristics were analyzed by using descriptive statistic and the result of this study was reported as means and standard deviations (SD). The independent t - test was used to compare the difference between groups for continuous data and Chi-square test for categories data. For nonparametric data, Mann-Whitney U test was used to compare the difference between groups for continuous data. Friedman test used to analyze within the group for movement patterns and motivation level and pairwise comparison specifically. The significance level was set at $p<0.05$.

RESULTS

Demographic characteristics

The characteristics of the participants are illustrated in Table 1. The average age for all children was 10 years. There were no significant difference between typical children and children with CAI groups for age, sex, height, weight, leg length, leg dominance, experience with active video game, the Cumberland Ankle Instability Tool-Youth score (CAITY) and single leg stance test ($p> 0.05$). However, there was a significant difference between groups for a number of pervious of ankle sprain ($p< 0.05$) as shown in the table 1.

Table 1. Demographic characteristics

Characteristics	All subjects (N=30)	Groups		P-value
		Typical children (n=15)	Children with CAI (n=15)	
Age (y)	10.40 ± 1.83	10.27 ± 1.75	10.53 ± 1.96	0.697
Sex (boy: girl)	17:13	10:5	7:8	0.269
Leg length (cm)				
Left side	72.19 ± 7.18	71.11 ± 6.95	73.26 ± 7.48	0.423
Right side	72.04 ± 7.11	70.90 ±6.92	73.19 ± 7.35	0.387
Height (cm)	137.13 ± 11.55	134.87±11.45	139.40± 11.58	0.290
Weight (kg)	33.91±9.41	30.86 ± 6.11	36.96±11.22	0.075
Leg dominance (right: left)	21:9	9:6	12:3	0.232
No. of previous of sprain (n)	10	0	10	0.010*
No. of experience with active videogame (n)	5	4	1	0.142
CAITY score (mean)				
Left side	22.70 ± 4.60	23.87 ± 4.69	21.53 ± 4.36	0.169
Right side	21.27 ± 5.56	23.20 ± 5.25	19.33 ± 5.33	0.055
Single leg stance test (sec)				
Left side (eyes open)	22.96 ± 8.29	22.40 ± 8.51	23.52 ± 8.31	0.718
Right side (eyes open)	23.26 ± 8.01	23.24 ± 8.52	23.27 ± 7.75	0.992
Left side (eyes closed)	8.02 ± 6.55	7.28 ± 6.31	8.75 ± 6.91	0.547
Right side (eyes closed)	9.18 ± 5.21	8.18 ± 5.20	10.18 ± 5.21	0.301

Abbreviations: CAI; Chronic ankle instability, CAITY; the Cumberland Ankle Instability Tool-Youth

Note: The data are presented as mean ± standard deviation (SD) for continuous data. P-value corresponds to independent sample t-test for independent sample. The data are presented as frequency for categories data. P-value corresponds to Chi-square test for independent sample. * Significant level at $p<0.05$

Percentage movement patterns while playing the 4 active video games

To compare the movement patterns between groups, there were no significant difference ($p>0.05$) between groups except DLS while performing the catching fish ($p<0.05$) (Table 2). However, the movement patterns were significantly different for all AVGs ($p<0.001$) except running (Table 3).

Table 2. Comparison of percentage of movement patterns while playing 4 active video games between typical children and children with CAI

Movement patterns	Typical children (n=15)	Children with CAI (n=15)	P-value
Single leg stance;			
Left side			
Running	0	0	1
Dancing	25.10 ± 8.79	23.43 ± 8.48	0.980
Catching fish	16.20 ± 14.67	12.55 ± 7.88	0.755
Russian block	25.75 ± 13.25	24.55 ± 11.11	0.575
Right side			
Running	0	0	1
Dancing	15.11 ± 10.94	15.65 ± 7.36	0.819
Catching fish	27.54 ± 16.06	27.04 ± 8.17	0.967
Russian block	20.90 ± 11.91	20. 60 ± 9.46	0.772
Double leg stance;			
Running	0	0	1
Dancing	22.05 ± 13.79	26.85 ± 14.55	0.455
Catching fish	17.20 ± 12.92	27.69 ±7.11	0.033*
Russian block	41.17 ± 11.91	39.78 ± 7.83	0.547
Hopping;			
Sideway			
Running	0	0	1
Dancing	1.84 ± 6.16	0	0.150
Catching fish	0	0	1
Russian block	0	0	1
Anteroposterior (AP)			
Running	0	0	1
Dancing	0	0	1
Catching fish	0	0	1
Russian block	0	0	1

Movement patterns	Typical children (n=15)	Children with CAI (n=15)	P-value
Reaching directions;			
Left side: Anterior			
Running	0	0	1
Dancing	5.21 ± 4.95	9.75 ± 12.01	0.542
Catching fish	0	0	1
Russian block	0	0	1
Left side: Posteromedial (PM)			
Running	0	0	1
Dancing	1.78 ± 4.36	1.14 ± 3.24	0.632
Catching fish	8.88 ± 13.18	6.07 ± 8.57	0.626
Russian block	2.73 ± 3.89	4.31 ± 4.72	0.329
Left side: Posterolateral (PL)			
Running	0	0	1
Dancing	0	0.22 ± 0.86	0.317
Catching fish	1.11 ± 4.30	0	0.317
Russian block	0	0.19 ± 0.74	0.317
Right side: Anterior			
Running	0	0	1
Dancing	17.65 ± 13.63	13.53 ± 11.00	0.429
Catching fish	0	0	1
Russian block	0	0.22 ± 0.86	0.317
Right side: Posteromedial (PM)			
Running	0	0	1
Dancing	11.24 ± 11.15	9.08 ± 5.67	0.755
Catching fish	0	0	1
Russian block	9.31 ± 10.93	10.35 ± 9.94	0.528
Right side: Posterolateral (PL)			
Running	0	0	1
Dancing	0	0.35 ± 1.36	0.317
Catching fish	29.06 ± 14.20	26.66 ± 7.11	0.467
Russian block	0.13 ± 0.52	0	0.317

Abbreviations: CAI; Chronic ankle instability

Note: The data are presented as mean ± standard deviation (SD). P-value corresponds to Mann-Whitney U test for independent sample. * Significant level at $p<0.05$

Table 3. Comparison of percentage of movement patterns while playing 4 active video games (N=30)

Games	Movement pattern											P-value
	Single leg stance (SLS)		Double leg stance (DLS)	Hopping		Reaching (Left side)			Reaching (Right side)			
	Left side	Right side		Sideway	Anteroposterior (AP)	Anterior	Posteromedial (PM)	Posterolateral (PL)	Anterior	Posteromedial (PM)	Posterolateral (PL)	
Running	0	0	0	0	0	0	0	0	0	0	0	1
Dancing	24.27±8.53	15.38±9.17	24.45±14.14	0.92±4.38[b,c,d]	0[b, c,d]	7.48±9.31[b]	1.46±3.79[b,c,d]	0.11±0.61[b,c,d]	15.59±12.35	10.16±8.76[a]	0.18±0.96[b,c,d]	< 0.001
Catching fish	14.37±11.72	27.29±12.52	22.44±11.55	0[b,e]	0[b,e]	0[b,e]	7.48±11.02[b,f]	0.56±3.04[b,e]	0[b,e]	0[b,e]	27.86±11.10	< 0.001
Russian block	25.15±12.03	20.75±10.57	40.48±9.92	0[b,d]	0[b,d]	0[b,g]	3.52±4.32[b]	0.10±0.52[b,g]	0.11±0.61[b,g]	9.83±10.28[b]	0.07±0.37[b,g]	< 0.001

Note: Note: Data are reported as mean ± standard deviation (SD). P-value corresponds to Friedman test for dependent sample and pairwise comparison. * Significant level at p-value < 0.001

[a] Significant different when compared with Lt. SLS and DLS

[b] Significant different when compared with Lt. SLS, Rt. SLS and DLS

[c] Significant different when compared with Lt. anterior reaching and Rt. anterior reaching

[d] Significant different when compared with Rt. PM reaching

[e] Significant different when compared with Lt. PM reaching and Rt. PL reaching

[f] Significant different when compared with Lt. PL reaching and Rt. PL reaching

[g] Significant different when compared with Lt. PM reaching and Rt. PM reaching

Motivation level while playing the 4 AVGs

There were significant differences between groups for perceived competence in Russian block game, effort/importance in catching fish game, and value/usefulness in dancing game (p<0.05) (Table 4). The dancing caused more pressure and tension than catching fish and Russian block (Table 5).

Table 4. Comparison of motivation levels while playing 4 active video games between typical children and children

Games	All subjects (N=30)	Groups		P-value
		Typical children (n=15)	Children with CAI (n=15)	
Interest/enjoyment				
Running	9.00 ± 1.74	9.20 ± 1.57	8.80 ± 1.94	0.590
Dancing	6.67 ± 2.98	7.67 ± 2.32	5.67 ±3.29	0.059
Catching fish	7.87 ± 2.10	8.47 ± 1.81	7.27 ± 2.25	0.135
Russian block	8.03 ± 2.76	8.47 ± 3.16	7.60 ± 2.32	0.105
Perceived competence				
Running	8.83 ± 1.78	9.27 ± 1.10	8.40 ± 2.23	0.408
Dancing	7.07 ± 2.94	7.07 ± 3.24	7.07 ± 2.71	0.800
Catching fish	7.87 ± 2.62	8.67 ± 2.35	7.07 ±2.71	0.037*
Russian block	7.90 ± 2.31	8.80 ± 1.74	7.00±2.51	0.040*
Effort/importance				
Running	8.83 ± 1.64	8.67 ± 1.84	9.00 ± 1.46	0.769
Dancing	7.73 ± 2.61	8.27 ± 2.52	7.20 ± 2.68	0.140
Catching fish	8.20 ± 2.31	9.33 ± 0.98	7.07 ± 2.71	0.015*
Russian block	8.13 ± 2.13	8.67 ± 1.95	7.60 ± 2.23	0.138
Pressure/tension				
Running	1.73 ± 2.86	2.53 ± 3.36	0.93 ± 2.09	0.080
Dancing	4.47 ± 3.92	4.00 ± 3.82	4.93 ± 4.10	0.581
Catching fish	2.07 ± 2.97	2.27 ± 3.49	1.87 ± 2.45	0.892
Russian block	1.47 ± 2.24	1.27 ± 2.22	1.67 ± 2.32	0.527
Value/usefulness				
Running	8.87 ±1.20	8.73 ± 1.98	9.00 ± 2.07	0.902
Dancing	8.33 ± 2.16	9.27 ± 1.28	7.40 ± 2.47	0.016*
Catching fish	7.87 ± 2.68	8.60 ± 2.13	7.13 ± 3.02	0.155
Russian block	7.50 ± 3.11	7.27 ± 3.71	7.73 ± 2.46	0.948

with CAI

CAI; Chronic ankle instability. Data are reported as mean ± standard deviation (SD). P-value corresponds to Mann Whitney U test for independent sample. * Significant level at p-value < 0.05

Table 5. Comparison of percentages of motivation levels while playing 4 active video games (N=30)

Games	Motivation level					P-value
	Interest/enjoyment	Perceived competence	Effort/importance	Pressure/tension	Value/usefulness	
Running	29.23 ± 6.57	29.30 ± 8.89	27.55 ± 6.01	17.69 ± 31.20[a]	28.05 ± 7.79	<0.001
Dancing	20.50 ± 7.12[b]	21.59 ± 6.20	22.96 ± 6.06	38.05 ± 36.60	26.11 ± 7.25	<0.05
Catching fish	25.08 ± 5.37	24.31 ± 5.72	24.94 ± 5.80	15.09 ± 22.24[a]	23.56 ± 5.13	<0.05
Russian block	25.19 ± 7.73	24.80 ± 4.17	24.55 ± 3.15	12.51 ± 21.61[a]	22.29 ± 7.06	<0.001

Note: Data are reported as mean ± standard deviation (SD). P-value corresponds to Friedman test for dependent sample and pairwise comparison. * Significant level at p-value < 0.05

[a] Significant different when compared with interest/enjoyment, perceived competence, effort/importance, and value/usefulness

[b] Significant different when compared with effort/importance, pressure/tension, and value/usefulness

DISCUSSION

Patients with CAI may experience perceived instability, mechanical instability and/or recurrent sprain[2]. The components can be found in children as the prevalence of CAI in children was reported as higher than that of adults. Apart from rehabilitation, AVGs were acceptable and enjoyable as a promising physical activity and motivation for children[22]. This study explored the movement patterns and intrinsic motivation level while playing the 4 active video games in typical children and children with CAI. The findings demonstrated that children with CAI performed the 4 games using the similar movement patterns as children without CAI, except the DLS while playing catching fish game play ($p<0.05$). This finding can be explained by the results that catching fish games required more single leg stance repetitions. Children with CAI could not perform single leg stance so they had to spend more times in DLS when compared with typical children. In addition, the nature of this game requiring 3 major directions to perform, including sideway, posteromedial, and posterolateral foot reaching. Children with CAI have deficits in postural control, especially in anterior, posterior and medial directions[23]. Therefore, they had difficulty participating in this game as shown by a shorter single leg stance (Table 2). During playing game, children with stand on a dance mat, stepping on up, down, right, and left pressure sensitive arrows, as they watch a video game screen with moving arrows directing them where to step while listening to a game-song. It requires rhythmic beat and arrow perception with accurate stepping onto the correct sensor. Dance pad sensors detected position and timing information to provide participants with real-time visual feedback, similar to actual game-play. It involved in execution of a complex motor task that requires visual, auditory, and somatosensory integration as well as cognitive processing to respond accurately in order to maximize performance and game scores[24]. Balance training should be offered for the children to improve their postural control. The balance training reduced the incidence of ankle sprains in 38% compared with the control group, increase in the distance of reach in the anterior, posterolateral and posteromedial through the SEBT[25]. Therefore, these game seem to be a challenging to improving common deficits in children with CAI.

The results also revealed significant differences between groups for perceived competence in Russian block; effort/importance in catching fish; and value/usefulness in dancing ($p<0.05$). Children with CAI rated lower motivation levels when compared with typical children. These findings supported the challenging perceptions of the children with CAI on the catching fish, Russian block and dancing games. Since these games consist of many arrows to achieve targets. Children had to move their feet to press the corresponding arrows correctly. Children with CAI may have difficulties due to their impairments such as balance deficits, muscle weakness, ROM restriction, proprioception deficits, so these games were challenging their limitations[26].

However, this study showed high intrinsic motivation levels, such as enjoyment and values or usefulness in all games. Therefore, the selected 4 games are useful and enjoyable for children with and without CAI. This finding supported a previous study that exercising with the therapeutic exergaming system could improve dynamic postural stability and showed a greater level of interest and enjoyment when compared to a group doing similar balance training without the game system[20]. Previous experimental study had generally demonstrated that individuals who participate in tasks for internal reasons including intrinsic motivation persist in free-choice behavior better than those motivated by extrinsic factors[27].

The present study has a limitation in using only 30 children. A small sample size was, therefore, analyzed by using non-parametric statistics. In addition, other factors such as levels of impairments of children with CAI and levels of physical activity of all children were not recorded. Future studies are recommended to investigate the multidimensional effects of AVGs for improving common impairments of children with CAI.

CONCLUSION

The present study revealed that the 4 selected AVGs were rated as having high enjoyment and usefulness levels of children with CAI and typical children. The catching fish, dancing and Russian block games required variety of movement patterns when compared to running. However, the dancing game caused higher pressure (motivation level) than catching fish and Russian block. In addition, children with CAI performed more DLS in catching fish game than typical children. Therefore, the present study suggested using catching fish and Russian block for rehabilitation purposes of children with CAI. Since these games are inexpensive and have been proved of offering high motivation level and easy to apply in clinic and at home. They may help to improve impairments of CAI and improve exercise adherence in children with CAI. Children with CAI may use these games to exercise at home to save cost of transportation. Further studies are recommended to explore the multidimensional effects of the games in children with CAI.

REFERENCES

1. Hertel J. Functional anatomy, pathomechanics, and pathophysiology of lateral ankle instability. J Athl Train. 2002; 37(4): 364-75.

2. Mandarakas M, Pourkazemi F, Sman A, Burns J, Hiller CE. Systematic review of chronic ankle instability in children. J Foot Ankle Res 2014; 7(1): 1-10.

3. Hiller CE, Refshauge KM, Herbert RD, Kilbreath SL. Intrinsic predictors of lateral ankle sprain in adolescent dancers: a prospective cohort study. Clin J Sport Med. 2008; 18: 44-8.

4. Lekskulchai R, Kadli S. Prevalence and factors associated with chronic ankle instability among children aged 7 to 12 years. J Assoc Med Sci. 2020; 53(1): 42-48.

5. Hale SA, Hertel J, Olmsted-Kramer LC. The effect of a 4-week comprehensive rehabilitation program on postural control and lower extremity function in individuals with chronic ankle instability. J Orthop Sports Phys Ther. 2007; 37(6): 303-11.

6. de Vasconcelos GS, Cini A, Sbruzzi G, Lima CS. Effects of proprioceptive training on the incidence of ankle sprain in athletes: systematic review and meta-analysis. Clin Rehabil. 2018; 32(12): 1581-1590.

7. Gruskay JA, Brusalis CM, Heath MR, Fabricant PD. Pediatric and adolescent ankle instability: diagnosis and treatment options. Curr Opin Pediatr. 2019; 31(1):69-78.

8. Cruz-Díaz D, Lomas Vega R, Osuna-Pérez MC, Hita-Contreras F, Martínez-Amat A. Effects of joint mobilization on chronic ankle instability: a randomized controlled trial. Disabil Rehabil. 2015; 37(7):601-10.

9. Hoch MC, Andreatta RD, Mullineaux DR, English RA, Medina McKeon JM, Mattacola CG, McKeon PO. Two-week joint mobilization intervention improves self-reported function, range of motion, and dynamic balance in those with chronic ankle instability. J Orthop Res. 2012; 30(11):1798-804.

10. Hall EA, Docherty CL, Simon J, Kingma JJ, Klossner JC. Strength-training protocols to improve deficits in participants with chronic ankle instability: a randomized controlled trial. J Athl Train. 2015; 50(1): 36-44.

11. Ha SY, Han JH, Sung YH. Effects of ankle strengthening exercise program on an unstable supporting surface on proprioception and balance in adults with functional ankle instability. J Exerc Rehabil. 2018; 14(2):301-305.

12. Anguish B, Sandrey MA. Two 4-Week Balance-Training Programs for Chronic Ankle Instability. J Athl Train. 2018 Jul;53(7):662-671.

13. Wortmann MA, Docherty CL. Effect of balance training on postural stability in subjects with chronic ankle instability. J Sport Rehabil. 2013; 22(2): 143-9.

14. Sefton JM, Yarar C, Hicks-Little CA, Berry JW, Cordova ML. Six weeks of balance training improves sensorimotor function in individuals with chronic ankle instability. J Orthop Sports Phys Ther. 2011; 41(2): 81-9.

วารสารวิทยาศาสตร์และเทคโนโลยีการกีฬา ปีที่ 20 ฉบับที่ 1, ธันวาคม 2563
Journal of Sports Science and Technology Volume 20, No. 1, 2020

15. Cruz-Diaz D, Lomas-Vega R, Osuna-Pérez MC, Contreras FH, Martínez-Amat A. Effects of 6 Weeks of Balance Training on Chronic Ankle Instability in Athletes: A Randomized Controlled Trial. Int J Sports Med. 2015; 36(9): 754-60.
16. Rohmansyah NA, Hiruntrakul A. The influence of proprioceptive training in foot and ankle disability with chronic ankle sprain. J Health Sci Altern Med. 2019; 1(1): 14-19.
17. Mattacola CG, Dwyer MK. Rehabilitation of the ankle after acute sprain or chronic instability. J Athl Train. 2002; 37(4): 413-29.
18. Lin CW, Delahunt E, King E. Neuromuscular training for chronic ankle instability. Phys Ther. 2012; 92(8):987-91.
19. Hale SA, Hertel J, Olmsted-Kramer LC. The effect of a 4-week comprehensive rehabilitation program on postural control and lower extremity function in individuals with chronic ankle instability. J Orthop Sports Phys Ther. 2007; 37(6): 303-11.
20. Fitzgerald D, Trakarnratanakul N, Smyth B, Caulfield B. Effects of a wobble board-based therapeutic exergaming system for balance training on dynamic postural stability and intrinsic motivation levels. J Orthop Sports Phys Ther. 2010; 40(1): 11-9.
21. Mentiplay BF, FitzGerald TL, Clark RA, Bower KJ, Denehy L, Spittle AJ. Do video game interventions improve motor outcomes in children with developmental coordination disorder? A systematic review using the ICF framework. BMC Pediatr. 2019; 19: 22; 1-15.
22. Staiano AE and Flynn R. Therapeutic Uses of Active Videogames: A Systematic Review. Games Health J. 2014; 3(6): 351-65.
23. Chen H, Li HY, Zhang J, Hua YH, Chen SY. Difference in postural control between patients with functional and mechanical ankle instability. Foot Ankle Int. 2014; 35(10): 1068-74.
24. Tachibana A, Onozuka M. Parietal and temporal neural mechanisms with a multimodal exergame. Proceedings of ICME International Conference on Complex Medical Engineering July I - 4, Kobe, Japan. 2012; 80-85.
25 de Vasconcelos GS, Cini A, Sbruzzi G, Lima CS. Effects of proprioceptive training on the incidence of ankle sprain in athletes: systematic review and meta-analysis. Clin Rehabil. 2018; 32(12): 1581-1590.
26. Hertel J, Corbett RO. An Updated Model of Chronic Ankle Instability. J Athl Train. 2019; 54(6): 572-588.
27. Deci EL, Koestner R, Ryan RM. A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. Psychol Bull. 1999: 125: 627- 68.