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Original Investigation

The Effect of Virtual Reality Exergames on General Mood Scale of Summer Sports Camp Participants with Moderate Intellectual Disabilities

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Purpose: This research aims to present the effect of virtual reality (VR) exergames on the change of general mood in summer camp participants with Moderate Intellectual Disabilities (MID), while observing for the presence of variables such as physical or mental problems with understanding the exergames main task.
Methods: The participants were divided randomly (n= 48) into two groups: experimental (n= 24) and control (n= 24). The experimental group participated in exergames class lasting 30 minutes of physical activity (PA) using VR glasses, while the control group participated in PA at the rope park. Both groups completed two measurements of the General Mood Scale (Positive Mood Scale and Negative Mood Scale) and heart rate before, during and after PA to control the moderate intensity of exercise. Also, each participant was observed for difficulty of exergames main task: understanding commands, interest in the type of PA, motor competence, engagement, completion of PA, difficulties with locomotion after completing main task.
Results: The analysis examined two factors: 'group' (experimental vs. control) and 'measurements' (pre-test and post-test). The study shows a significant interaction effects "group" × "measurements" for the Positive Mood Scale $F_{(1.46)}$= 6.69, P= .013, η^2= .13, power= .72) and the Negative Mood Scale $F_{(1.46)}$= 6.47, P= .014, η^2= .12, power= .70. There were practically no physical or mental problems related to understanding the main task of the exergames (participants scored 95.5%).
Conclusions: Exergames may lead to an increase in Positive Mood Scale and decrease in Negative Mood Scale for summer sports camp participants with MID. Exergames can be used as a PA for MID because of the low possibility of problems with understanding the main task.

Keywords: intellectual disabilities, exergames, virtual reality, mood; emotions; physical activity

Introduction

The International Classification of Diseases-10 (ICD-10) code range for Intellectual Disabilities (ID) F70-F79 is a medical classification list by the World Health Organization. According to ICD-10 classification ID can be categorized as mild, moderate, severe, profound, others or unspecified ID.[1] Mild severity is characterized with an IQ between 50 and 70, moderate is between 35 and 49, severe is between 20 and 34, and profound is less than 20.[1] Moderate Intellectual Disability (MID) is a developmental disorder diagnosed before the age of 18,[1] characterized by significant limitations in both intellectual functioning and adaptive behavior. Research indicates that individuals with MID, both adults and children,[2] engage in lower levels of PA compared to their peers with typical development. Such individuals have limited speech range, usually require daily supervision, but are able to engage in simple social activities. Functioning in the area of self-care and motor skills is also impaired. This reduced PA is linked to poor fitness, including low cardiovascular fitness, muscular strength and endurance, and higher rates of overweight and obesity.[3] Consequently, there is a pressing need to develop effective strategies to increase PA participation among individuals with ID, especially children and young adults, who are developing enduring exercise routines.

International classifications categorize intellectual disability based on the degree of cognitive impairment and daily functioning.[1] Psychological practice employs various intelligence tests, often divided into three categories: fluid intelligence, crystallized intelligence, and tests designed for specific populations, such as children.[4] The Raven's Progressive matrices test assess fluid intelligence, which measures innate problem-solving abilities.[4] Fluid intelligence is the ability to reason and solve unfamiliar problems without relying on prior knowledge. It tends to decline with age, especially after the late twenties, and is influenced by genetic factors.[4] The David Wechsler Intelligence Scale is a widely used tool for measuring crystallized intelligence, reflecting acquired knowledge and skills. Crystallized intelligence, on the other hand, represents the ability to apply learned knowledge to problem-solving. It generally increases with age. The currently used WISC-V intelligence test assesses five cognitive abilities: visual-spatial processing, fluid reasoning, working memory, processing speed, and verbal comprehension. Individual scores from these domains are combined to calculate an overall full-scale intelligence quotient.[4] For young children, the Leiter International Performance Scale is a popular nonverbal intelligence test.[5]
Exergames, incorporating interactive technology and immersive VR experiences, have shown promise in promoting physical

activity [6] and may be used as a tool of physical education lessons.[7] By combining video gameplay and physical activity, exergames offer a potentially valuable approach to enhancing physical activity engagement and improving health outcomes.[8,9] Some study attempted to confirm the exergame motivation and the results indicated that exergames was useful and efficient tools for improving PA attitudes and behaviors for MID children.[10] The study [10] suggest the mechanism behind exergames influence as essential factors are: self-presence, mood, and enjoyment. Mood and cognitive performance can be increased in individuals with mild IDs after one session of 30 minutes of moderate level of PA.[11]

Moods tend to shape thought processes, which in turn influence behavior across various situations.[12] In contrast, emotions often elicit immediate, specific responses to pressing circumstances.[12] Moods seem to influence how people perceive, interpret, plan, and execute strategic interpersonal behaviors, ultimately affecting the social information they focus on and their chosen processing strategies.[12] Research on coping, which involves intentional efforts to manage emotions, thoughts, actions, and physical responses to stressful situations,[13] has found that adults with mild ID tend to rely less on emotion-focused coping strategies than non-emotional ones. This may indicate specific challenges in processing and managing emotions.[14,15] Therefore, findings of the study need to be confirmed with studies that use observational methods (e.g., in virtual environments) and teacher-reports of mood regulation as an addition to self-reports.[15]

Although social inclusion is a fundamental aspect of quality of life for individuals with ID,[16] historically, they have faced obstacles to participating fully in community settings and are more likely to experience exclusion compared to those without a diagnosis.[17] People often gravitate toward communities that share their characteristics, so while ID individuals now have more integrated opportunities, true inclusion remains a distant goal.[18] Summer sports camps offer a distinctive community where youth prioritize fun, social interaction, and personalized learning for individuals with ID.[19] Studies have found that camp participation can boost self-esteem and provide a supportive environment for learning.[20,21]

For the existing indications that the exergaming can change the mood, a comprehensive review of the literature revealed no prior studies investigating exergaming experiences of summer camp participants with MID have been reported. In this study we hypothesized that: exergames would lead to an increase in Positive Mood Scale and a decrease in Negative Mood Scale. We also hypothesized that exergames can be used as a PA for summer sports camp participants with MID because of the low possibility of problems with understanding the main task.

Methods

Participants

All participants (n= 60) of a summer sports camp were approached on the basis that they were pupils either special schools and they have MID (using information from both the special school they attended basis on psychological and pedagogical diagnosis and the summer sports camp qualification card provided by their parents who were also obliged to provide appropriate data by attached a photocopy certified degree of MID from psychological and pedagogical counseling center).

The level of physical fitness and mental health was assessed by the physical education (PE) teacher and psychologist of their school as good to be able to participate in the sports camp. All participants exercise regularly in PE lessons in their schools

Twelve participants were subsequently excluded from the study due to below of moderate conversation and comprehension skills, leaving data from 48 participants to go forward for analysis.

A total of 48 participants (male= 29; female= 19) with age 15.56±2.98 years, took part in the study.

Inclusion criteria were: no VR experience before study; VR familiarization successfully completed; MID; participants of a summer sports camp who attend the camp 1 time in a year; at least moderate level of conversation and comprehensions skills; wearing or not correction glasses (a special overlay for glasses was applied); right or left-handed; no psychotropic medicines; lack of long term injuries and fresh injuries.

The Experimental group consisted of 24 participants (male= 15; female= 9) aged between 9 and 23 years (age 15.12±2.80 years) and were for this group randomly selected. The body weight of the Experimental group participants was within the range 41.50 and 83.00 kg (Body mass 58.38±14.80 kg) and stature was within the range 149.60 cm and 190.00 cm (stature 168.25±8.39 cm). The heart rate (HR) was collected heart rate before, during and after physical activity, and mean data are presented as shown: -10 minutes before start the activity (HR 66.08±8.50 bpm), 5 minutes of activity (HR 79.67±9.36 bpm), 15 minutes of activity (HR 94.29±12.23 bpm), 25 minutes of activity (HR 109.17±12.98 bpm) and +5 minutes after activity (HR 122.96±13.45 bpm).

The Control group consisted of 24 participants (male= 14; female= 10) aged between 9 and 23 years (Age 16.00±3.15 years) and were for this group randomly selected. The body mass of the Control group participants was within the range 38.00 and 86.00 kg (Body mass 58.72±15.42 kg) and stature was within the range 150.20 and 187.00 cm (Stature 170.02±7.74 cm). The heart rate was collected heart rate before, during and after physical activity, and mean data are presented as shown: -10 minutes before activity (HR 54.10±7.77 bpm), 5 minutes of activity (HR 68.05±5.12 bpm), 15 minutes of activity (HR 90.19±13.02 bpm), 25 minutes of activity (HR 112.10±10.83 bpm) and +5 minutes after activity (HR 124.88±15.66 bpm).

Participants and they parents were fully informed about the study procedures and provided written consent. The study was approved by the Bioethics Committee and aligns with the Helsinki Declaration.

Design

Summer sports camp participants and their parents attended an information meeting conducted by the researcher and the camp manager. They were informed of the study and encouraged to ask questions, after which they signed a written consent form if they agreed to participate.

Summer sports camp participants came once to be approved for research and to take part in the main task of the study. A subject who did not complete 2 out of 5 verbal commands such as: raise both hands up, squat, count to ten out loud, describing outfit; describing your mood; was not qualified for the study. Completion of all commands was assessed as very good conversation and comprehension skills, 4 out of 5 as good conversation and comprehension skills, and 3 out of 5 as a moderate conversation and comprehension skills. Twelve participants were subsequently excluded from the study due to below of moderate conversation and comprehension skills. Then, 48 people selected for the study began familiarization with the VR equipment and the rope park. The subjects were allowed to touch the equipment, put on VR glasses and controllers, put on a safety harness in the rope park, and view obstacles in the rope park. Familiarization was on morning time and duration time

was 20 minutes.

We randomly divided the group of *n*= 48 summer camp participants (randomized controlled study) with MID into two groups: Experimental group (*n*= 24) and Control group (*n*= 24). The Experimental group participated in exergames class lasting 30 minutes of PA using VR glasses, while the control group participated in PA at the rope park also for 30 minutes. Both groups completed two measures of the General Mood Scale: Positives Mood Scale and Negatives Mood Scale (pre-test and post-test) and heart rate before, during and after physical activity. Trained researchers conducted in-person interviews with each subject, administering General Mood Scales verbally. The interviews lasted approximately 5-10 minutes. To maintain consistency, researchers followed a prepared script. Recognizing the potential challenges of using self-report measures with individuals with MID, we implemented additional procedures. Each mood descriptor was presented individually, and subjects were asked to confirm their understanding. If there was any uncertainty or confusion, we provided up to two alternative words to clarify the meaning. To facilitate children's comprehension of the Likert scale, each response option on the 5-point scale was illustrated with a relevant picture (an emoticon).

Also, each participant was observed for difficulty of exergames task: understanding commands, interest in the type of PA, motor competence, engagement, completion of PA, difficulties with locomotion after completing physical activity. To facilitate the recording of the occurrence of the above-mentioned variables, a proprietary Observation Questionnaire was used. A graphical representation of the research procedure is available in Figure 1.

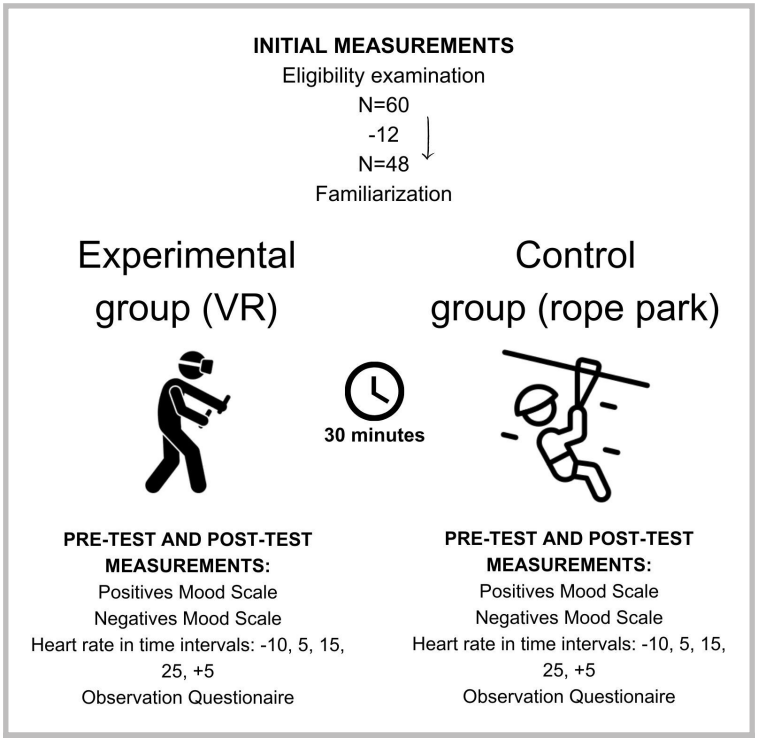

Figure 1. A graphical representation of the research procedure

Methodology

Technology

The VR Meta Quest 2 128 GB system (Meta Platforms Technologies Ireland Limited, 2023, Ireland) was used as the VR environments in this study, consisting of a wireless headset through which the VR environment could be viewed and exergaming, two hand controllers that enabled interaction with the VR environment. To ensure proper performance, the room size should be at least 2.0 × 2.0 meters. The VR Meta Quest 2 128 GB has display 5.7 inches, resolution 1832 × 1920 pixels per eye, OLED display type, refresh frequency 60-90 Hz. The name of the game which was used is Oh Shape and was distributed from Meta Quest store app.

General Mood Scale

The General Mood Scale is consisting of 10 statements divided into the Positive Mood Scale and the Negative Mood Scale rated on a 5-point scale.[22] The scales are characterized by satisfactory psychometric properties. The authors indicate that Cronbach's alpha for the General Mood Scale used on a group of children is .89 (.75 for the Positive Mood Scale and .79 for the Negative Mood Scale), and for adults is .96. Respondents filling out the scale indicate on 5-point rating scales how much they agree or disagree with each of these statements. The overall scale score is the average of the ratings from the individual rating scales (so the score can vary from 1 to 5). Items describing the General Mood Scale are: 1. I am in a bad mood; 2. I feel great; 3. I am in a bad mood; 4. I feel relaxed and calm; 5. I feel gray and hopeless; 6. I have a good humor; 7. I am cheerful; 8. I feel depressed; 9. My well-being is bad; 10. My well-being is good. Questions number 2,4,6,7,10 form a set of Positive Mood Scale and questions number 1,3,5,8,9 form a set of Negative Mood Scale. The General Mood Scale was used in polish version with the addition of a proprietary table with a scale from 1 to 5 adapted for disabled people. Recognizing the difficulties that adults and children with intellectual disabilities encounter in understanding Likert scale, simplifying the wording of the original scale is a common approach to reduce cognitive demand.[10,23,24] To improve children's understanding of the Likert scale, each response option on the 5-point scale was illustrated with a visually representative picture (an emoticon). In contrast, the researcher provided presented the questions to the participants orally as well. Emoticons card with 5-point rating scales is available in Figure 2. The General Mood Scale was chosen because of its simple structure enabling measurement in a group of people with ID and because the authors of the questionnaire emphasize its unique structures of use before and after the experimental

session, regardless of the time period of the study without compromising on reliability.[22]

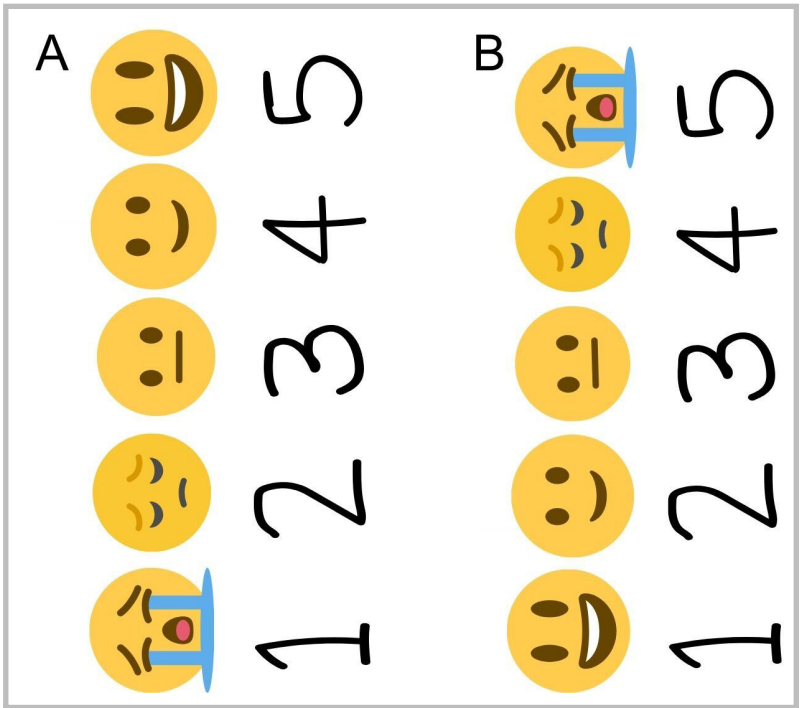

Figure 2. Emoticons card with 5-point rating scales (A. Positive Mood Scale version, B. Negative Mood Scale version)

Exergames main task

Experimental group take part in 5 minutes of warm-up (minute for each): running in place, arm swings, torso twists, torso bends, warming the joints: wrist, ankle. The safety space for the subjects to move was a square of 2.5 × 2.5 meters. In the VR environment, the controllers were represented by hands with gym gloves. The 2-minute tutorial was built in steps, with each step being supported by instructions on what tasks to perform to meet the goal to proceed to the next step and the tasks were graded from the easiest (touch) to the most difficult (squat and hit by both arms). The task had 28 minutes, and the main part of the task involved collecting yellow coins, matching the subject silhouette to the appearing holes in the transparent wall which was approaching, and avoiding yellow walls and breaking the red ones. This task was performed by moving the whole body around the safe space. During exergames, heart rate was collected by Xiaomi Mi Band 4 on wrist (Xiaomi, Pekin, China). Data were collected for two reasons: first, it allowed for real-time monitoring of participants' health (if there were any alarming readings despite the participant's lack of comment, the study could be stopped, a heart rate above 80% would be alarming); second, it allowed for monitoring of physical effort, which assumed to be moderate in both groups. The Observation Questionnaire was filled by researcher. Figure 3A-B section illustrates the MID subjects engaged in exergaming while fully immersed in a VR headset (A. Example of participant X; B. Example of participant Y).

Figure 3. Moderate Intellectual Disability subjects engaged in virtual reality exergaming (A. Example of participant X; B. Example of participant Y).

Observation questionnaire

Each subject was observed by researcher for difficulty of exergames main task: understanding commands, interest in the type of physical activity, motor competence, engagement, completion of PA, difficulties with locomotion after completing PA. The first five variables were rated as: yes (2 points), partially (1 points), no (0 points). The last one was inverted as: no (2 points), partially (1 points), yes (0 points). Data were collected through an Observation Questionnaire created by the study authors.

Statistical Analysis

All data are reported as mean and standard deviation (SD), while the frequency analysis are reported as percentage (%). The level of significance was set with $P < .05$ and data analysis was performed with Statistica 13.0 software (TIBCO Software Inc., Palo Alto, CA, USA). Two-way repeated measures ANOVA was used to analyze the variability of dependent variables, and the Tukey HSD post hoc was done as well. The Shapiro-Wilk test confirmed that most variables had approximately normal distributions. The analysis examined two factors: 'group' (Experimental vs. Control) and 'measurements' (pre-test or post-test). Partial eta-squared η^2 was calculated to assess the effect size of the 'group' × 'measurements' interaction.

Results

The analysis examined two factors: 'group' (experimental vs. control) and 'measurements' (pre-test and post-test). The study shows: a significant interaction effects "group" × "measurements" for Positive Mood Scale $F_{(1.46)} = 6.69$, $P = .013$, $\eta^2 = .13$, power = .72 and a significant interaction effects "group" × "measurements" for Negative Mood Scale $F_{(1.46)} = 6.47$, $P = .014$, $\eta^2 = .12$, power = .70. Detailed data are available in Table 1.

Table 1. Interaction effect for pre-test and post-test measurements for General Mood Scale

Group	Positive Mood Scale a.u.		Interaction effect	Negative Mood Scale a.u.		Interaction effect
	Pre-test	Post-test	*P value*	Pre-test	Post-test	*P value*
Experimental group	3.62	4.70	$P = .013$	2.10	1.43	$P = .014$
Control group	3.89	4.43		1.70	1.68	

Expected marginal means and significant interaction effect ($P = .013$) are showed in Figure 4A, while the Positive Mood Scale ($P = .014$) in Figure 4B. Negative Mood Scale. Post-hoc comparisons for Positive Mood Scale using the Tukey HSD test showed statistically significant differences between groups ($P < .001$). Post-hoc comparisons for Negative Mood Scale using the Tukey HSD test showed statistically significant differences only within experimental group ($P < .001$).

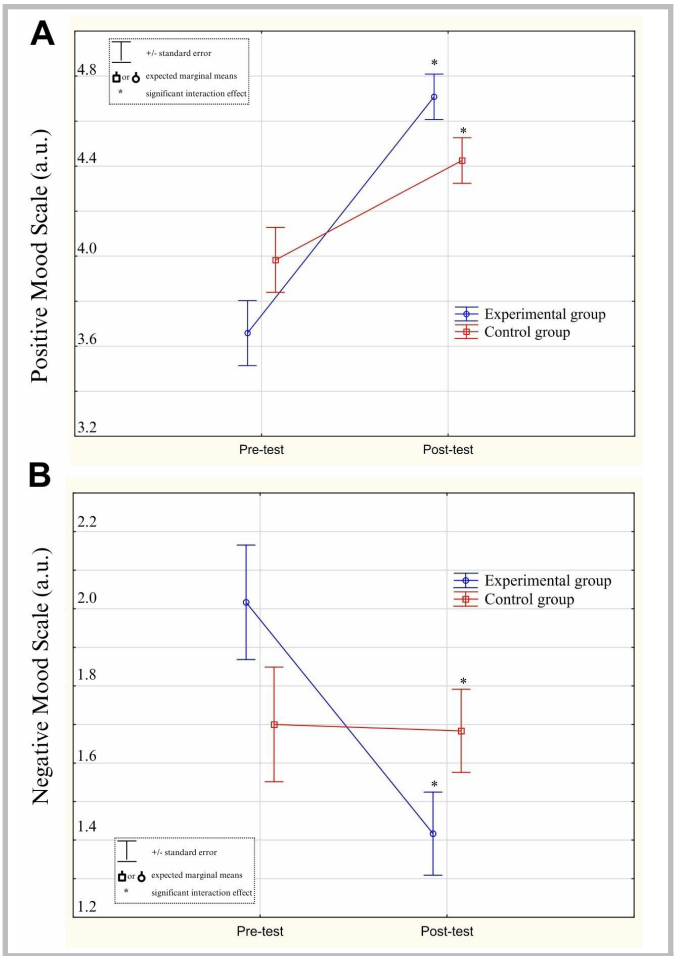

Figure 4. The effect of exergames in General Mood Scale (A. Positive Mood Scale, B. Negative Mood Scale)

Physical or mental problems with understanding the exergames main task were almost did not appear (participants obtained 95.5% of the possible score). Detailed data from Observation Questionnaire data for each item of exergames main task are presented in Table 2.

Table 2. Observation Questionnaire data for each item of exergames main task.

Observation Questionnaire items	Experimental group points	Result for Observation Questionnaire items Experimental group VERBAL RATING (n; %)	Control group points	Result for Observation Questionnaire items Control group VERBAL RATING (n; %)
1. Understanding commands	2.00	**YES** (n=24; 100%) **NO** (n=0; 0%) **PARTIALLY** (n=0; 0%)	2.00	**YES** (n=24; 100%) **NO** (n=0; 0%) **PARTIALLY** (n=0; 0%)
2. Interest	2.00	**YES** (n=24; 100%) **NO** (n=0; 0%) **PARTIALLY** (n=0; 0%)	2.00	**YES** (n=24; 100%) **NO** (n=0; 0%) **PARTIALLY** (n=0; 0%)
3. Motor competence	1.92	**YES** (n=22; 91.7%) **NO** (n=0; 0%) **PARTIALLY** (n=2; 8.3%)	1.83	**YES** (n=21; 87.5%) **NO** (n=1; 4.2%) **PARTIALLY** (n=2; 8.3%)
4. Engagement	2.00	**YES** (n=24; 100%) **NO** (n=0; 0%) **PARTIALLY** (n=0; 0%)	2.00	**YES** (n=24; 100%) **NO** (n=0; 0%) **PARTIALLY** (n=0; 0%)
5. Completion of main task	1.83	**YES** (n=21; 87.5%) **NO** (n=1; 4.2%) **PARTIALLY** (n=2; 8.3%)	1.79	**YES** (n=18; 75.0%) **NO** (n=1; 4.2%) **PARTIALLY** (n=5;20.8%)
6. Difficulties with locomotion	1.71 **Result score:** 11.46/12.00 (95.5%)	**YES** (n=2; 8.3%) **NO** (n=19; 79.2%) **PARTIALLY** (n=3;12.5%)	1.79 **Result score:** 11.41/12.00 (95.1%)	**YES** (n=2; 8.3%) **NO** (n=21; 87.5%) **PARTIALLY** (n=1;4.2%)

Footnote: n – number of people. The 1-5 items were rated as: yes (2 points), partially (1 points), no (0 points). The 6 item was inverted as: no (2 points), partially (1 points), yes (0 points). The maximum score that can be obtained was 12 points.

Discussion

The aim of the current study was to gain more insight into exergames and the mood changing of summer sports camp participants with MID. Results showed that exergames would lead to an increase in positives mood and decreased in negatives mood after one session of VR PA in the summer sports camp. Within the experimental and control group researcher reported that exergames can be used as a PA for MID because of the low possibility of problems with understanding the main task.

The findings of the current study, first, show that exergames would lead to an increase in positives mood and decrease in negatives mood after one session of VR on the summer sports camp. On the one hand, this might imply that children and young adults with MID who attend the camp at least 1 time in a year haven't difficulties in regulating their mood. People often gravitate toward communities that share their characteristics. Summer sports camps offer a distinctive community where youth prioritize fun, social interaction, and personalized learning for individuals with ID.[19] Studies have found that camp participation can boost self-esteem and provide a supportive environment for learning.[20,21] On the other hand, exergame is a type of PA that may influenced differently on MID peoples than another PA available on the summer sports camp. For this study, two types of PA available at the summer sports camp were used: one VR session or one session in a rope park. The selection was random, and participants had a chance to familiarize themselves with each type of activity, according to the researchers, was

supposed to increase the reliability of the study and is important for increasing comfort and confidence among individuals with MID.[25,26]

Another important aspect is adapting the questionnaire to the capabilities of MID. In order to accommodate the cognitive limitations of young adults and children with IDs, simplifying the wording of scales is a standard practice to enhance comprehension.[27] This helps reduce the overall complexity of the assessment. To enhance children's understanding of the Likert-type items in this study, we used two strategies: first, we paired each answer option with a corresponding visual aid (an emoticon), and second, we presented the questions orally in addition to the written format. Thanks to this prepared questionnaire of the General Mood Scale, the study participants had no problem in indicating their answers to the questions.

The last result of the current study indicates that exergames can be used as a PA for summer sports camp participants with MID because of the low possibility of problems with understanding the main task. The researchers emphasize that MID participants who met the conditions for inclusion in the study had no difficulties in understanding the task. The task understanding consisted of the six following variables: understanding commands, interest in the type of PA, motor competence, engagement, completion of PA, difficulties with locomotion after completing main task. The results in the Experimental group (11.46/12.00 points; 95.5%) and Control group (11.41 /12.00 points; 95.1%) differed only slightly. Detailed information from the Observation Questionnaire for Experimental group and Control group provides information about the scoring in each mentioned aspect. It can be concluded that any PA at a summer sports camp is good choice for MID. However, it is important to remember to choose an activity of moderate intensity and 30 minutes of duration.[11]

Practical applications

Based on these findings, several practical applications may be considered:

1. Incorporating exergames into summer sports camp programs for MID people, especially for children and young adults.
2. Involve exergames as a therapeutic tool for managing mood in individuals with MID.
3. Promote exergames as inclusive physical activity options for MID individuals with various abilities.
4. Foster a sense of belonging and empowerment through shared physical activities.

The study's findings highlight the potential benefits of exergames for individuals with MID. By incorporating exergames into summer camp programs and therapeutic interventions, we can create more inclusive and engaging experiences that promote physical activity, mental health, and social well-being.

The study focused on the age group of 9 to 23 years with MID. Due to the limited research, more studies are needed to draw definitive conclusions about their effects. The authors see the need to conduct further research, especially long-term studies.

Conclusions

Exergames may lead to an increase in Positive Mood Scale and decrease in Negative Mood Scale for summer sports camp participants. Exergames can be used as a PA for MID people because of the low possibility of problems with understanding the main task.

Acknowledgments

Not applicable.

Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Ethical Committee approval

Bioethics Committee at the Karol Marcinkowski Medical University in Poznań (no. 684/23).

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Topic

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Conflicts of interest

The authors have no conflicts of interest to declare.

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Author-s contribution

Conceptualization, J.C. and T.B.; methodology, J.C; T.B software, J.C.; validation, J.C.; formal analysis, J.C., T.B., and A.W.; investigation, J.C.; resources, J.C. and T.B.; data curation, J.C., T.B,; writing—original draft preparation, J.C. and T.B.; writing—review and editing, J.C., T.B., J.M. and A.W.; visualization, J.C. and T.B.; supervision, J.M.; project administration, J.C. and T.B. All authors have read and agreed to the published version of the manuscript.

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