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Zoom-delivered Physical Activities Can Increase Perceived Physical Activity Level in Children with Autism Spectrum Disorder: a Pilot Study

Erkan Yarımkaya[1] · Oğuz Kaan Esentürk[2] · Ekrem Levent İlhan[3] · Serkan Kurtipek[3] · Ayşe Türksoy Işım[4]

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Abstract

Although the benefits of regular physical activity are clearly expressed, children with Autism Spectrum Disorder (ASD) are less physically active than their typically developing peers. Recent empirical studies have revealed that the level of physical activity of children with ASD has further decreased during the novel coronavirus (COVID-19) pandemic, which has adversely affected the whole world. The aim of this study was to evaluate the potential efficacy of a Zoom-delivered physical activities for children with Autism Spectrum Disorder (ASD). Twenty-two families (parent and child dyads) participated in the study. Families were assigned randomly to an experimental group (n = 11) and a control group (n = 11). Families in the experimental group were engaged in 10 weeks of the Zoom-delivered physical activities. Data were collected using multiple data collection strategies (Personal Information Form- Leisure Time Exercise Questionnaire–Semi-Structured Interview). After the Zoom-delivered physical activities, a significant increase was observed in the physical activity level of children with ASD in the experimental group ($F = 95.396$, $p = 0.000$, $\eta^2 = 0.834$). Parents reported that Zoom-delivered physical activities are a viable and useful intervention to increase the level of physical activity of children with ASD. The findings suggest that Zoom-delivered physical activities merit further investigation as an intervention to increase physical activity in children with ASD.

Keywords Neurodevelopmental disorder · Intervention · Zoom · Exercise · Perception

✉ Erkan Yarımkaya
yarimkayaerkan@gmail.com

Extended author information available on the last page of the article

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Introduction

Autism spectrum disorder (ASD) is characterized by deficits in social communication and social behavior, including problems interpreting nonverbal gestures, difficulty in developing age-appropriate friendships, and adapting to environmental change (American Psychiatric Association, 2013). ASD negatively affects not only the social skills of children with this diagnosis, but also their physical activity level (Bandini et al., 2013; Pan & Frey, 2006). Children with ASD are less physically active compared to their typically developing peers (McCoy et al., 2016) and tend to lead a mostly sedentary life (Zuckerman et al., 2014). A high level of sedentariness is a major concern for children with ASD, which increases their risk of developing health problems (Garcia-Pastor et al., 2019). It is because children with ASD have fewer opportunities to participate in physical activity and exercise, which exposes them to the risk of developing other health problems (Pan et al., 2011). There are many factors that increase the sedentary behavior in children with ASD (Hinckson et al., 2013). Many individuals with disabilities, including children with ASD, are more inclined to spend a large amount of time on inactive behavior, such as watching television or occupations that often involve inactivity (Must et al., 2014), and parents often use this as a tool to engage their children with ASD (Sandt & Frey, 2005). In addition, the limitations experienced by children with ASD in the areas of social, cognitive, behavioral and physical development negatively affect their physical activity levels (Bandini et al., 2013; Pan & Frey, 2006; Yarımkaya & Esentürk, 2020a).

Physical activity is an effective practice recommended for reducing the risks arising from the developmental characteristics and sedentary lifestyle of children with ASD. According to the National Professional Development Center on ASD (NPDC on ASD 2014) report, physical activity is included in evidence-based interventions. Previous studies have revealed that participation in physical activity positively affects various developmental areas of children with ASD (Healy et al., 2018; Petrus et al., 2008). Children with ASD who participate in physical activities show improvement in their manipulative skills, locomotor skills and skill-related fitness (Lalonde et al., 2014; Menear & Neumeier, 2015). Moreover, children with ASD who participate in physical activities increase their communication and socialization skills, as well as their self-confidence and self-efficacy level (Colombo-Dougovito & Block, 2019; Lang et al., 2010; Sowa & Meulenbroek, 2012; Yarımkaya et al., 2017).

As seen in the literature, studies aimed at improving physical activity in children with ASD reveal that physical activities have a critical impact on the biological and psycho-social development of these children (Yarımkaya et al., 2021). While these results are encouraging, the novel Coronavirus (COVID-19) pandemic, which has affected the world deeply since spring 2020, has emerged and access to available physical activity programs for children with ASD has been severely restricted. As part of the measures taken by governments to combat the pandemic, schools and rehabilitation centers where children with ASD received physical education were closed. Children with ASD faced risks of

physical inactivity and sedentary life during the pandemic. Studies (Esentürk, 2020; Yarımkaya & Esentürk, 2020a) reported that during the COVID-19 pandemic, sedentary behaviors, excessive eating habits and behavioral problems of children with ASD increased, while their motor skills decreased. These studies also reported that parents did not know what to do to increase the physical activity level of their children with ASD and they lacked an appropriate physical activity program. For this reason, the researchers suggested that there was a need for an alternative physical activity program that children with ASD could do at home with their parents and could reach wider audiences (Esentürk & Yarımkaya, 2021a). The COVID-19 pandemic has changed and transformed the learning and teaching processes of children with ASD, as well as affecting their daily lives and routines. There has been an abrupt transition to distance education in all disciplines, including physical education, for children with ASD. Along with distance education, internet technologies, programs and applications have begun to be used and evaluated more in the education process of children with ASD. One of these applications is the Zoom software (Yarımkaya & Esentürk, 2020b).

Platforms such as Zoom software are thought to be an important alternative model for providing physical activity to children with ASD, who cannot access physical activity due to the COVID-19 pandemic and other reasons. Educators can show remotely physical activity examples to children with ASD and their parents via Zoom software and contribute to increasing their physical activity level with instant feedback. Zoom software is a useful application that can act as a bridge between educators and students, facilitates communication with many people at the same time, and supports learning needs in today's digital environment (Fitriyani et al., 2020). Zoom software is easily accessed using computers, tablets or smartphones. Zoom software allows students to attend the class at the same time, share audio, video and screens with each other and follow the explanations and feedbacks of the educators without having to come together physically (Laili & Nashir, 2020). To our knowledge, there is only one study examining the effects of physical activity delivered remotely via platforms such as Zoom software on the physical activity level of individuals with ASD. Garcia et al. (2021) reported that remotely delivered judo activities via Zoom are an effective intervention to increase the physical activity level of youth with ASD. Although the results of study reveal that remotely delivered physical activities seem useful for youth with ASD, the study involved judo, which requires specialized personnel, costly special equipment, and non-naturalistic venues. In the current study, unlike the study of Garcia et al. (2021), the focus is on creating physical activities that can be done easily in the home environment and presenting these physical activities to children with ASD and their parents in sync via Zoom software. It is anticipated that the results of the study will contribute to the stakeholders (parents, teachers, academics, caregivers, etc.) on how to increase the physical activity level of children with ASD through Zoom. In this context, the main purpose of the current study is to examine the efficacy and applicability of Zoom delivered physical activities to increase the physical activity level of children with ASD. In line with this general purpose, the questions sought to be answered in the research are as follows:

1. Is there a significant change in the physical activity level of children with ASD after zoom-delivered physical activities?
2. What are the parents' opinions on the changes in the physical activity level of their children with ASD and on Zoom-delivered physical activities?

Method

Study Design

This study used the explanatory mixed-method design consisting of quantitative and qualitative stages. In this design, quantitative data are collected on the subject to be investigated, and then qualitative data are obtained in order to explain the quantitative data (Creswell & Clark, 2011). In the quantitative stage of the study, the effects of 10-weeks Zoom-delivered physical activities on the physical activity level of children with ASD were investigated through a quasi-experimental design with experimental and control groups. In the qualitative stage, semi-structured interview questions were used to explore the changes in the physical activity level of children with ASD and parents' views on Zoom-delivered physical activities. Qualitative findings were collected to assist explain and interpret the findings of the quantitative stage. Finally, quantitative and qualitative findings were interpreted together (see Fig. 1 for flow chart of current study).

Participants

A total of 22 families (parent and child dyads) participated in the study (see Table 1 for participant characteristics). Participants were recruited from four special education and rehabilitation centers serving children with ASD during the COVID-19 pandemic in Ankara, Turkey. As a result of the first COVID-19 case in Turkey on March 11, 2020, some rapid and protective measures were taken by the Turkish government. One of these measures was the closure of schools where children with ASD received education, excluding care centers. There are special education and rehabilitation centers, special education schools, special education classes and inclusive classes for children with ASD in the Turkish education system. Special education and rehabilitation centers are education centers that offer additional support to children with ASD outside of school time (Yarımkaya & Töman, 2021). At the time of data collection (18 December 2020–1 March 2021), special education and rehabilitation centers where children with ASD received education were closed due to COVID-19 measures.

The criterion sampling method, which is one of the purposive sampling methods, was used to determine the participants (Creswell, 2014). The criterion sampling model involves the selection of participants according to predetermined criteria in accordance with the purpose of the research (Merriam & Tisdell, 2015). The criteria in the study are: a) agreeing to participate in the study voluntarily, b) having a child with ASD, c) parents and children not having any health problems that prohibit

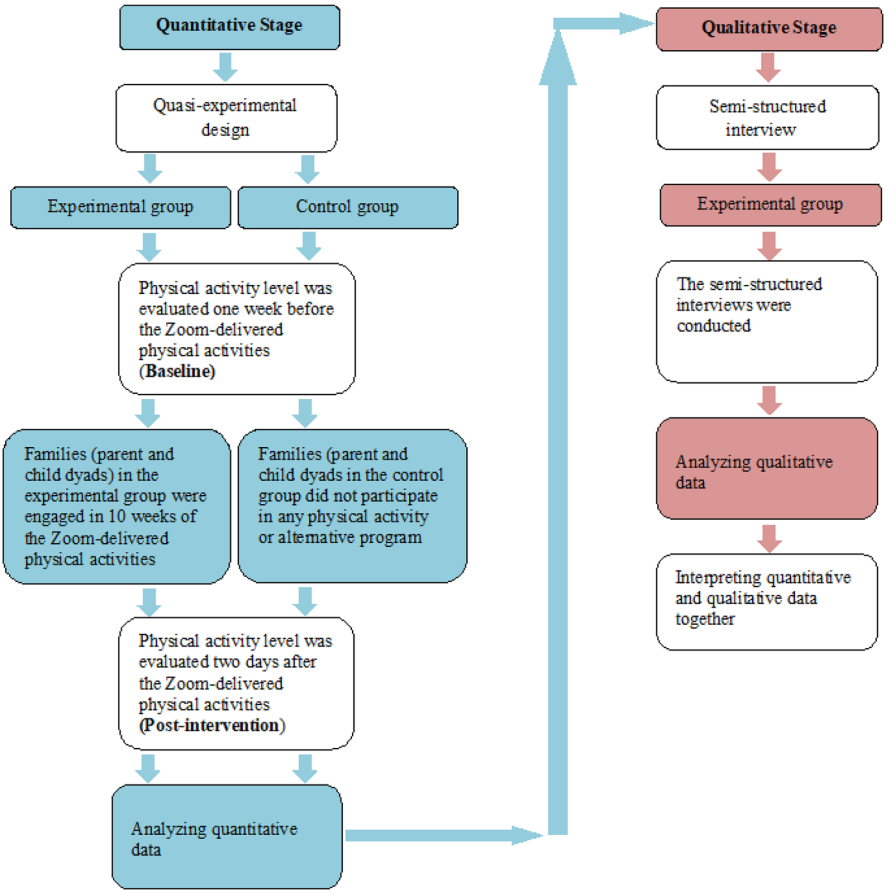

Fig. 1 Flow chart for the current study

physical activity, and d) parents agreeing to be interviewed on the phone. In line with these criteria, support was received from special education and rehabilitation centers for the identification of parents. We identified only 22 families who met the criteria from the special education and rehabilitation centers in our region that we knew before. Since special education and rehabilitation centers are closed due to the pandemic, we could not contact special education and rehabilitation centers in remote areas. With the cooperation of the directors of the rehabilitation centers, the primary researcher talked to the parents having children with ASD on the phone and explained the purpose of the study and the participation process to the parents. Children with a formal diagnosis of ASD (doctor and hospital-approved) were learned during initial eligibility visits through the directors of their rehabilitation center. Also, information on the potential severity of children's ASD symptoms and health problems that prohibit physical activity was obtained through parent self-reports. Parents expressed their self-reports to the researchers in three ways:

Table 1 Participant characteristics

			Groups	
			Experimental (n = 11)	Control (n = 11)
Children (n = 22)	Sex n(%)			
		Female	4(36.37%)	3(27.27%)
		Male	7(63.63%)	8(72.73%)
	Age (M + Sd)		10.72 + 0.82	9.27 + 0.97
	Diagnosis n(%)			
		ASD	11(100%)	11(100%)
	Additional comorbidities n(%)			
		ID	6(54.55%)	4(36.37%)
		LD	3(27.27%)	5(45.45%)
		N	2(18.18%)	2(18.18%)
Parents (n = 22)	Sex n(%)			
		Female	9(81.82%)	7(63.63%)
		Male	2(18.18%)	4(36.37%)
	Age (M + Sd)		36.2 + 4.23	38.4 + 5.47
	Education n(%)			
		Secondary school	3(27.27%)	2(18.18%)
		High school	2(18.18%)	4(36.37%)
		University	6(54.55%)	5(45.45%)

M Mean, *Sd* Standard deviation, *ASD* Autism Spectrum Disorder, *ID* Intellectual Disability, *LD* Learning Disability, *N* None

1) telephone interviews, 2) demographic information form, and 3) consent form. According to parent self-reports, hospital doctors used CARS, M-CHAT, medical observations, and medical techniques in the process of diagnosing their child with ASD. No observations were made on children with ASD during the determination of the participants. A consent form was requested from the families regarding their voluntary participation in the study via e-mail. The families were randomly divided into two groups as the experimental group (n = 11) and the control group (n = 11). All families completed the intervention and the measures. However, families (parent and child dyads) were sometimes absent. In general, the attendance to the sessions was around 80%. No action was taken for the absent families and the missed session was skipped. Characteristics of parents and their children with ASD are presented in Table 1.

Parent Teaching

Before the zoom-delivered physical activities, parents in the experimental group (n = 11) were given parent-mediation training in three separate 40-min sessions to ensure that the parents were ready to practice the physical activities. These training sessions were prepared in the light of previous studies (Esentürk & Yarımkaya,

2021a, b; Healy & Marchand, 2020; Yarımkaya & Esentürk, 2020b) that offered suggestions for the active participation of children with ASD in physical activities together with their parents. In sessions supported with visual presentations, (1) information about preparing children with ASD for physical activities (wearing sports clothes, social stories, preview of activities and equipment), (2) organizing the environment where physical activities will take place (safety, ventilation of the environment and sports pictures), (3) including other members of the family in physical activities (parent and sibling participation) and (4) rewarding is given. In addition, a special WhatsApp group was created to provide parents with the Zoom access link and to provide them with information about physical activities. Before the Zoom-delivered physical activity sessions, the Zoom access link was shared in the WhatsApp group. Parents' questions about the implementation of physical activities and the use of Zoom software were answered instantly via the WhatsApp group. Moreover, at the end of each daily physical activity session, parents chatted in the WhatsApp group to evaluate the efficacy of the session and to explore the experiences of the parents.

Zoom-delivered Physical Activities

Zoom-delivered physical activities were created to increase the physical activity level of children with ASD. The program was implemented for 10 weeks, 4 days a week and 30–35 min a day (20 December 2020 – 28 February 2021). Children with ASD in the experimental group and their parents participated in physical activities together. During the study, children with ASD in the control group did not participate in any physical activity or an alternative program. In the preparation of Zoom-delivered physical activities, studies in which physical activities were delivered remotely for children with ASD (Esentürk & Yarımkaya, 2021a; Healy & Marchand, 2020; Yarımkaya et al., 2021) were used. Each daily physical activity session consisted of 3 periods = a) a warm-up period of about 10 min, b) a physical activity period of about 10 min, and c) a stretching-cool down period of about 10 min. *The warm-up period* included short-distance walking, rotation of joints in the extremities such as knees and ankles, hips, neck and shoulders, and stretching movements accompanied by music. During *the physical activity period*, home-based exercises (plank, back extensions, squats, side knee lifts, superman, bridge, chair dips, chest opener, child's pose, seated meditation and legs up the wall), fun games that can be made using items which can be found in the home environment, dance activities such as hip hop, zumba and fitness activities (jumping jacks, burpees, squat, plank, synchronized step, knee bending, bending to the side, sit-ups, and push-ups) were applied. *Cool-down period* included breathing and stretching exercises. Each daily physical activity session was implemented synchronously via Zoom software. During the zoom-delivered physical activity sessions, the trainers were 1st and 2nd authors of the study. The show-and-make strategy was used in the teaching of the activities. Instant feedback was provided to encourage and support children with ASD and their families. In addition, at the end of each daily physical activity session, parents chatted in the WhatsApp group to evaluate the efficacy of the session and to prepare for

the next session. Implementation stages of the Zoom-delivered physical activities study are shown in Table 2.

Measures

Data were collected with three tools: Personal Information Form, Leisure Time Exercise Questionnaire-LTEQ and Semi-Structured Interview Form. Measurements were made two days before and after Zoom-delivered physical activities. Due to the COVID-19 quarantine, data was obtained via Google forms. Google form links were shared on WhatsApp and all parents were asked to fill out the forms on the links within two days.

Personal Information Form = The personal information form was used to obtain demographic information (sex, age, weight, height, education level, and an additional comorbidities) about children with ASD and their parents.

Leisure Time Exercise Questionnaire (LTEQ) = LTEQ was developed by Godin and Shephard in 1985 and is a short and practical questionnaire used to evaluate the physical activity level of individuals in their leisure time based on their self-reports (Sari & Erdoğan, 2016). LTEQ shows what is considered strenuous, moderate or mild physical activity for users. To help parents, we also added to the LTEQ which physical activity in the study was considered strenuous, moderate or mild physical activity In previous studies (Esentürk & Yarımkaya, 2021a; Hamm & Yun, 2018; Healy & Marchand, 2020; Marchand & Healy, 2019; Memari et al., 2015; Russell et al., 2018; Yarımkaya et al., 2021), LTEQ were used frequently to determine the physical activity level of individuals with ASD in their leisure time. Memari et al. (2015) showed that LTEQ has a good test–retest reliability score that can be used to determine the physical activity level of children with ASD. LTEQ aims to determine the number of times a) strenuous physical activities, b) moderate physical activities, and c) mild physical activities are performed for at least 15 min in the last week (Godin & Shephard, 1985). The total score of the questionnaire is calculated as follows: weekly leisure activity score: (9 × strenuous physical activities) + (5 × moderate physical activities) + (3 × mild physical activities) (Godin, 2011). Increasing scores are associated with increased exercise behavior. The final score provides us with references about the contribution of physical activity to health (Sari & Erdoğan, 2016). In the adaptation study of LTEQ to Turkish culture (Yerlisu-Lapa et al., 2016), a single-factor structure was obtained that explained 55% of the total variance as a result of the Exploratory Factor Analysis (EFA). Test–retest analysis was carried out within the scope of the reliability of the questionnaire. The test–retest reliability coefficient for the Turkish version of the LTEQ was calculated as 0.84 for the overall questionnaire and 0.80, 0.76 and 0.72 for the items of the questionnaire, respectively. In addition, the Spearman correlation coefficient was found to be 0.92 as a result of the correlation analysis made with the "International Physical Activity Questionnaire-Short Form" in line with the criterion validity.

Semi-Structured Interview Questions = With semi-structured interview questions, parents in the experimental group evaluated the changes in the physical activity level of children with ASD and Zoom-delivered physical activities.

Table 2 Implementation stages of the Zoom-delivered physical activities

Stage 1: Sharing the Zoom access link	Stage 2: A warm-up period	Stage 3: A physical activity period	Stage 4: A stretching-cool down period	Stage 5: Evaluation of the session and preparation for the next session
Before the Zoom-delivered physical activity sessions, the Zoom access link was shared in the WhatsApp group	Warm-up activities were applied for about 10 min	Physical activities such as home-based exercises, fun games, dance activities, and fitness activities were performed for about 10 min	Stretching-cool activities were applied for about 10 min	At the end of the daily sessions, parents chatted in the WhatsApp group to evaluate the session and prepare for the next session

Interview questions were created with the help of three academicians (1 Professor, 2 Associate Professors) who are experts in physical activity and qualitative research in children with ASD. Then, a pilot study was conducted to examine the clarity of the interview questions with two parents of children with ASD. Parents who participated in the pilot study were not included in the study sample. According to the feedback from the parents in the pilot study, the interview questions were finalized. Interviews started after obtaining consent forms from the parents. Due to the COVID-19 outbreak, the primary investigator spoke to the parents on the phone. The interviews lasted an average of 25 min and were recorded for content analysis. The following questions were included in the interview form = (a) How was your general experience with Zoom-delivered physical activities? (b) How beneficial were the Zoom-delivered physical activities on your child's physical activity level? (c) What can you say about the usefulness of Zoom-delivered physical activities?

Data Analysis

The quantitative findings of the study were analyzed using SPSS software (Version 20.0). Physical activity level of children with ASD before and after Zoom-delivered physical activities were examined with mixed measures ANOVA and ANCOVA. Before performing ANCOVA, the homogeneity of variance assumption was tested using the Levene's test for equality of variance. For ANCOVA, the homogeneity of regression was also examined.

The analysis of the qualitative data of the study was carried out using both inductive and deductive coding (Mayring, 2014). In the analysis process, first of all, the audio recordings were transcripted into text by the researchers. Then, the researchers analyzed and coded all the data independently, using an inductive approach, without depending on a code scheme. The researchers determined the themes and sub-themes by considering the importance of the codes and their relations with each other. After applying the inductive approach, the analysis process continued with the deductive approach. Themes were created in line with the aims of the research and the data were matched with the themes. For the whole analysis process, help was received from two academicians (2 professors) who are experts in the field of qualitative research. Two main themes were created in line with expert opinions. Three methods were used for the validity and reliability of the qualitative data analysis process. First, at the beginning of the analysis process, the data transcripted into written text were shared with parents via e-mail for control. Second, the data were coded independently by researchers and academicians, and the codes and the themes represented by the codes were compared. Miles and Huberman (1994) (Consensus / (Consensus + Dissensus) × 100) formula was calculated to ensure the reliability of the data. The consensus between researchers and academicians was calculated as 93%. Third, detailed parent opinions were included in the themes and sub-themes obtained without the intervention of the researcher.

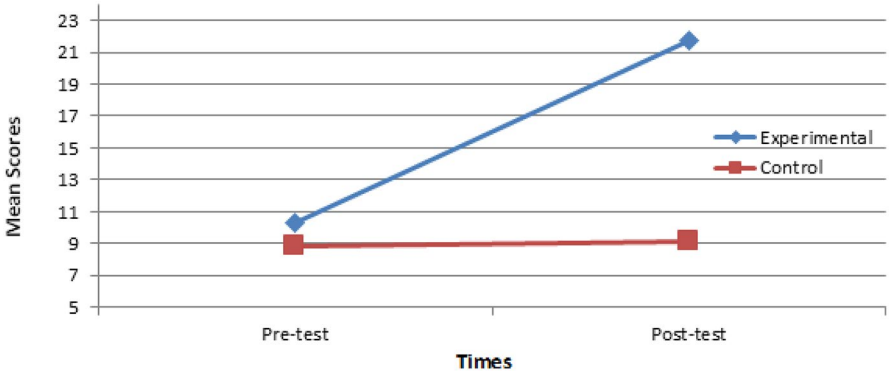

Fig. 2 Mean physical activity scores of the groups in pre-test an post-test

Results

The Changes of Physical Activity Level of the Children with ASD

A mixed measures ANOVA with the between subjects factor 'Group' and the within-subjects factor 'Time and, with physical activity level as the dependent variable, was used to compare the physical activity level of children with ASD between groups (see Table 2). ANOVA showed a significant main effect for 'group' ($F_{(1,20)} = 93.769$, $p = 0.000$ $\eta^2 = 0.824$) due to higher a physical activity level by experimental group than by control group. There was a marginally significant tendency for 'Time' ($F_{(1,20)} = 79.492$, $p = 0.000$ $\eta^2 = 0.799$) due to higher a physical activity level for post-test than for pre-test. Importantly, there was an interaction between 'Group and Time' ($F_{(1,20)} = 70.09$, $p = 0.000$ $\eta^2 = 0.778$, Fig. 2, Table 3).

ANCOVA was conducted to analyze the efects of the intervention on the dependent variable, i.e. physical activity level between pre-test (baseline) and post-test. Controlling for baseline scores, the diference in physical activity level between the two groups was signifcant in favor of the experimental group

Table 3 Mixed model ANOVA analysis results of pre-test and post-test scores of the groups

Source	Type III Sum of Squares	df	Mean Square	*F*	*p*	η^2
Time	384.091	1	384.091	79.492	0.000*	0.799
Error (Time)	96.636	20	4.832			
Group	539.000	1	539.000	93.739	0.000*	0.824
Error (Group)	115.000	20	5.750			
Time*Group	338.273	1	338.273	70.09	0.000*	0.778
Error (Time*Group)	57.500	20	2.875			

*represented $p < .05$; $\eta^2 = \text{eta}^2$

($F = 95.396$, $p = 0.000$), with the efect size value very close to 1 ($\eta^2 = 0.834$), indicating signifcant effect of the intervention (Table 4).

The Parents' Views About the Zoom-delivered Physical Activities

Two main themes emerged as a result of the analysis of the data collected to explore the views of the parents in the experimental group about Zoom-delivered physical activities: (1) Effects of Zoom-delivered physical activities on the physical activity level of children with ASD and (2) Applicability of Zoom-delivered physical activities.

Effects of Zoom-delivered Physical Activities on the Physical Activity Level of Children with ASD

According to the parents, the physical activity level of their children with ASD had decreased significantly due to the COVID-19 pandemic. Parents stated that the physical activity level of their children who stayed at home and were physically inactive during the COVID-19 pandemic increased after Zoom-delivered physical activities.

"First of all, thank you for including us in this study. The pandemic really tired the children and us. Being at home all the time and doing the same things in a limited way became very boring. My daughter was very inactive during this process. But on the physical activity days, my daughter and I really enjoyed and made movements."-P3's Mother

"Yes, it was very useful. Thanks to physical activities, my daughter making movements and doing activities made me very happy. Obviously, the physical activity level has increased not only for her but also for us. When I stayed at home due to the pandemic, I realized how harmful this inactivity is. Staying at home all the time and not moving has never been good for us."-P8's Mother

"*Thank you and your team. It has been a useful experience for us. We were very happy as a family. My daughter's interest in sports increased day by day with this work. In fact, the fact that she normally forces us in front of the refrigerator or TV was replaced with physical activities and games."-P11's Mother*

"My son was receiving special education at the rehabilitation center, but my child's school was closed because the virus was detected. That's why my son could not go to school at all, and he started to want to eat at home all the time and to play games on computer or tablet. Physical activities became an alternative for us. We were very happy that he made movements after physical activity and that his level of physical activity increased."-P5's Mother

Table 4 ANCOVA analysis results of the pre-test-post-test scores of the groups

Groups	N	Mean	Adjusted Means	F	p	η^2
Experimental	11	21.72	21.62	95.396	0.000*	0.834
Control	11	9.18	9.28			

*represented $p < .05$; $\eta^2 = \text{eta}^2$

"Thank you so much, it was an amazing and very useful experience for us. I had an active sports life and I believe in the power of sports. That's why I wanted to take part in the research. Physical activities contributed to the increase of my child's physical activity level in a fun way."-P2's Mother

Applicability of Zoom-delivered Physical Activities

Parents reported that they were happy to participate in Zoom-delivered physical activities with their children. According to the parents, Zoom-delivered physical activities were a highly useful, interesting and fun intervention to increase the physical activity level of their children with ASD. Parents reported that Zoom-delivered physical activities were a new daily routine for their children whose daily routines had changed due to the COVID-19 pandemic.

"The activities were extremely useful. So we did it easily with my son. We also had a lot of fun. We have seen examples of beneficial physical activities that we can do as a family from now on. Thank you, again, for calling us for such a study and for your interest."-P9's Mother
"We could easily implement the activities. So we did not have any difficulties while applying it. I think they are extremely easy-to-apply activities. The activities were already interesting, it wasn't too hard to get my daughter used to it and she had a lot of fun, of course we had fun with her."-P10's Mother
"We needed such activities during the pandemic process. We did family activities with ease. Our daughter's daily routines had changed a lot. She became much less active during this epidemic process than before. However, we now easily practice the physical activities that we learned with your study every day. Physical activities became a new daily routine for us."-P6's Father
"Actually, I was a person who did not look very warmly to distance education. Because interaction in distance education seemed very low to me. However, my opinion has changed with your study. Together with my daughter, we participated in activities with pleasure. The activities were interesting and fun. We will try to do the physical activities I have learned not only during the pandemic but also in normal times."-P1's Mother
"Sir, these are physical activities that can be applied easily. I can say this very clearly because we participated in activities as a family. I am 53 years old and I did the work with my son easily. We also had a lot of fun. First of all, my son spending his time well, making movements and being happy affected us positively."-P4's Father

Discussion

The aim of this study was to examine the effects of Zoom-delivered physical activities on the physical activity level of children with ASD. To our knowledge, this study is among the pioneering studies evaluating the efficacy of alternative physical activity interventions, such as Zoom-delivered physical activities, to increase

the level of physical activity in children with ASD. Results from the questionnaires showed that there was no significant difference between the physical activity levels of children with ASD in the experimental and control groups before Zoom-delivered physical activities. On the other hand, it was determined that there was a positive and significant increase in the physical activity level of children with ASD in the experimental group after Zoom-delivered physical activities compared to children with ASD in the control group. In addition, the parents participating in the study reported that Zoom-delivered physical activities are a viable and useful intervention to increase the physical activity level of children with ASD. These results indicated that Zoom-delivered physical activities may be an alternative physical intervention to increase the physical activity level of children with ASD.

Recently, researchers have begun to show interest in alternative physical activity interventions that can reach wider audiences and that children with ASD can do with their families at home. Various studies have been conducted on sustainable physical activity interventions, especially for children with ASD who cannot access physical activity (Esentürk & Yarımkaya, 2021a; Garcia et al., 2021; Healy & Marchand, 2020; Yarımkaya et al., 2021). The results of the studies revealed that physical activities delivered remotely via WhatsApp, Facebook and Zoom are effective interventions to increase physical activity in children with ASD. Although the results of these studies are promising, there are some features that limit the sustainability of the studies. Firstly, Judo, a technical sport branch, was shown as physical activity to parents and children with ASD, who usually do not have any educational background. Access to physical activities such as judo that require specialist personnel, costly special equipment, and non-naturalistic venues is often limited to the areas and people served by specialist personnel (Marchand & Healy, 2019). Therefore, it is thought that parents will have difficulty in applying Zoom-delivered judo activities to their children with ASD. Secondly, parents were not provided with parental mediation training to ensure that parents were ready to practice physical activities prior to physical activities. Since parents have a critical role in the participation of children with ASD in physical activity (Baranowski, 1997; Sallis et al., 2000), it is extremely important for sustainability to provide parents with the ability to practice physical activity. Third, pre-prepared physical activity videos in the studies were delivered to the parents and the activities in the videos were applied asynchronously. Therefore, researchers did not observe how and at what level the physical activities of children with ASD were performed, and instant feedback was not given to children and parents with ASD by the researchers. According to Bolliger and Halupa (2012) and Fuller et al. (2006), asynchronous activities cause disadvantages such as lack of a shared environment between students and practitioners, lack of interpersonal interaction and low motivation. It is stated that synchronized lessons, which offer various interaction opportunities, are the most suitable solution to these disadvantages (Guo, 2020; Hurd & Xiao, 2010; Wdowik, 2014). The current study considered the limitations of studies suggesting alternative physical activity interventions to increase the physical activity level of children with ASD. Unlike previous studies, physical activities that can be done easily by parents and children with ASD were used. Parent mediation training was given to parents to ensure they were ready to practice physical activities. In addition, each daily physical activity session was implemented synchronously through the

Zoom software. In this way, parents' questions were answered instantly and feedback was given to them.

The current study provided significant support to parents to increase the physical activity level of their children with ASD during the COVID-19 pandemic. According to the qualitative findings of the study, parents reported that Zoom-delivered physical activities are a new daily routine for their children whose daily routines have changed due to the pandemic. Parents reported that they were happy to participate in the studies and had fun with their children. Similarly, previous studies (Esentürk & Yarımkaya, 2021a; Yarımkaya et al., 2021) have also revealed that parents are happy to participate in remotely delivered physical activities for their children with ASD during the COVID-19 pandemic and have learned extremely useful information about physical activities during the intervention. In conclusion, in consistent with the literature, the current study showed that Zoom-delivered physical activities effectively increased the physical activity level of children with ASD. The findings provide evidence that Zoom-delivered physical activities can be an alternative physical activity that can be easily implemented in the home environment through parents.

Limitations of the Study

Although the study is one of the few studies examining the efficacy of Zoom-delivered physical activities on the physical activity level of children with ASD, it does have some limitations. Since the sample consisted of 22 families (parent and child dyads), the generalizability of the results obtained from the questionnaires and interviews regarding the physical activity level of children with ASD may be limited. Also, as the study was conducted during the COVID-19 pandemic, it is unclear whether Zoom-delivered physical activities will make a significant difference in the physical activity level of children with ASD at normal times (when there are daily routines). In addition, parent mediation training was organized in order to prepare parents in the experimental group before Zoom-delivered physical activities to practice physical activities. However, no interviews were conducted addressing parent mediation training to determine the perceived usefulness of this training. Also, we relied on parental self-report measures to diagnose ASD. Due to the pandemic, no observations could be made on the severity of children's ASD symptoms. Moreover, data on the level of physical activity of children with ASD were collected only based on parental self-report, and the perceptions of children with ASD about the activity program were excluded. Finally, the persistence test was not applied to determine whether the changes in the physical activity level of children with ASD persisted after the intervention.

Implications for Practice and Future Research

Future studies may use metrics such as accelerometers and pedometers, in addition to the LTEQ and interview questions, to assess the level of physical activity of children with ASD during Zoom-delivered physical activities. In addition, future

studies may address their children's perceptions of the program as well as parental self-reports when determining the level of physical activity of children with ASD. The current study does not contain any information on the comparison of Zoom-delivered physical activities with other physical activity programs. Future studies may compare the effects of Zoom-delivered, WhatsApp-delivered, Web-based or face-to-face physical activities. In addition, the effects of only synchronous or asynchronous Zoom-delivered physical activities on children with ASD can be examined. The current study did not present any findings on the perceived usefulness of parent mediation training. In the future studies, parents may be interviewed about the usefulness of parental mediation education.

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Declarations

Informed Consent Written consent was obtained from each parents.

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in the study involving human participants were in accordance with the ethical standards of the institutional committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Authors and Affiliations

Erkan Yarımkaya[1] · Oğuz Kaan Esentürk[2] · Ekrem Levent İlhan[3] · Serkan Kurtipek[3] · Ayşe Türksoy Işım[4]

[1] Şehitler Secondary School, Ministry of National Education, Bayburt TR-69300, Turkey

[2] School of Physical Education and Sports, Erzincan Binali Yıldırım University, Erzincan TR-24000, Turkey

[3] Faculty of Sports Sciences, Gazi University, Ankara TR-06500, Turkey

[4] Faculty of Sports Sciences, Istanbul-Cerrahpaşa University, Istanbul TR-34098, Turkey