International Journal of Applied Sports Sciences
2024, Vol. 36, No. 1, 77-90.
https://doi.org/10.24985/ijass.2024.36.1.77

ISSN 2233-7946 (Online)
ISSN 1598-2939 (Print)

A Systematic Review of Web-based Physical Activity Interventions for Individuals with Disabilities

Ki-Hyun Park[b], Jun-Seong Kim[c], Seungjae Kim[a], Byungmo Ku[a*]

[a]*Department of Special Physical Education, College of Sports Science, Yong-In University, Gyeonggi Do, South Korea*

[b]*Ko-Ki-Ri Child and Youth Development Center, Seoul, South Korea*

[c]*Public Health Center of Yong-In Special City, Cheoin-gu, Yong-In-si, Gyeonggi Do, South Korea*

Abstract

Given the barriers to physical activity (PA) that people with disabilities face, web-based PA interventions have garnered attention to promote their engagement in PA. However, previous studies have yielded inconsistent results regarding the impact of these interventions on PA among peoples with disabilities. The aim of this systematic review was to assess the effects of web-based PA interventions on PA in peoples with disabilities. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines were adopted as the framework for this review. Four databases—Academic Search Complete, Medline Complete, PsycINFO, and Web of Science—were searched, and three coders independently reviewed the retrieved studies. A total of nine studies were included in this review. These studies comprised a combined sample size of 314 participants, with 192 in the experimental groups and 122 in the control groups. The web-based interventions examined in these studies fell into four categories: 1) application-based, 2) text messaging, 3) video/phone calls, and 4) web platforms. Of the nine studies, four reported significant and positive effects on PA among people with disabilities. However, the remaining studies found no significant effects. Given these inconclusive findings, further research is warranted to ascertain the effectiveness of web-based PA interventions. Future studies should focus on identifying and addressing the barriers that participants may face in accessing these interventions.

Key words: application, exercise, programs, remote, sports

Introduction

Physical Activity (PA) has positive effects not only on physical health, but also on a wide range of diseases, mental health, and overall well-being (Centers for Disease Control and Prevention; CDC, 2022). Regular PA has effects on reducing blood pressure, improving autonomic function, increasing cardiac function, also effective for preventing cardiovascular disease, diabetes, cancer, hypertension and premature death (Warburton et al., 2006). It also benefits cognitive function, anxiety and depression, sleep time and overall quality of life (U.S. Department of Health and Human Services, 2018).

Submitted : 19 April 2024
Revised : 13 June 2024
Accepted : 18 June 2024
Correspondence : bmk@yiu.ac.kr

In particular, it has been reported that the participation of people with disabilities in group-type physical activities can not only expect the effect of multi-faceted health promotion, such as improving the quality of life through interpersonal relationships (Williams et al., 2018), but also affects the reduction of medical expenses (Public Health England, 2018). In addition, regular PA and exercise improve exercise performance with or without disability (Su et al., 2022), and reducing the risk of cardiovascular disease and metabolic disease, thereby positively affecting the health improvement of people with developmental disabilities (Schroeder et al., 2019). With these ample benefits, the World Health Organization (WHO) has issued guidelines for physical activity, including those with disabilities, to encourage 150 minutes of moderate-to-vigorous PA per week (Bull et al., 2020).

Approximately 1.5 billion people worldwide are found to have physical, mental, sensory, and intellectual disabilities, and they have serious health problems due to insufficient PA (Martin Ginis et al., 2021). People with disabilities face even greater challenges, as they are consistently found to have significantly lower levels of PA compared to people without disabilities (Jaarsma et al., 2014). Specifically, a meta-analysis found that people with disabilities participated in less PA than their counterparts (Jung et al., 2018). In addition, a national representative study also indicates that children with disabilities were significantly less likely to be sufficiently active compared to their peers without disabilities, a trend that was not observed among adolescents (Ross et al., 2020).

To overcome this challenge, various interventions are being evaluated, and with the advancement of technology, research on web-based PA intervention is also underway (Jahangiry et al., 2017; Ramachandran et al., 2022). Web-based PA intervention refer to the use of online platforms and digital technologies to promote PA. It allows people to access and participate in PA remotely, providing a flexible approach to increase PA. A meta-analysis by Jahangiry et al. stated that web-based PA interventions increased PA level by 13.4 for MVPA, 2185 step counts, and 0.17minutes for walking per week. Another systematic review also demonstrated that computer and web-based interventions had a statistically significant increase in PA (Hamel et al., 2011). More recently, a systematic review demonstrated that web-based PA interventions resulted in improving PA in children and adolescents without disabilities (Goodyear et al., 2023).

Contrary to the research for people without disabilities, studies targeting people with disabilities have shown varying results. Fjellstrom and colleagues (2022) found that a website intervention did not improve PA behaviors in adults with intellectual disabilities. The intervention involved web-based home exercises with moderate intensity, 50 minutes, three times per week for 12 weeks. Despite their efforts, 62% of participants did not improve their PA behaviors after completing the intervention. Similarly, a randomized-controlled study used a tablet computer to educate adolescents with intellectual disabilities regarding the importance of PA and strategies to change their PA behaviors for two months (Ptomey et al, 2015). However, the pre-PA behaviors in adolescents with intellectual disabilities were not significantly different from their post-PA behaviors.

However, another body of literature offers opposing results. Esentürk and Yarımkaya (2021) used a WhatsApp-based intervention to encourage parents of children with autism spectrum disorder to facilitate their child’s PA for 4 weeks. The intervention included daily strategies such as fun educational games, dancing, and fitness exercises. As a result, child's PA increased from moderately active to highly active behaviors. Another study by Yarımkaya and colleagues (2023) found similar results using a Zoom-delivered intervention for children with autism spectrum disorder. The intervention involved a synchronous online exercise program that included a variety of home-based exercises including both parents and children with autism spectrum disorders. The results showed that the PA

behaviors in the experimental group were significantly higher compared to the control group who did not participate in the intervention.

With the conflicting results from previous studies, it is important to synthesize the findings to comprehensively understand the association between web-based interventions and physical activity (PA) behaviors in people with disabilities. The objective of this systematic review is to confirm the effects of web-based PA interventions on PA in people with disabilities. Additionally, this study aims to identify the main findings and limitations of web-based PA interventions for people with disabilities.

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, developed by Moher and colleague (2009), served as the framework for the present systematic review.

Study Inclusion Criteria

In order to be included in the current systematic review, an article needed to fulfill the following criteria: a) a peer-reviewed article, b) written in English, c) published between 1990 and 2023, d) an experimental study for promoting PA in people with disabilities, e) the study should use a web-based intervention, and f) the physical activity behaviors of the people should have been measured using either a self-reported PA measure (such as a questionnaire) or an objective measure (such as an accelerometer or pedometer). In this review, a web-based intervention for PA refers to an online program or application designed to promote and facilitate regular PA among people. It utilizes web-based technologies such as websites, mobile apps, smart-phone text message, or social media platforms to deliver various components aimed at increasing PA. In addition, disability refers to "any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restriction)" (Centers for Disease Control and Prevention, 2019). In the current systematic review, PA is defined as "any bodily movement generated by skeletal muscles that leads to energy expenditure" (Caspersen et al., 1985, p. 129) This definition encompasses both organized PA, such as participating in sports clubs or taking lessons, as well as non-organized PA, including free play and leisure-time physical activity.

Study Exclusion Criteria

If an article needed to meet one of the following criteria, it was excluded from the current systematic review: a) a study targeting people with diseases (e.g., cancer, diabetes, or obesity), b) a study considered virtual games as web-based interventions (e.g., Wii, Xbox, and Mobile game), and c) a study used a single-subject design.

Search Strategies

The keywords used in the current systematic review can be found in Table 1. Four databases including Academic Search Complete, Medline Complete, Psycinfo, and Web of Science were used for the systematic search. For the systematic evaluation, the three authors conducted independent reviews of articles following the PRISMA guideline (Moher et al., 2009). The review process involved removing duplicate manuscripts, conducting title/abstract screening, and performing a full-text review. In cases where there were discrepancies between the three authors, a discussion took place, and a double-review process was carried out, involving the joint review of the article. The initial search yielded 2,215 articles from the four databases. After removing duplicate studies, a total of 813 studies were excluded based on title/abstract screening. Subsequently, 106 studies underwent full-text screening,

Table 1. *The operational definitions of main keywords*

Target variable(word)	Keywords	Reference
Internet	(Internet OR computer OR phone OR smartphone OR web-based OR tele-health OR social media OR e-Health OR Web OR online OR email OR electronic mail OR Internet OR social networking combined with PA OR technology OR application)	(Jahangiry et al., 2017)
Physical Activity	("physical activit*" OR "exercise*" OR "sport*")	(Sung et al., 2022)
Disability	(developmental disabilit* OR "autism" OR attention-deficit hyperactivity disorder OR "cerebral palsy" OR fragile X syndrome OR "intellectual disability*" OR "language disorder*" OR "learning disorder*" OR "tourette syndrome")	(CDC, 2020)
Intervention	("intervention*" OR "program*")	(Ku & Sung, 2022)

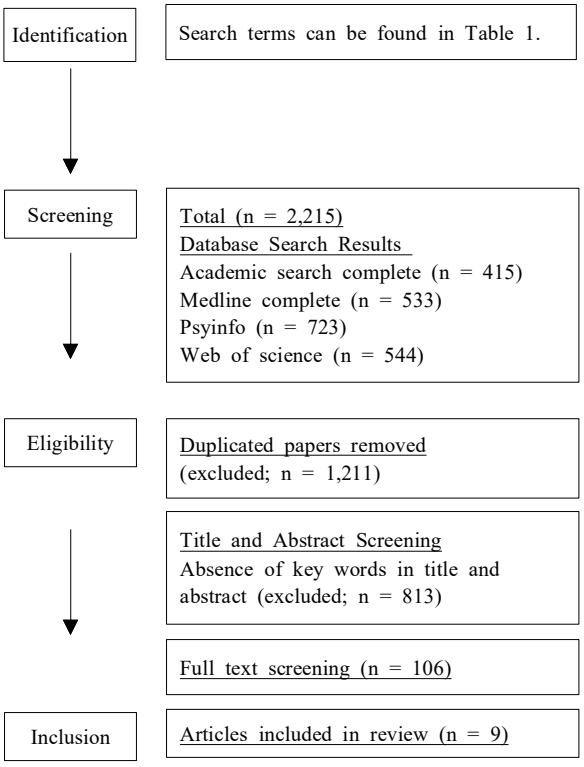

Figure 1. *PRISMA flow diagram*

resulting in the exclusion of 97 that did not meet the predetermined inclusion criteria. Therefore, a total of nine studies were included in the present systematic review. Figure 1 includes more detailed information regarding the study selection.

Data Extraction

In accordance with the objectives of this systematic review, the relevant data were extracted from the articles. This included information regarding the study's published year, country, characteristics of participants (age, disability type, and sample size), characteristics of intervention (types, main results, time, frequency, length), measurement tools utilized to assess physical activity behaviors of people with disabilities. The categories were selected based on a previous study related to PA intervention (Ku & Sung, 2022). Table 2 provides a comprehensive overview of this information, along with the quality scores assigned to each study.

Data Analysis

The total of nine studies included in this review were categorized into two distinct categories: *positive change* and *no change*. The *positive change* category signifies those participants experienced significant increases in their PA behaviors following their involvement in a web-based intervention, or there was a notable difference in post-intervention PA behaviors between an experimental group and a control group. The *no change* category indicates that participants did not exhibit a significant increase in physical activity behaviors after

participating in a web-based intervention, or there was no significant difference in post-intervention physical activity behaviors between an experimental group and a control group.

Results

Characteristics of the Included Studies

Fundamental characteristics of nine studies are shown in Table 2. The studies include a total of 314 participants, with 192 in the Experimental Group (EG) and 122 in the Control Group (CG). In each study, the sample size ranged from seven to 39 participants. Two studies (Esentürk & Yarımkaya, 2021; Fjellstrom et al., 2022) were single-group studies without a CG and had 22 and 14 participants, respectively. A study by Ptomey et al. (2022) included three intervention groups, consisting of EG1 (n=39), EG2 (n=35), and CG (n=36). The mean age for all participants in the included studies was 17.71, with the mean ages for the EG, CG, and single group being 17.42, 16.19, and 24.14, respectively, ranging from 4.78 to 36.2. Among the included studies, there were four different types of disabilities studied: intellectual and developmental disabilities (four studies), autism spectrum disorder (three studies), Spina Bifida (one study), and Rett Syndrome (one study). The studies were conducted in four different countries, with four from the United States, three from Turkey, one from Sweden, and one from Australia.

Intervention Type

Details of interventions in nine studies are shown in Table 3. All nine selected studies were experimental

Table 2. *Fundamental characteristics of included studies*

Study (year, country)	Age (Years)	Sample size (n)	Disability type	PA assessment tools	Quality score (out of 28)
Yarimkaya (2021, Turkey)	EG = 5.22 CG = 5.90	EG = 21 CG = 21	Autism Spectrum Disorder	Leisure Time Exercise Questionnaire (Godin 2011)	21
Crytzer (2013, US)	EG = 23.5 CG = 26.7	EG = 7 CG = 12	Spina Bifida	Physical Activity Scale for Individuals with Participation Questionnaire Arm Ergometer (Saratoga Silver I, Game Cycle)	22
Downs, (2023, Australia)	EG = 21.83 CG = 15.5	EG = 19 CG = 19	Rett syndrome	Accelerometer (activPal) Accelerometer-type device (SAM)	17
Ptomey (2017, US)	EG = 15.9 CG = 13.9	EG = 10 CG = 10	Intellectual and developmental disabilities	Accelerometer (ActiGraph Model GT3) Fitbit	23
Fjellstrom (2022, Sweden)	EG = 36.2 CG = N/A	EG = 22 CG = N/A	Intellectual disability	IPAQ-SF (International Physical Activity Questionnaire-Short Form)	16
Ptomey (2018, US)	EG = 29.9 CG = 25.8	EG = 14 CG = 13	Down Syndrome	Fitbit (Charge HR)	14
Ptomey (2022, US)	EG1 = 15.6 EG2 = 16.7 CG = 16.3	EG1 = 39 EG2 = 35 CG = 36	Intellectual and developmental disabilities	Fitbit (Charge HR) Pedometer (Omron HJ-320) Accelerometer (ActiGraph wGT3x-BT)	25
Yarimkaya (2022, Turkey)	EG = 10.72 CG = 9.27	EG = 11 CG = 11	Autism Spectrum Disorder	Leisure Time Exercise Questionnaire (Godin 2011)	24
Esenturk (2021, Turkey)	EG = 12.15 CG = N/A	EG = 14 CG = N/A	Autism Spectrum Disorder	Leisure Time Exercise Questionnaire (Godin 2011)	22

Note. EG = Experimental group, CG = Control group

Table 3. Details of the web-based PA interventions

Study (year, country)	Time	Frequency (week)	Length	Remote delivery of	Intervention information
Yarimkaya (2021, Turkey)	N/A	N/A	6 weeks	1) Education : information, strategies, and PA videos to parents	Parents were instructed and provided PA promotion strategies and PA videos by professionals for their children through WhatsApp. Videos were sent day before the activity.
	20-30mins	7 days	6 weeks	Recorded PA Video	
Crytzer (2013, US)	N/A	3 days	8 weeks	Reminder	2 groups exercising on 2 different devices (GameCycle, Saratoga), with the use of text(Textinghome.com), voice(Iping.com) message reminders 30min before exercise or not, then crossed over to the opposite message group, to evaluate participations.
Downs, (2023, Australia)	N/A	N/A	12 weeks	Education : Physiotherapists assisted goal setting and goal evaluation to parents	Goal-based telehealth(video/phone call) PA support program delivered in participant's natural environment by physiotherapist to increase 'uptime' and steps per day.
Fjellstrom (2022, Sweden)	50mins	3 days	12 weeks	Recorded PA Video	Pre-recorded training program, provided through web-based platform MyMOWO. Participants chose whether they wanted to split the session, join the group, and select the location.
Ptomey (2017, US)	30mins	1 day	8 weeks	Education : Diet, goal setting, and PA data were reviewed.	Participants and parents met with instructor (registered dietitian nutritionist) via FaceTime once a week to receive diet and PA feedback and education. During the meeting, parents were informed lifestyle modification session covering social support, self-monitoring, PA, environmental control, and self-efficacy.
Ptomey (2018, US)	20mins	1 day	12 weeks	Education : Weekly topic such as the importance of exercise, the selection of exercise clothing and footwear, maintaining hydration.	MVPA sessions either 1 or 2 times a week, led by a trained health educator using Zoom conference, additionally asked to attend individual support/education sessions by FaceTime to assess the feasibility of delivering web-based MVPA.
	30mins	1 or 2 days	12 weeks	Real-time PA	
Ptomey (2022, US)	30-45mins	Once every 2 weeks	6 months	Education : strategies for increasing support and decreasing barriers. Reviewed self-monitoring data by health educator.	Groups were divided to compare the effects of two diets (eSLD) vs. (CD), and two delivery strategies (FaceToFace) vs. (Remote delivery : FaceTime) for weight loss.
Yarimkaya (2022, Turkey)	30-35mins	4 days	10 weeks	Real-time PA	Zoom delivered PA including warm-up, and cool-down instructed by the study author with parent involved as well.
Esenturk (2021, Turkey)	20-30mins	7 days	4 weeks	Education : information, strategies, and PA videos to parents	3 separate videos of warm-up, activity, and cool-down were given to the parents by WhatsApp with detailed information to conduct with their children.
			4 weeks	Real-time PA	

research and conducted web-based PA interventions. Two studies conducted application-based PA interventions (Esentürk & Yarımkaya, 2021; Yarımkaya et al., 2022). Both studies provided education regarding PA. For the PA videos, they were sent to parents via WhatsApp the day before the exercise. Each session consisted of three videos with a total duration of 30 minutes (10 minutes each). Communication was implemented through WhatsApp without time constraints, allowing for comments and interaction. One study utilized text messages and used voice messages when needed (Crytzer et al., 2013). Messages were sent three times a week for eight weeks to participants 30 minutes prior to the exercise sessions. Among the nine studies, five utilized video/phone calls as an intervention method. However, it was not possible to determine the specific call method used in the study by Downs and colleagues (2023). Two studies utilized FaceTime, another study used Zoom, and the final study utilized both Zoom and FaceTime. Lastly, the study by Fjellstrom and colleagues (2022) provided a web-based training program, which was pre-recorded, through a commercially available platform called MyMOWO. Participants received a 12-week exercise program, consisting of three sessions per week, with each session lasting 50 minutes.

Time, Frequency, and Duration

The PA intervention time in the included studies ranges from 20 minutes to 60 minutes. Intervention time and frequency by Downs and colleagues (2023) were not included since it was designed individually for each participant, and precise time and frequency data for all participants were not provided. There were also two studies (Ptomey et al., 2017, 2022) that conducted PA for less than 20 minutes in the beginning period of the intervention; however, as the sessions progressed, PA time gradually increased to 60 minutes. As a result, all the included studies conducted more than 20 minutes of PA interventions, and the average intervention time was 32.5 minutes. The frequency of PA per week ranged from once to seven times a week. Although one study only conducted PA once or twice a week, it additionally asked participants to attend an individual support/ education session via FaceTime (Ptomey et al., 2022). We did not include the in-person education sessions; however, we considered additional remote education as a positive extension. As a result, the PA frequency was found to be 4.31 days per week. The durations of each web-based PA intervention in the nine studies ranged from 4 weeks to 6 months, with an average duration of 10.77 weeks.

Assessments of Physical Activity in People with Disabilities

A total of nine different assessment tools were used across the included studies: four questionnaires and five objective measures. The questionnaires included the Leisure Time Exercise Questionnaire (Godin & Shephard, 1985), Physical Activity Scale for People with Disabilities (Washburn et al., 2002), and International Physical Activity Questionnaire (Hagströmer et al., 2006). Objective measures included five types of PA measuring devices: accelerometers (ActiGraph Model GT3, activPal), a Fitbit (Fitbit Charge HR) model, an accelerometer-type device, a pedometer (Omron HJ-320), and ergometers (GameCycle, Saratoga Silver). Questionnaires were used to assess changes in PA behaviors in people with disabilities (Esentürk, 2021; Fjillstrom et al., 2022; Yarımkaya et al., 2022, 2023). An arm ergometer was used to measure distance (Crytzer et al., 2013). Accelerometers and accelerometer-type devices were used to assess sedentary time, PA level, and daily step counts (Downs et al., 2022; Ptomey et al., 2017, 2022). Fitbit models measured step counts and minutes of MVPA (Ptomey et al., 2017, 2018, 2022). A pedometer was also used to measure daily steps (Ptomey et al., 2022).

Quality Score

The Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet et al., 2004) was employed to assess the quality of the studies in this systematic review. Two researchers were involved in this process, each comparing the results and calculating the final scores. When discrepancies occurred, discussions were held to align the scores with the corresponding author of the current study. A higher score indicates higher study quality, while a lower score indicates lower study quality. The scores ranged from 14 to 25 out of a maximum of 28. The top two studies with the highest scores (Ptomey et al., 2022; Yarımkaya et al., 2022) focused on teenagers, had appropriate sample sizes, and included comparison groups. In contrast, the two studies with the lowest scores (Fjellstrom et al., 2022; Ptomey et al., 2018) focused on adults, had inappropriate sample sizes, and were not evidently and appropriately designed. However, the specific types of disabilities, PA assessment tools, and intervention durations did not influence the scores.

Intervention Effects on Physical Activity

Table 4 provides a summary of the main results of the studies. Out of nine studies, four found significant and positive changes in PA in people with disabilities (Esentürk & Yarımkaya, 2021; Fjellstrom et al., 2022;

Table 4. *The main results of studies*

Study	Method	Effects	*p*-value	Main results
Yarimkaya (2022, Turkey)	Compared with CG	(+) Significant increase of PA level on post-test compared to pre-test in EG. Not the case for CG.	.001	WhatsApp-delivered PA positively affected the PA level of children with ASD.
Crytzer (2013, US)	Compared with CG	(-) No significant difference in participation between the message reminder groups.	.35	Additional social support and encouragement should be provided.
Downs, (2023, Australia)	Compared with CG	(-) EG and CG both increased the number of steps per day by 264.7 and 104.8.	.39	Goal-based telehealth-supported intervention seemed to produce small improvements in PA for RTT in uptime and steps per day.
Fjellstrom (2022, Sweden)	Pre-Post Test	(+) Significant increase of PA levels on post-test compared to pre-test	.03	Web platform MyMOWO was effective and feasible for increasing PA levels and improving health markers for people with ID.
Ptomey (2017, US)	Compared with CG	(-) No significant increases in MVPA	.18	Adolescents with IDD can lose significant weight with remote delivery directions including PA, social support, etc from a RDN.
Ptomey (2018, US)	Compared with CG	(-) No significant difference in MVPA	.16	No significant difference were found between groups, however, exercise delivered by group video conferencing may be feasible in adults with Down syndrome.
Ptomey (2022, US)	Compared with CG	(-) No significant increase in MVPA.	.44	Non-significant increase in MVPA which was not associated with the magnitude of weight loss.
Yarimkaya (2022, Turkey)	Compared with CG	(+) Significant increase of PA level was observed in the EG.	.001	Positive and significant increase in the PA level in the experimental group after Zoom-delivered PA compared with the control group.
Esenturk (2021, Turkey)	Pre-Post Test	(+) Significant increase of PA on post-test compared to pre-test	<.05	PA level of the children with ASD was positively affected after 4 weeks of WhatsApp-based physical activity intervention during the COVID-19 pandemic.

Note. + = Positive change, - = No change

Yarımkaya et al., 2022, 2023). However, the rest of the studies reported no significant changes (Crytzer et al., 2013; Ptomey et al., 2015, 2018, 2022). Two studies that showed significant changes did not include control groups and conducted pre-post tests (Esentürk & Yarımkaya, 2021; Fjellstrom et al., 2022). Two studies have measured effects on step counts (Downs et al., 2023; Ptomey et al., 2015). Both have shown increased daily steps; however, the effect size was not statistically significant. The study from Downs and colleagues (2023) reported an increase of 264.7 steps per day during the 12-week intervention period (baseline to post-test). Ptomey and colleagues (2017) also reported an increased daily step count in both groups by an average of 3,000 steps across the 2-month intervention.

Discussion

The purpose of the current systematic review was to investigate the effects of web-based interventions for physical activity (PA) in people with disabilities. With the systematic search, a total of nine studies were included in this review. Among these, four studies provided significant positive effects on PA in people with disabilities, whereas the rest provided inconclusive findings. As the included studies still offer inconsistent results regarding the effects, more research is needed to confirm their effectiveness. This result contradicts a previous systematic review targeting people without disabilities, where 14 trials reported that the interventions significantly increased moderate-to-vigorous PA and walking (Jahangiry et al., 2017). Another review also found significant positive effects of web-based interventions on increasing PA in older individuals (Beishuizen et al., 2016). Despite receiving education or training via web-based interventions, people with disabilities might find it difficult to apply the knowledge and skills they have acquired to engage in PA in their everyday lives. For example, a major barrier may be the lack of accessible environments, such as parks with suitable paths or gyms equipped with adaptive equipment. Additionally, some participants felt that the instructional videos, while informative, did not adequately address the specific adaptations they required for their individual conditions, leading to frustration and decreased motivation. Further research is needed to explore why web-based interventions are less effective for this population.

Significant increases in PA were reported in four studies, all of which included parent-proxy interventions. In these studies, parent-child dyads participated in interventions where parents served as coaches or interventionists to promote PA among children with disabilities. A systematic review study conducted by Ku and Rhodes (2020) indicates that parents play an important role in increasing PA in children with disabilities. If parents support their child's PA or engage in PA together with their child, children with disabilities are more likely to participate in PA. With this evidence, it is possible that including parents in a web-based intervention may be crucial for the positive outcomes. People with disabilities may find it challenging to translate learning from web-based interventions into practice. Parents may act as interventionists in these web-based PA programs. Another commonality of the four studies is providing instructional videos. It is logical that visual cues and teaching tools are effective for educating people with developmental disabilities (Munna & Kalam, 2021). A review suggests that providing universal instructions with visual cues effectively promotes learners' expectations and academic performance (Munna & Kalam, 2021). Specifically, people with autism spectrum disorder often prefer visual learning methods, such as videos or short clips (Lidstone & Mostofsky, 2021). Thus, the provision of parent- proxy intervention and instructional videos appears to play a crucial role in promoting PA in people with disabilities.

In the five studies that reported no significant changes, three shared a commonality in the frequency of the intervention. Studies that provide interventions three times per week showed significant results, but

studies that offered interventions no more than twice a week did not show significant results. This suggests that increased exposure to an intervention may provide greater opportunities for people with disabilities to participate in PA, potentially leading to higher levels of engagement. Another possible explanation for the non-significant results could be the age of the participants. Studies that did not show significant increases targeted older people, in contrast to those that reported significant improvements. Since the participants are adults, caregivers or parents may not be involved in these studies. Given the barriers they face, there may be a need for additional in-person support to help them apply learning from the web-based interventions to their real-life contexts. The last explanation could be the use of objective measures. All studies except one (Crytzer et al., 2013) utilized objective measures such as accelerometers, pedometers, or Fitbits. In contrast, studies that reported significant increases in PA relied on self-reported questionnaires. A major limitation of using self-reported questionnaires is the tendency to overestimate PA behaviors (Agiovlasitis et al., 2018). Participants of web-based interventions might report increased PA, even if their actual PA have not changed significantly. Since objective measures are more sensitive to detecting individual movements, they could provide a more accurate explanation for the observed results.

As PA is complex movements, there are various measures for PA. In addition, it is still questionable for validity and reliability of PA measurements in adults with disabilities because of a behavioral issue and transportation issue. For example, to measure PA with an accelerometer, it is recommended for participants to wear it for a week including three days of weekdays and one day of weekend. However, the compliance of wearing time in adults with disabilities are lower compared to adults without disabilities (cite). A key outcome of this study is the positive impact revealed through questionnaire-based assessments. Specifically, three studies employed the Godin's Leisure-Time Exercise Questionnaire, while one utilized the International Physical Activity Questionnaire-Short Form. Despite the proven validity and reliability of these tools, they are not without limitations. In particular, the studies utilizing Godin's questionnaire relied on parental reports to gauge children's PA, which, despite parental involvement in the interventions, might lead to overestimations or inaccuracies in capturing the true extent of the child's PA. On the other hand, research employing objective measurement devices, such as accelerometers (e.g., ActivePal, Actigraph), Fitbits, and pedometers, presented not significant results. These objective measures, in contrast to parent-reported data, potentially offer a more accurate assessment of PA, especially in people with disabilities. With this result, future studies should be conducted to explore whether the type of PA measure can be a moderator for the association between the web-based PA intervention and PA in people with disabilities.

Future research on web-based PA interventions should prioritize understanding and addressing the barriers participants may encounter. A critical consideration is the adaptation of user interfaces to ensure inclusivity. Many platforms lack features such as screen readers for visually impaired users, speech-to-text options for those with motor impairments, and simplified layouts to assist people with intellectual disabilities. Personalization is another essential aspect often overlooked; generic PA programs that fail to cater to individual interests, abilities, and goals can significantly diminish motivation and engagement. Furthermore, the effectiveness of these interventions can be compromised by insufficient feedback and encouragement, as regular, positive reinforcement is vital for sustaining participant motivation. Physical accessibility also poses a significant barrier; individuals may face difficulties in accessing necessary equipment or encounter programs that are not adapted to their specific physical capabilities. Researchers could consider equipping participants with customized PA tools specifically

tailored to their needs as part of web-based interventions. The current study has several limitations. Firstly, the inclusion of only nine studies may limit the generalizability of the findings. Secondly, the study did not consider online or vi Jacinto

rtual game-related studies, as its primary focus was to examine the effects of remote online interventions on physical activity in individuals with disabilities. Lastly, two of the included studies (Esenturk et al., 2021; Fjellstrom et al., 2022) lacked control groups and utilized a pre-post single experimental design. These factors should be taken into account when interpreting the results of the current study.

Acknowledgments

The authors of this study would like to express their gratitude to other researchers who have published studies on web-based interventions.

Author Contributions

Ki-Hyun Park: Conceptualization, Data Review, Writing

Jun-Seoung Kim: Data Review, Writing

Seungjae Kim: Data Review, Writing

Byungmo Ku: Analysis, Conceptualization, Methodology, Project administration, Writing, Editing

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