

ORIGINAL ARTICLE

Feasibility and benefits of a videoconferencing-based home exercise programme for paediatric cancer survivors during the coronavirus disease 2019 pandemic

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Funding information

National Research Foundation of Korea, Grant/Award Number: 2019R1F1A1058944

Abstract

Objective: We aimed to determine the feasibility and benefits of a videoconferencing-based home exercise programme to improve health-related quality of life (HRQOL), posttraumatic growth and physical strength levels of paediatric cancer survivors during the coronavirus disease 2019 (COVID-19).

Methods: Eight paediatric cancer survivors participated in the intervention for 8 weeks. The programme comprised home exercise sessions administered using Zoom, a videoconferencing platform. The supervised exercise sessions were performed two times per week; the participants were taught to perform joint exercises at home for the remaining 5 days of the week. HRQOL, posttraumatic growth and physical strength levels were assessed at baseline and after the intervention.

Results: The rates of recruitment, retention and attendance were 52.9%, 88.9% and 98.4%, respectively. There were no cases of adverse events. The programme significantly improved flexibility ($z = -2.21$, $p = 0.03$), muscle strength ($z = -2.67$, $p = 0.01$) and power ($z = -2.41$, $p = 0.02$) among five domains of physical fitness measured using a physical activity promotion system and also improved total physical strength ($z = -2.67$, $p = 0.01$). Posttraumatic growth decreased slightly, whereas HRQOL improved slightly; however, the change was not statistically significant.

Conclusion: The study findings present preliminary evidence of the feasibility and benefits of this videoconferencing-based home exercise programme among paediatric cancer survivors.

KEYWORDS

COVID-19, home exercise programme, paediatric cancer survivor, physical activity, posttraumatic growth, psychological, quality of life

1 | INTRODUCTION

The survival rates of patients with paediatric cancers are steadily increasing owing to advances in medical technology. A recent report indicated that the 5-year relative survival rates of patients with major

paediatric cancers ranged from 84.5% to 85.3% (Howlader et al., 2013; Korea Central Cancer Registry, National Cancer Center, & Ministry of Health and Welfare, 2020). As a result of the increased cure rates of paediatric cancers, greater attention is now being paid to the quality of life (QOL) of survivors.

Most acute problems, such as neutropenia, nausea and vomiting, associated with paediatric cancer have been largely resolved (Erickson et al., 2013). However, patients are still subject to damages of the

This work was supported by the National Research Foundation of Korea grant funded by the Korea government (2019R1F1A1058944).

endocrine, nervous, cardiopulmonary and musculoskeletal systems (e.g., limited functional mobility, flexibility and range of motion) during the process of cancer treatment (Goodenough et al., 2021; Wilson et al., 2015). Damage of these systems contributes to reduced engagement in physical activities by paediatric cancer survivors (Schindera et al., 2020). Paediatric cancer survivors engage in significantly less physical activity than the general paediatric population (Antwi et al., 2019). Furthermore, 45% of paediatric cancer survivors fail to meet the level of physical activity recommended by the World Health Organisation (Schindera et al., 2020). In addition, paediatric cancer survivors experience physical problems such as limited physical strength after completing treatment (Lim, 2018). As body movement is extremely limited during an extended hospital stay and when patients are bedridden, underactivity may persist even after treatment completion (Wilson et al., 2015). The fact that concerns regarding physical strength persist after treatment is undesirable for both survivors and their caregivers (Kim et al., 2018). This highlights the need for physical activity programmes to enhance the physical fitness of paediatric cancer survivors. Regular physical activity improves cardiopulmonary health, reduces fatigue, facilitates psychological well-being and strengthens the immune system, the most critical aspect for paediatric cancer survivors; thus, physical activity has protective effects against recurrence in cancer survivors (Cheung et al., 2021; Li et al., 2018; Manchola-González et al., 2020; Winker et al., 2021). Previous studies of exercise interventions for paediatric cancer survivors showed that these interventions are safe and feasible and are effective in improving flexibility, muscle strength, physical strength and health-related QOL (HRQOL) (Howell et al., 2018; Kim & Park, 2019). Furthermore, exercise interventions have been reported to effectively promote posttraumatic growth among paediatric cancer survivors (Kim & Park, 2019). Posttraumatic growth refers to affirmative changes in the life of an individual following an adversity. These affirmative changes include inner strength, gratitude for life, positive changes in interpersonal relationships and psychological growth. Posttraumatic growth is important because it is associated with better perceived physical health and a healthier immune system in patients with cancer (Ramos et al., 2018). In addition, it contributes positively to HRQOL (Liu et al., 2020). Thus, the effects of non-face-to-face exercise interventions on posttraumatic growth and HRQOL in paediatric cancer survivors are worth investigating.

Reduced engagement in physical activity owing to the coronavirus disease 2019 (COVID-19) pandemic and its consequent negative effects on health are evident worldwide (Caputo & Reichert, 2020). Paediatric cancer survivors have been affected by this pandemic as well and may be at an elevated risk for COVID-19 infection owing to their weakened immune systems (Cheung et al., 2020). To reduce the risk of exposure to COVID-19, parents of paediatric cancer survivors usually prefer having their children stay at home and not engage in outdoor activities (Cheung et al., 2020). Thus, prolongation of the COVID-19 pandemic can further extend the lifestyle limitations of paediatric cancer survivors (Forster & Schulte, 2021). Considering these challenges, a home exercise programme designed in consideration of the preventive measures of the COVID-19 pandemic, such as

social distancing, is warranted for paediatric cancer survivors (Dwyer et al., 2020).

A previous study indicated that barriers in exercises for paediatric cancer survivors include a lack of an appropriate time and place (Kim et al., 2018). However, the non-face-to-face lifestyle that has become the norm during the COVID-19 pandemic could allow for safe involvement in physical activities at home. Thus, this study aimed to develop and evaluate the feasibility and benefits of a videoconferencing-based home exercise programme, which has few restrictions on time and place for paediatric cancer survivors during the COVID-19 pandemic.

2 | METHODS

2.1 | Study design

This was a pilot study conducted using a one-group pretest–posttest experimental design to assess the feasibility and benefits of a home exercise programme for paediatric cancer survivors administered using Zoom (Zoom Video Communications Inc., San Jose, CA, USA), a videoconferencing platform.

2.2 | Study participants

The study population comprised children diagnosed with paediatric cancer who completed treatment or were undergoing maintenance chemotherapy at a general hospital in Korea. All participants' parents or guardians provided written-informed consent to participate in this study. Potential participants who met the following criteria were included in the study: (i) diagnosed with paediatric cancer and completed treatment or was undergoing maintenance chemotherapy; (ii) aged 9–12 years and able to read and answer questionnaires; (iii) willing to participate in an exercise programme and (iv) signed an informed consent form. The exclusion criteria were as follows: (i) history of abdominal surgery, (ii) current fracture or (iii) inability to participate in the exercise programme twice a week.

The study participants were recruited by posting an announcement on the bulletin board at the outpatient paediatric department of a general hospital in Korea and by posting an announcement on the paediatric cancer patient group blog. Additionally, healthcare professionals at the hospital introduced us to potential candidates for recruitment (via 'consent to contact' forms). Considering the limited data available and the feasibility of the study, no sample size was calculated.

2.3 | Ethical considerations

The institutional review board of the first author's university approved this study. This study was performed in accordance with the 1964 Helsinki Declaration and its later amendments or comparable ethical

standards. The participants were informed of the purpose and method of the study and their right to withdraw from participation at any time. In addition, the participants and their parents or guardians were informed that any information they provided would be kept strictly confidential. Data collection was conducted once the patients' parents or guardians voluntarily signed informed consent forms.

2.4 | Study procedure

2.4.1 | Home exercise program

We developed an 8-week home-based programme of play combined with exercise after adequate literature review. Each session in the programme lasted 60 min, and each 60-min session comprised a warm-up (joint mobility-enhancing exercise and low-intensity aerobic exercise), main part and cool-down (stretching and breathing exercise). The main part lasted for 40–50 min and comprised exercises aimed to improve basal fitness, power, muscle strength, cardiorespiratory endurance, flexibility and control, as well as stabilisation and compound exercises. The play-combined exercises consisted of single and partner exercises with a sibling or a parent. The single exercises occurred in 12 out of 16 sessions, and partner exercises occurred in 4 out of 16 sessions. The exercises were performed using a mat, soft-ball and resistance band. Three participants performed exercises with a sibling, and the others performed exercises with their parent in the partner exercises. To avoid potential bias, the same partner performed exercises with the participant throughout the four sessions. For example, the exercises included various styles of walking, throwing and catching a ball, spinning a ball on a body part, running around a ball, standing on a mat with eyes closed, pulling a band, sitting to standing and touching legs with a partner and sitting and standing while holding a band behind the body. The amount of exercise was adjusted depending on each participant's state and needs. The programme was designed with some flexibility such that physical activity could be promoted in consideration of the child's mood, emotions and physical status but in compliance with the overall flow of the programme. Prior to being implemented, the programme was reviewed through consultation with an expert panel. The panel comprised a paediatric haematology-oncology specialist, paediatric oncology nurse, oncology nurse and physical education professor to enhance safety and ensure the programme would adequately target both psychosocial and physical health outcomes.

The intervention was administered twice a week by the authors and a sports medicine expert (certified clinical exercise physiologist) via Zoom. Additionally, a step-by-step video of joint exercises was provided for all participants to follow at home (30 min per day for 5 days) during the remaining days of the week to maintain physical activity. During the 8-week intervention, we called or texted the participants' parents every week to encourage them to make use of the step-by-step video of joint exercises and to participate in the programme, as well as to check for and resolve any issues. Participants who were absent from the programme received phone calls and the

others received text messages (e.g., 'How are you doing?', 'Have you performed the exercises in the 30-minute step-by-step video of joint exercises this week?' and 'Are there any difficulties or injuries due to the program?'). All participants performed the step-by-step exercises 5 days per week for the 8 weeks.

In addition, the sports medicine expert checked the appropriateness of the exercise intensity by applying the Borg Rating of Perceived Exertion (RPE) 6–20 (Borg, 1982), which can be used to assess the role of exercise in paediatric cancer (Klika et al., 2018). The Borg RPE 6–20 was shown via zoom, and the participants were then asked to assess their perceived exertion before warm-up, in the middle of the main session and at the end of cool-down. The exercise intensity was set to be of low to moderate intensity (40–60%; 10 to 12 of RPE) during the main session, considering the participant's health status. The participants were instructed to continue with any exercises or activities that they had been performing before the intervention programme but not to start a new type of exercise other than the intervention. One had been playing badminton, and the others did not participate in any exercises during the 8-week period. At baseline and after the intervention (within 1 week of completing the 8-week intervention), the HRQOL, posttraumatic growth and physical strength levels of the participants were assessed.

2.5 | Outcome measures

2.5.1 | Feasibility

The feasibility of the programme was the primary outcome of this study and was assessed based on recruitment, retention, attendance and adverse events. Recruitment was defined as the number of eligible participants who were recruited by a healthcare professional or via the recruitment announcement and were enrolled in the programme. Retention was defined as the number of participants who completed the 8-week programme. Attendance was defined as the number of survivors who participated in each session of the exercise programme. Adverse events were defined as any negative outcomes during the 8-week programme.

2.5.2 | Potential benefits

The secondary outcome was the potential benefits of the programme. This was assessed by evaluating changes in HRQOL, posttraumatic growth and physical strength levels of survivors. HRQOL was assessed using the Korean version of the Pediatric Quality of Life (PedsQL) 4.0 Generic Core Scale (Varni et al., 2002) (self-report questionnaire for children aged 8–12 years) (Chung & Yang, 2012). This is a 23-item Likert-type response scale (0 for *never a problem*, 1 for *almost never*, 2 for *sometimes*, 3 for *often* and 4 for *almost always*), with higher scores indicating better functioning. The score for each item is converted as follows: a score of 0 = 100, 1 = 75, 2 = 50, 3 = 25 and 4 = 0. The scale comprises four subscales: physical functioning (eight

items), social functioning (five items), emotional functioning (five items) and school functioning (five items).

Posttraumatic growth was assessed using the Korean version (Song et al., 2009) of the Post-traumatic Growth Inventory (Tedeschi & Calhoun, 1996). This is a 16-item Likert-type response scale with responses ranging from 1 for *I did not experience this change as a result of my crisis* to 5 for *I experienced this change to a very great degree as a result of my crisis*. Higher scores indicate better growth.

Physical strength levels were measured using age-specific fitness indices (body mass index [BMI], cardiorespiratory endurance, flexibility, muscle strength and power) presented in the Physical Activity Promotion System (PAPS) (Ministry of Education, 2009), a standardised system used for assessing the physical fitness of elementary school students in Korea. The score was determined (1–20, with higher scores indicating better physical strength levels) based on age- and item-specific criteria in the PAPS. Cardiorespiratory endurance was measured using shuttle runs, whereas flexibility was measured using the sit-and-reach and comprehensive flexibility test for the shoulders, trunk, flank and lower extremities. Muscle strength was measured using sit-ups and grip tests, whereas power was measured using the 50-m dash. All measurements were taken according to the guidelines in the PAPS manual (Ministry of Education, 2009) at a gymnasium in a university. In the PAPS manual, the place should be considered with the weather in mind; the selected gymnasium was an appropriate place as it was less affected by weather conditions and had all equipment for measurements.

2.6 | Data analysis

Given the exploratory nature of the study, a repeated measures within-subjects design was selected. Statistical significance was set at 0.05 for all analyses, and two-tailed tests were used. The normality of each parameter was tested, and non-normally distributed data were analysed using nonparametric tests. Sociodemographic and clinical characteristics of the participants were analysed using descriptive statistics. The feasibility of the programme was described in terms of recruitment, retention and attendance rates. Changes in HRQOL,

posttraumatic growth and physical strength levels after the intervention compared to baseline values were analysed using Wilcoxon signed-rank tests. The collected data were analysed using the SPSS 21.0 software (IBM Corp., Armonk, NY, USA).

3 | RESULTS

3.1 | Participant characteristics

The general and clinical characteristics of the participants who completed the programme are described in Table 1. Eight participants (four boys and four girls) completed the programme. The participants' ages were 9 ($n = 2$), 10 ($n = 4$), 11 ($n = 1$) and 12 ($n = 1$) years. Their diagnoses included acute lymphoblastic leukaemia ($n = 5$), acute myeloid leukaemia ($n = 1$), non-Hodgkin's Lymphoma ($n = 1$) and severe aplastic anaemia ($n = 1$). Six participants underwent only chemotherapy, whereas two participants underwent chemotherapy, radiation therapy and stem cell transplantation. Time since diagnosis ranged widely, from 11 to 43 months. Three participants were undergoing maintenance chemotherapy at the time of this study.

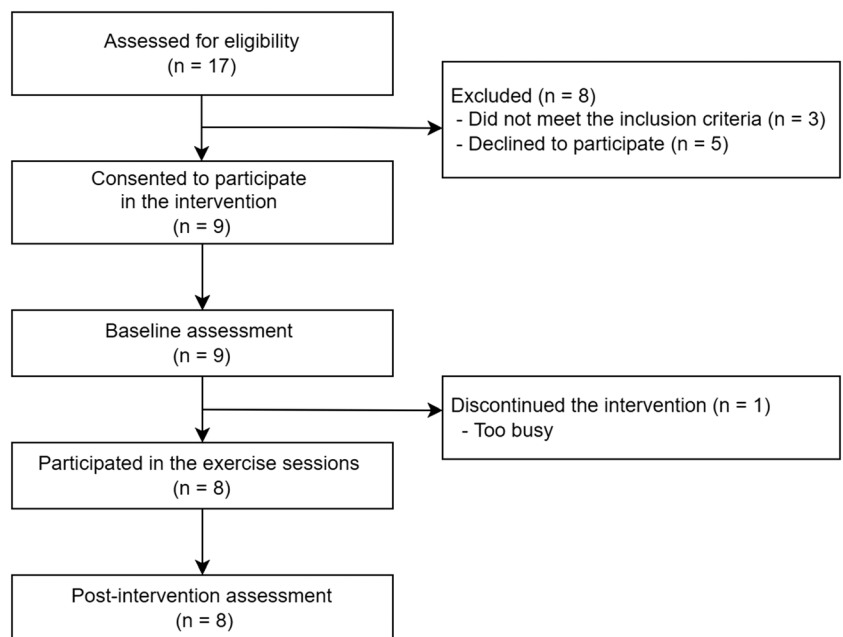
3.2 | Feasibility

The recruitment process is outlined in Figure 1. All participants' parents or guardians signed a 'consent to contact' form and were introduced by a healthcare professional for enrolment. A total of 17 survivors were referred or contacted the research coordinator and were assessed for eligibility. Among them, three were excluded for different reasons, including bone pain and inability to participate in the programme regularly. Five others declined to participate for reasons such as concerns regarding COVID-19. Nine participants were enrolled, resulting in a recruitment rate of 52.9% (9/17). Among the nine participants enrolled, eight (88.9%, 8/9) completed the 8-week programme. All participants who completed the 8-week programme completed all assessments (100%, 8/8). The participant who did not complete the programme (11.1%; 1/9) attended the baseline

TABLE 1 General and clinical characteristics of the study participants

Participant	Sex	Current age (years)	Current status	Dx	Treatment type	Duration after Dx (months)
1	F	10	Off Tx	ALL	Chemo	39
2	M	12	Under Tx	ALL	Chemo	21
3	M	10	Off Tx	SAA	Chemo, RT, SCT	11
4	F	9	Off Tx	ALL	Chemo	35
5	F	11	Off Tx	ALL	Chemo	35
6	M	10	Under Tx	NHL	Chemo	13
7	M	9	Under Tx	ALL	Chemo	32
8	F	10	Off Tx	AML	Chemo, RT, SCT	43

Abbreviations: ALL, acute lymphoblastic leukaemia; AML, acute myeloid leukaemia; Chemo, chemotherapy; Dx, diagnosis; F, female; M, male; NHL, non-Hodgkin lymphoma; RT, radiation therapy; SAA, severe aplastic anaemia; SCT, stem cell transplantation, Tx, treatment.

FIGURE 1 Flow diagram of the recruitment process and the progression of the intervention**TABLE 2** Changes in posttraumatic growth and health-related quality of life during the 8-week intervention

	Baseline mean (SD)	Post-intervention mean (SD)	Neg. MR	Pos. MR	Wilcox. Z	Probability
Posttraumatic growth	50.38 (10.01)	49.63 (17.71)	5.83	3.70	-0.07	0.94
HRQOL						
Total	1,650.00 (205.28)	1,753.13 (243.28)	3.33	5.20	-1.12	0.26
Physical	506.25 (93.30)	581.25 (76.47)	1.50	5.00	-1.87	0.06
Social	378.13 (48.98)	396.88 (74.92)	3.50	3.50	-0.74	0.46
Emotional	412.50 (68.13)	421.87 (47.12)	2.00	2.00	-0.54	0.59
School	353.12 (52.50)	353.13 (80.66)	3.83	3.17	-0.21	0.83

Abbreviations: HRQOL, health-related quality of life; Neg. MR, negative mean rank; Pos. MR, positive mean rank; SD, standard deviation; Wilcox. Z, Wilcoxon's Z score.

assessments and five sessions before dropping out. The participant's reason for discontinuing the programme was being too busy with summer vacation. Average attendance for those who completed the intervention was 98.4%, with a minimum of 93.8% (15/16 sessions attended) and a maximum of 100% (16/16 sessions attended). The main reasons for not attending included going on summer vacation and not feeling well. One participant who was absent owing to not feeling well recovered within a day. There were no other adverse events.

3.3 | Benefits

The benefits of the programme were assessed by examining the changes in posttraumatic growth and HRQOL after the intervention compared to the baseline. There were no statistically significant improvements in posttraumatic growth ($z = -0.07$, $p = 0.94$) and total HRQOL ($z = -1.12$, $p = 0.26$). The mean posttraumatic

growth score slightly decreased from 50.38 (standard deviation [SD] = 10.01) at baseline to 49.63 (SD = 17.71) after the intervention. The total HRQOL slightly improved from 1,650.00 (SD = 205.28) at baseline to 1,753.13 (SD = 243.28) after the intervention; however, the change was not statistically significant (Table 2).

Among the five indices of physical strength levels measured using PAPS, flexibility ($z = -2.21$, $p = 0.03$), muscle strength ($z = -2.67$, $p = 0.01$), power ($z = -2.41$, $p = 0.02$) and total physical strength ($z = -2.67$, $p = 0.01$) significantly improved. The mean flexibility score increased from 11.00 (SD = 5.89) at baseline to 17.25 (SD = 3.15) after the intervention, whereas the mean muscle strength score increased from 4.50 (SD = 2.24) at baseline to 12.63 (SD = 2.18) after the intervention. The mean power score increased from 0.05 (SD = 0.07) at baseline to 4.00 (SD = 2.29) after the intervention, whereas the mean total physical strength score increased from 27.88 (SD = 10.84) at baseline to 47.00 (SD = 7.96) after the intervention (Table 3).

TABLE 3 Changes in physical strength levels during the 8-week intervention

	Baseline mean (SD)	Post-intervention mean (SD)	Neg. MR	Pos. MR	Wilcox. Z	Probability
BMI	23.86 (6.39)	23.76 (6.23)	4.67	5.67	-0.65	0.52
Cardiorespiratory endurance	1.50 (2.59)	2.38 (2.73)	2.50	3.13	-1.36	0.18
Flexibility	11.0 (5.89)	17.25 (3.15)	0.00	3.50	-2.21	0.03
Muscular strength	4.50 (2.24)	12.63 (2.18)	0.00	5.00	-2.67	0.01
Power	0.05 (0.07)	4.00 (2.29)	0.00	4.00	-2.41	0.02
Total score	27.88 (10.84)	47.00 (7.96)	0.00	5.00	-2.67	0.01

Abbreviations: BMI, body mass index; Neg. MR, negative mean rank; Pos. MR, positive mean rank; SD, standard deviation; Wilcox. Z, Wilcoxon's Z score.

4 | DISCUSSION

This study was conducted to analyse the feasibility and benefits of an 8-week play-combined home exercise programme for paediatric cancer survivors during the COVID-19 pandemic. The rates of recruitment, attendance and retention in this study were 52.9%, 98.4% and 88.9%, respectively. The recruitment rate was not high because many candidates were hesitant or declined to participate in the programme due to COVID-19. However, the attendance rate was high, presumably because the programme was designed as a home exercise programme in consideration of the restrictions on outdoor activities during the COVID-19 pandemic. It should be noted that our findings cannot be directly compared to previous research owing to a lack of studies conducted on patients in the same age group during the same period and using the same exercise intensity as in the present study. A previous pilot study conducted prior to the COVID-19 pandemic in which paediatric cancer survivors engaged in indoor wall climbing had an attendance rate of 57.43% (Däggelmann et al., 2020). Another pilot study of a home-based physical activity intervention for childhood cancer survivors aged 15–35 years had a retention rate of 79% (Le et al., 2017). Moreover, a 75% retention rate was set as the threshold for feasibility in a previous exercise intervention study (Ruble et al., 2016). We speculate that the high retention rate of 88.9% achieved in the present study is attributable to the easy, fun and engaging nature of our home exercise programme. In addition, we did not observe any health-related adverse events. This may be attributable to the fact that we continuously checked the appropriateness of intensity of the exercises and adjusted the routine in accordance with the health status of the survivors. These findings indicate that our home exercise programme conducted through videoconferencing is feasible and can be administered during the COVID-19 pandemic without provoking anxiety among parents of childhood cancer survivors regarding gathering in person to participate in group exercises.

In addition to feasibility, the results of the present study suggest that the exercise programme was beneficial. Among the five physical strength domains (BMI, cardiorespiratory endurance, flexibility, muscle strength and power) used in PAPS, flexibility, muscle strength, power and total physical strength score significantly improved after the intervention. These results are consistent with those of previous studies that demonstrated that exercise programmes improve physical activity levels (Beulertz et al., 2016; Chung et al., 2015; Li et al., 2018),

physical fitness (Howell et al., 2018) and muscle strength (Fiuza-Luces et al., 2017) in paediatric cancer patients or survivors. We presumed that this finding could be attributed to our use of various exercise modalities to target a variety of factors such as basal fitness, power and muscle strength. However, although physical strength significantly improved in this study, BMI and cardiorespiratory endurance did not change significantly. This is similar to the findings of previous studies that demonstrated that exercise interventions do not significantly alter BMI and cardiorespiratory fitness in paediatric patients with solid tumours (Fiuza-Luces et al., 2017). In this study, low to moderate intensity exercises that were 10 to 12 of Borg RPE 6–20 were performed. As the regimen was administered flexibly in consideration of the physical states of the survivors and the exercise intensity was not assessed by objective measurements, such as using an actigraph, it is possible that the intervention did not have the appropriate intensity and amount of exercise needed to improve cardiorespiratory endurance (Lee et al., 2017). Nevertheless, this study is significant in that it confirmed that a home exercise programme administered through videoconferencing improves the physical fitness of paediatric cancer survivors during the COVID-19 pandemic.

The exercise programme did not significantly promote post-traumatic growth in childhood cancer survivors. In a previous study of the effects of an exercise intervention on posttraumatic growth in paediatric cancer survivors, which was conducted before the outbreak of COVID-19, posttraumatic growth significantly improved after the intervention (Kim & Park, 2019). In another study in which a mixed intervention, including exercise, was administered to patients with breast cancer, posttraumatic growth improved after the intervention (Bae, 2017). The home exercise programme in this study was conducted via videoconferencing as an alternative to conventional face-to-face programmes due to COVID-19 restrictions. Considering that social support and interpersonal interactions affect posttraumatic growth (Laslo-Roth et al., 2022), it is likely that interactions, social support and emotional effects from interpersonal relationships, all of which are easily and better incorporated in in-person programmes, were weaker in the present study. The childhood cancer survivors in this study could not have active interactions with other participants during the programme as they had to follow the motions of a sports medicine expert via Zoom. Taken together, these interventions might lead to the lack of significant improvement in posttraumatic growth. However, it should be noted that the abovementioned previous

studies were not conducted during the COVID-19 pandemic. Future studies are required to identify specific factors responsible for the differences between the outcomes of in-person and non-face-to-face exercise interventions.

HRQOL did not significantly improve in the present study. This finding is consistent with findings of previous studies that involved in-person exercise interventions (Cox et al., 2018; Dubnov-Raz et al., 2015; Fiuza-Luces et al., 2017). As the participants of our programme had relatively good baseline QOL scores, it is possible that the exercise intervention did not lead to further improvement in QOL (Dubnov-Raz et al., 2015). However, our results are contradictory to those of some studies in which in-person exercise programmes or adventure-based training increased the HRQOL of childhood cancer survivors (Kim & Park, 2019; Li et al., 2018). In addition, another previous study showed that a web-based physical activity intervention significantly increased the HRQOL of childhood cancer survivors (Howell et al., 2018). However, the intervention in that study (Howell et al., 2018) was a non-face-to-face programme administered using multimedia (internet) and a reward system, in which participants can collect points and exchange them for a t-shirt or gift card. Thus, it is not clear whether the positive effects of the intervention on HRQOL can be attributed to the non-face-to-face aspect of the programme or the reward system. Furthermore, the present study was conducted during the COVID-19 pandemic; thus, the differences between non-face-to-face interaction during the COVID-19 pandemic and prior to the COVID-19 pandemic should also be considered.

Ultimately, although our programme did not significantly improve posttraumatic growth and HRQOL, the survivors and their parents were highly satisfied with the intervention. Although we did not assess the participants' satisfaction through objective measurement, the parents who could tell the effect on their children through their facial expressions, actions, postures and voices at a close distance mentioned that the children grew brighter and happier and were satisfied after completing a regular physical activity. This is in line with the results of a previous qualitative study of the effects of a videoconferencing-based programme, which comprised fitness, yoga, tai chi, dance therapy, music therapy and meditation, on patients with cancer (Emard et al., 2021). The programme strengthened the psychological coping of participants, provided motivation and promoted adherence to health behaviours (Emard et al., 2021).

This study had a few limitations. First, the sample size was small, and the possibility of selection bias cannot be eliminated. Therefore, randomised controlled exercise intervention studies with larger samples of childhood cancer survivors are needed to assess the effectiveness of these interventions. Second, the effects of exercise were assessed only immediately after the intervention, not after a longer follow-up period. Future studies should include follow-up assessments of the long-term effects of exercise interventions. Third, as nutritional variables were not controlled in the present study, they could have been a potential confounder. Fourth, there was heterogeneity among the participants' characteristics such as current treatment status, diagnoses and time since diagnosis. Given that posttraumatic growth is related to these clinical characteristics (Liu et al., 2021), the

heterogeneity of these characteristics may have influenced the results of the present study. Therefore, additional studies of homogeneous samples are needed to assess the influence of these interventions on posttraumatic growth. Despite these limitations, this study is highly significant in that it demonstrated that an online, real-time, home exercise programme can improve the physical fitness of childhood cancer survivors during the COVID-19 pandemic.

This study demonstrated the feasibility of our 8-week videoconferencing-based home exercise programme and provided preliminary evidence of its beneficial effects on the physical strength levels of childhood cancer survivors. However, we did not observe a statistically significant improvement in HRQOL and posttraumatic growth of the participants. Thus, we recommend that future studies should include a home exercise programme with emotional support elements and should focus on the psychosocial well-being of childhood cancer survivors. Nevertheless, the non-face-to-face exercise programme developed in this study can be a foundation for the development of strategies for addressing the physical problems of childhood cancer survivors during the COVID-19 pandemic and in the post-COVID-19 era.

ACKNOWLEDGEMENTS

We would like to thank the Korean government, which supported the National Research Foundation of Korea grant and all research participants.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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How to cite this article: Kim, Y., Chae, H., & Park, S. J. (2022). Feasibility and benefits of a videoconferencing-based home exercise programme for paediatric cancer survivors during the coronavirus disease 2019 pandemic. *European Journal of Cancer Care*, e13624. <https://doi.org/10.1111/ecc.13624>