



Design and implementation of a home-based online exercise program for individuals surviving cancer.

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SUMMARY/ABSTRACT

Starting point: Pediatric individuals with acute lymphoblastic leukemia undergo extensive chemotherapy treatment and, as a result, suffer from fatigue and, therefore, a decrease in their daily physical activity level, even after the cessation of the treatment. The symptoms of post-treatment thus disable the participation of the children in sports and games, which play a major role in childhood and adolescence.

Group: Thirteen 5- to 15-year-old individuals surviving cancer with acute lymphoblastic leukemia (1 and 3 years after cancer treatment) were recruited to an 8-week home-based exercise program.

Methods: This study aims to present the design and possibilities of implementing a home-based online exercise program for children who have overcome cancer, taking into account their age and the logistical availability of such physical therapy.

Results: Thirteen individuals completed the home-based online exercise program, and the success rate of participation ranged from 79.2% to 95.8%. The overall success rate was 85.6%. The design and implementation of a home-based online exercise program in our conditions proved to be advantageous and often the only way to allow individuals surviving cancer to exercise in real-time, as the distance of many families from exercise centers proved to be a significant obstacle in creating habits of regular exercise in children.

Conclusions: We demonstrated that individuals surviving cancer and their parents are interested in physical activity interventions and a home-based online exercise program is available and convenient.

KEYWORDS

pediatric oncology, physical activity, tailored exercise program, post-cancer treatment

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1 INTRODUCTION

In children, acute lymphoblastic leukemia (ALL) is the most frequent cancer (Jankowska-Polańska et al. 2020, Verwaaijen et al. 2022), and it accounts for about 25% of all childhood cancers globally (Katz et al. 2015). Medical intervention for ALL has significantly advanced in the last ten years (Hunger et al. 2012), and 5-year survival rates now exceed 90% (Howlader et al. 2023). We must not overlook the significant negative impact of numerous adverse effects, many of which persist even after the end of treatment (Wilson et al. 2015), even though the treatment of ALL produces very good results in the pediatric population (Fardell et al. 2017). High doses of chemotherapy, radiation, or a combination are the conventional treatments for children with ALL, and a combination is frequently required for a full recovery. However, due to various side effects, these therapies may negatively impact the child's overall health condition and health-related quality of life (HRQoL) (Manchola-González et al. 2019), which include motor impairments and activity limitations such as imbalance, flexibility, posture, walking, or functional mobility issues (Coombs et al. 2020, Tanner et al. 2020). Other undesirable side effects during and after treatment include a decline in an individual's physical fitness (Söntgerath and Eckert 2015), deficit in muscle strength (Ness et al.

2011), low level of cardiorespiratory fitness (Manchola-González et al. 2019), decreased mineral bone density (Silverman 2014), or higher risk of depression (Faucett et al. 2019). Non-invasive interventions like exercise training, which can be done either before or after anti-cancer therapies, have garnered more attention in recent years for ALL individuals. These interventions aim to maximize exercise performance capacity, promote autonomy, increase participation in daily living activities, and lessen emotional problems (Simioni et al. 2018). It has been established that exercise training is safe and practical when used in conjunction with anti-cancer medicines (Klika et al. 2018). The long-term strategic goal in pediatric exercise oncology is to guarantee that all individuals surviving cancer receive appropriate long-term care that improves their health and survival rate, however there is a dearth of evidence to provide definitive and detailed exercise recommendations (Klika et al. 2018). The U.S. Department of Health and Human Services (2018) recommends at least 150 minutes of moderate-intensity aerobic activity, 75 minutes of vigorous-intensity aerobic activity, or a combination of moderate and intensive activity per week to promote good health and lower the risk of certain chronic diseases. While one report (Oeffinger et al. 2006, Hudson et al. 2013) claimed that individuals surviving cancer exercised at a rate similar to the general population, more recent research (Brier et al. 2015, Devine et al. 2018) revealed that survivors are less likely to fulfill the Centers for Disease Control's physical activity recommendations. There is, however, insufficient data to draw firm conclusions on how home exercise programs affect physical fitness indices (such as body composition, CRF, flexibility, and/or muscle strength) or functional capacity during day-to-day activities in individuals with leukemia (Manchola-González et al. 2019).

It would be simple to advance this as soon as exercise becomes more common in standard treatment, but there is a paucity of literature offering guidelines that allow practitioners to recommend exercise based on the available data. Therefore, we present our first design that we have used and wanted to find out the feasibility and feedback of a home-based online exercise program for individuals surviving cancer.

2 GROUP AND METHODS

Participants

We added individuals surviving cancer to the home-based online exercise program based on the date of ALL treatment completion (1 and 3 years after cancer treatment). All participants were chosen from among those receiving ALL treatment at the Pediatric Hematology and Oncology Department of the National Institute of Child Diseases (NICD). Individuals surviving cancer ($n = 13$) ranged in age from 5 to 15 years, mean age of 9 ± 2.7 years. Individuals in complete remission who underwent first-line treatment of acute lymphoblastic leukemia according to the treatment protocol (AEIOP BFM ALL 2009) had the following physical characteristics: height (136.9 ± 18.2 cm), weight (34.2 ± 11.6 kg), and BMI-for-age percentile (54.2 ± 31.3). A doctor interviewed individuals for the study during a medical check at the Pediatric Hematology and Oncology Department of the NICD. Before signing the informed consent, the study's chosen individuals received all the information materials. The study was approved by the National Institute of Child Diseases' Ethics Committee EK/1/22.

Home-based online exercise program

In the first phase, the protocol of exercises was created, and the structure of the home-based online exercise program was developed to enhance endurance and gradually restore the muscular strength of the individuals surviving cancer (Ugrayová et al. 2022). All the trainers that led and supervised the online program were all graduated experts from the Faculty of Physical Education and Sports at Comenius University in Bratislava, and all of them underwent special training aimed at working with individuals surviving cancer. The second phase consisted of the recruitment of the pediatric individuals described above and their control medical examination. Before the initiation of the program, the recruited individuals were divided into two groups: the first group exercised from 16:00–17:00 (5–9 years old), and the second group exercised from 17:00–18:00 (10–15 years old). The third phase was the home-based online exercise program, which occurred three times a week on Mondays, Wednesdays, and Thursdays. All training sessions were performed over an 8-week period from October to December, which seems long enough when examining the gut microbiota (Bielik et al. 2023).

The training session began with a preparatory section that included body-warming exercises lasting between 5 and 15 minutes. The main part included strength training targeting the lower and upper body segments (Table 1) lasting between 30 and 40 minutes. The exercises focused on large muscle groups, with an emphasis on proper technical execution, as well as engaging small muscle groups for movement stabilization. Each exercise was performed in 2–3 sets of 10–15 repetitions. At the end of each session, a 5-minute cool-down was applied. In the first two weeks, the individuals surviving cancer performed a lower number of repetitions, and the emphasis was on correct movement patterns and technique. In the next 6 weeks, the number of repetitions progressively increased to 15. The rest interval between sets ranged from 1–3 minutes. In designing the home-based online exercise program and the exercises themselves, we carefully respected the principles of gradual increases in coordination and fitness difficulty. If the individuals were not able to perform a given exercise in its entirety, modified exercises were offered (Table 2).

Table 1 Training protocol design for individuals surviving cancer

Table 2 Additional and alternative exercises

Individuals under training sessions used various aids such as a chair, weights (0.5-liter water bottles), a larger ball (e.g., football) or smaller (e.g., tennis) ball, or performed exercises with their own weight. To maintain the attention of individuals surviving cancer, increase their interest in physical activities, and create a pleasant atmosphere in the group, various games were implemented by the trainer between exercises at a frequency adapted to the age characteristics and specifics of the individuals. Games were also used as a form of relaxation or reward after active exercise; thus, the duration of particular training sessions varied and was not unified. The duration of one training session was 45–60 minutes. In the first group (5–9 years old), the session lasted between 45 and 50 minutes due to their lower level of awareness and concentration. The sessions in the second group (10–15 years old) lasted longer; hence, it was less demanding to keep the awareness of the individuals surviving cancer. Individual training sessions (24 training sessions in total) and training indices were recorded on a recording sheet. The content of the training sessions was consulted as needed and modified in relation to the instructions of the Department of Physiotherapy and Rehabilitation of the National Institute of Physiotherapy and Rehabilitation. The online form of the exercise program was chosen due to not having to commute as far as the participants often come from remote regions and many of them would not be able to engage regularly in the study.

3 STARTING POINT, OBJECTIVE, TASKS

This perspective study aims to present the design and possibilities of implementing a home-based online exercise program for children who have overcome cancer, taking into account their age and the logistical availability of such physical therapy. Large regional hospitals carry out cancer treatment, and individuals surviving cancer often come from more distant counties, making regular commutes for training difficult. Because of these reasons, we have tried to develop and implement a home-based online exercise program with available equipment to build a relationship with exercise and movement and mainly to observe the interest and feedback of pediatric individuals. In addition, this type of exercise can provide some guidance, either for the individuals surviving cancer or their parents, on how to properly engage in physical activities after treatment in terms of volume and intensity, but more importantly, correct technique and a more attractive and interactive approach to the engagement in physical activity for the youth individuals surviving cancer.

4 RESULTS

A total of 33 individuals surviving cancer were involved in a home-based online exercise program. However, 9 of them could not fulfill the criteria of participating in training 3 times a week. 11 individuals were excluded from the evaluation due to failure to meet 80% participation in the exercise program, which we set as a criterion for an objective assessment of the effectiveness of the exercise program. Finally, 13 individuals completed the home-based online exercise program. Participants included 9 boys (69,23%) and 4 girls (30,77%), with an average age of $9 \pm 2,7$. Individuals surviving cancer who participated in the 8-week home-based online exercise program had to achieve 80% participation. The success rate of participation in the home-based online exercise program of the individuals ranged from 79.2% to 95.8%. The overall success rate was 85.6%. The average duration of one training session was 48 ± 4.06 minutes.

5 DISCUSSION

The design and implementation of a home-based online exercise program for individuals surviving cancer may represent a significant advancement in survivorship care, offering a convenient and accessible approach to promoting physical activity and enhancing overall well-being. In Table 3, several key aspects of such a program are summed up, including its potential benefits, its differentiative forms, challenges, and implications for clinical practice and research. In our study, a systematic protocol of exercises was created with possible modifications, which were altered if needed according to doctor's recommendations or individuals' subjective needs, reaching an 85.6% success rate. In effective home-based programs, personalized exercise prescriptions should be incorporated, tailored to the unique needs and capabilities of individuals surviving cancer (Braam et al. 2016). In a previous study (Rokitka et al. 2021) noted that the participants would welcome a more tailored version of the exercise program. Nevertheless, in the same study, the participants marked as the most limiting factors `time` and, more importantly, `distance`. Even though the study was aimed at adults, this is consistent with a study with individuals surviving cancer (Arroyave et al. 2008). 57% of the pediatric participants mentioned a limitation to exercise at specific times was being too tired, in our case, the participants were required and supervised through an online platform, so they were obliged to exercise unless the doctor said so in a consultation before exercise, which was rarely the case. So, the home-based online exercise program seems to be more effective than solely exercising prescriptions and their independent execution. Concerning the time and distance demands, the previous study (Rokitka et al. 2021) summed up that most participants would endorse one 60-minute supervised occasional `in-person` session with guidance and individual adjustments to complete other activity sessions independently at home. Even though the control of the participants is considerably restricted, a 12-week-long randomized control trial (Pinto et al. 2005) concluded that the intervention group with prescribed exercises engaged significantly more in physical activity. Considerably, a combination of both online supervised sessions, unsupervised independent prescribed sessions, and occasional `in-person` guidance sessions might appear to be the best alternative, whether for adult or pediatric surviving cancer.

Table 3 Description of exercise training sessions in individuals with cancer (ALL)

A home-based online exercise program led by an experienced trainer has proven to have a significant impact on the physical and psychosocial development of children who have survived cancer. Its implementation in our conditions proved to be advantageous and often the only way to allow individuals surviving cancer to exercise in real-time, as the distance of many families from exercise centers proves to be a significant obstacle in creating habits of regular exercise in children, which is also in line with the research of other authors (Chandeying and Thongseiratch 2021). Longer-term social isolation and a lack of contact with peers have an impact on the psychological health and quality of life of individuals surviving cancer (Barrera et al. 2018, Tremolada et al. 2022). In addition, it can cause anxiety, sleep problems, psychological distress, a significant drop in mood, or motivation to participate in sports games or physical activities in a group, which were observed in the initial phases of exercise and are also in line with the findings of other authors (Mcdonnell et al. 2017, Berkman et al. 2022). The implementation of psychosocial interventions and physical exercise programs in a playful way has been proven to improve the social, emotional, physical, and school functioning of individuals (Li et al. 2013). It alleviates the feeling of difference, fear of relapse, and attachment to parents (Yi et al. 2016, Belpame et al. 2019). Although research shows that parents and their support during treatment are extremely important, leading a child to independence, developing social skills in a group of peers, and developing a sense of belonging are integral part of a child's healthy psychosocial development, which should be considered when compiling exercise programs with special emphasis on pediatric individuals (Li et al. 2013, Zhang et al. 2021). To mitigate the negative effects of cancer treatment and increase the positive psychosocial adjustment of children, we recommend developing psychosocial support interventions with an approach based on understanding, systematic motivation, and support for the physical activity of individuals. The occasional participation of parents in online physical activities and exercises together with the children in the comfort of their home has also proven to be effective and efficient, especially in the lower age categories, which we would recommend developing, precisely because the children became braver, better managed anxiety and stress from new people, and were more motivated

and focused on completing assigned tasks (Devine et al. 2016, Conklin et al. 2017). In addition, the playful form of training session, under the direction of a certified trainer, has become an inspiration for parents, who continue with many exercise games even after the end of the online training program, which can have a positive effect on building the right habits and healthy lifestyle of individuals surviving cancer (Chandeying and Thongseiratch 2021). In addition, the implementation of an 8-week exercise program has the potential to bring about positive changes in physical health indicators, especially in the areas of strength development, mobility, and coordination of movements, including proprioceptive perception, as well as positively influence the maintenance of balance and act preventively against the increasingly widespread sedentarism of children and juveniles (Li et al. 2013, Berkman et al. 2022).

Limitations

The intention was to create a solely home-based online exercise program with no obligation for the pediatric individuals and their parents to commute to the hospital, however, a more salutary way would be a familiarization session in person to get better control and guidance on the execution of particular exercises. We tried to minimize the age difference limitation by dividing the participants into two age groups, which resulted in a different approach by the coaches when leading the online session as the younger individuals (<10 years) required a more gamesome way to keep merriment and their interest, and multiple rest interventions were required to keep them attentive. As a consequence, there was not a uniform program, and in certain cases, it had to be modified and individualized. In the online program, there might have been some technical issues that we could not control. Further limitation was the relatively high exclusion of the participants due to the prescribed 80% attendance. In order to avoid that, we suggest preparing a spare training session on a different day. Though the implementation of the online program was successful, for future studies, we recommend the implementation of quantitative data to better evaluate physical fitness and the efficacy of the duration of the study. For such analyses, a higher number of participants would also be required. Eventually, based on the dialogue feedback, our study served as a satisfactory initial phase for movement therapy for individuals surviving cancer and their parents. The study provides a systematic battery of exercises with their possible modifications, which makes it more individualized and tailored according to the individual's needs.

6 CONCLUSIONS

The perspective study offers guidelines and inspiration for incorporating exercise as a treatment addition or support for the recovery of children and adolescents with cancer. On the one hand, the available research confirms up the viability, security, and efficacy of exercise programs for these individuals. On the other hand, the evidence is of poor quality, and the practice-related recommendations are insufficient. Parents, sports trainers, and oncology doctors can use the exercise program described in this work as a guide to help them understand what, how, when, and why to exercise with individuals with cancer both during and after treatment. The child's acute medical condition, the course of treatment or post-treatment state, or its side effects severely restrict a focused, methodical training program. However, it is possible to achieve a gradual increase in load and possibly enhance physical fitness with sensitive, individualized guidance through physical exercise.

We have shown that individuals surviving cancer and their parents are interested in physical activity interventions and sought to demonstrate the availability and convenience of a home-based online exercise program.

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7 ZUSAMMENFASSUNG

Ausgangssituation: Pädiatrische Patienten mit akuter lymphatischer Leukämie werden einer umfassenden Chemotherapie unterzogen und leiden infolgedessen unter Müdigkeit und somit unter einem Rückgang ihrer täglichen körperlichen Aktivität, auch nach Beendigung der Behandlung. Nachbehandlungssymptome behindern somit die Teilnahme der Kinder an Sport und Spiel, die in der Kindheit und Jugend eine große Rolle spielen. Kindheit und Jugend eine große Rolle spielen.

Gruppe: Dreizehn 5- bis 15-Jährige, die eine Krebserkrankung mit akuter lymphoblastischer Leukämie überlebt haben (1 und 3 Jahre nach der Krebsbehandlung), wurden für ein 8-wöchiges Bewegungsprogramm zu Hause rekrutiert.

Methoden: Ziel dieser Studie ist es, das Design und die Möglichkeiten der Implementierung eines häuslichen Online-Übungsprogramms für Kinder, die eine Krebserkrankung überwunden haben, unter Berücksichtigung ihres Alters und die logistische Verfügbarkeit einer solchen Physiotherapie.

Ergebnisse: Dreizehn Personen schlossen das häusliche Online-Übungsprogramm ab, und die Erfolgsquote der Teilnahme lag zwischen 79,2 % und 95,8 %. Die Gesamterfolgsquote lag bei 85,6 %. Die Konzeption und Implementierung eines häuslichen Online-Übungsprogramms unter unseren Bedingungen erwies sich als vorteilhaft und oft die einzige Möglichkeit, Menschen, die eine Krebserkrankung überlebt haben, ein Training in Echtzeit zu ermöglichen, da sich die Entfernung vieler Familien zu Fitnesszentren als erhebliches Hindernis bei der Schaffung von Gewohnheiten für regelmäßige Bewegung bei Kindern erwies.

Schlussfolgerungen: Wir haben gezeigt, dass Menschen, die eine Krebserkrankung überlebt haben, und ihre Eltern Interesse an körperlichen Aktivitäten haben und dass ein Online-Übungsprogramm für zu Hause verfügbar und bequem ist.

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