


# BMJ Open Exercise barriers and facilitators during hematopoietic stem cell transplantation: a qualitative study

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## ABSTRACT

**Objective** Although exercise is beneficial in patients undergoing hematopoietic stem cell transplantation (HSCT), motivating patients to exercise is challenging. We aimed to understand exercise barriers and facilitators during HSCT treatment while participating in a daily unsupervised exercise programme.

**Participants** Patients scheduled to have HSCT.

**Study design** 6 participants were included in this descriptive qualitative study during HSCT treatment while participating in an exercise programme to identify perceived barriers and facilitators of the exercise. An average of three semi-structured interviews were conducted per patient.

**Setting** Exercise during HSCT treatment in an isolated immune room.

**Intervention** Daily unsupervised exercise.

**Results** A total of six patients completed a 6-week exercise programme as well as all scheduled interviews, whose compliance to the exercise programme ranged from 12% to 79%. Based on interview results, three themes were identified as barriers to exercise and four themes were identified as facilitators to exercise. Patients experienced physical and psychological barriers such as nausea, vomiting, sore throat, reduced appetite, decreased willpower and anxiety due to feelings of isolation. Environmental factors included negative opinions about exercise programmes and lack of encouragement from the haematologist. Facilitators of exercise included willpower, easy and simple exercise, convincing explanations from haematologists and supervised support from exercise specialists.

**Conclusion** Our study has identified potential barriers and facilitators associated with exercise participation during HSCT. Supervised exercise recommended by a haematologist, convincing explanation on the benefit of exercise by medical personnel, positive feedback from other HSCT survivors and supervision by exercise specialists may increase compliance to the exercise programme during HSCT.

**Trial registration number** ISRCTN61498391.

## INTRODUCTION

Hematopoietic stem cell transplantation (HSCT), which includes high-dose conditioning chemotherapy and 6 weeks of hospitalisation, is increasingly used for

## Strengths and limitations of this study

- The current study is the first study which investigated patients' experience while participating in an exercise programme during hematopoietic stem cell transplantation (HSCT).
- Patients' compliance to the exercise programme during HSCT varies significantly, therefore understanding exercise barriers and facilitators through qualitative research rather than quantitative is one of the strengths of the current study.
- Although the small number of participants is one of the limitations of this study, each participant was interviewed at least three times during the course of exercise participation.

haematological malignancies or severe non-malignant haematological disorders.<sup>1</sup> Although HSCT has promising benefits, treatment-related burden is still high.<sup>2</sup> Patients undergoing HSCT experience adverse side effects such as infection, mucositis, diarrhoea and neutropenia.<sup>3</sup> Treatment also results in severe deterioration of physical functioning and extreme fatigue.<sup>4 5</sup> Moreover, temporary isolation to avoid infection in conjunction with rapid changes in clinical status leads to emotional stress, significantly impacting quality of life (QoL).<sup>6 7</sup> These side effects may interfere with the ability to cope with cancer and its treatment.<sup>8 9</sup>

Although the efficacy of exercise programme among HSCT patients varies, strong interest exists to develop effective exercise interventions for patients undergoing HSCT.<sup>10-14</sup> Despite potential benefits of exercise reported by previous studies, implementation varies across studies in terms of timing of exercise initiation, exercise types and duration of exercise.<sup>13</sup> Since patients undergoing HSCT still experience extreme fatigue, nausea, vomiting, loss of muscle mass and impaired physical function,<sup>2 5 15 16</sup> low

compliance to exercise programme is a challenging issue in this population.

In order to develop an exercise programme with good compliance during HSCT, it is important to understand patients' experience during participation of the exercise programme while undergoing HSCT treatment. Previous qualitative studies on multiple patients with myeloma provided data on patients' experience on exercise barriers, perceived benefit of exercise and physical activity preference.<sup>17,18</sup> However, these studies interviewed participants 2–12 months after treatment.<sup>17,18</sup> Furthermore, patients' experienced exercise barriers and facilitators during HSCT treatment have not been studied. Our study aimed to understand barriers and facilitators of inpatient exercise programme during the 6 weeks of HSCT through multiple interviews while still undergoing the exercise programme.

## METHODS

### Participants

Six participants (two men, four women) were recruited using purposive sampling at the Severance Hospital, Seoul, Korea, with the following inclusion criteria: (1) scheduled for HSCT within 1 week, (2) age 18–65 years, (3) fluent in Korean, (4) absence of psychiatric disease or cognitive impairment and (5) agreement to participate in inpatient exercise during HSCT. The recruitment of new participants stopped when the collection of new data did not show any new ideas or concepts related to exercise experience during HSCT treatment.<sup>19</sup> Morse<sup>20</sup> outlined that at least six participants are needed for phenomenological studies. Creswell<sup>21</sup> also recommended that between 5 and 25 interviews are required for phenomenological studies. According to these recommendations, the data acquired from participants in our study were sufficient enough to observe and analyse barriers and facilitators of exercise during HSCT.

### Characteristics of researchers

The research team in the current study is composed of medical oncologists, clinical nurses and exercise specialists. All interviews were conducted by an exercise specialist (YMS) who also implemented the exercise programme with another exercise specialist (AKY). The leader of exercise specialists (JYJ) has been working with patients with cancer for over 10 years, developing and testing exercise programmes tailored for various patients with cancer under different conditions. The interpretation and categorisation of the interview results were discussed among team members including: a haematologist (CJW), a clinical nurse (CMO) and exercise specialists (JYJ, BJY, AKY, YMS). In order to establish rapport between exercise specialists and patients, exercise specialists (AKY, YMS) accompanied haematologists/medical oncologists when treatment consultations and options were discussed. The haematologist (CJW) specifically introduced exercise specialists (AKY, YMS) who implemented

exercise programme to patients. In the process of exercise programme implementation, exercise specialists (AKY, YMS) met with patients 15 times over the course of the study.

### Exercise intervention

The exercise intervention was designed to maintain muscle mass, physical function and range of motion. The first education session was delivered before entering the isolated transplantation ward and included explanation of the benefit of exercise, how to perform exercises and the role of supporting staff. Handouts were provided and patients viewed exercise videos. The programme comprised of whole-body stretching and weight-bearing exercise using resistance bands when possible. A 10–20 min exercise session was performed once or two times per day. Exercise specialists visited the isolation ward at least two times a week to ensure that patients are exercising with correct posture and properly logging their exercise diaries. Participants were asked to record exercise type, exercise volume (number of sets), walking time, uncompleted exercises and reasons for not completing these exercises.

### Design and procedures of the study

We used a descriptive qualitative approach to understand participants' exercise participation behaviour including barriers and facilitators of exercise during HSCT. Semi-structured face-to-face interviews were conducted at different phases of HSCT (at hospitalisation, beginning of conditioning chemoimmunotherapy, immediately after HSCT and during recovery after engrafting) in six participants during 6 weeks of intervention between March 2017 and June 2017. The interview started with general open-ended questions, followed by key questions on attitudes toward exercise and other experiences during HSCT. The questions asked were as follows: (1) What is your attitude toward exercise during HSCT? (2) What exercise barriers have you experienced? and (3) What motivates you to exercise? The interviews lasted for 30 to 60 min. To conduct in-depth interviews with participants who have a weakened immune system, it was necessary to create an absolutely sterile interview atmosphere. The exercise specialist (YMS) sat in a chair outside the immune room and interviewed participants who were in bed. All interviews were recorded using a smartphone outside the immune curtain after obtaining consent, and the smartphone was placed as close to participants as possible in order to improve the quality of the recording. Immediately after the interview, recordings were transcribed verbatim by the exercise specialist who interviewed the participant. Field notes and observations during the interview were collected, including non-verbal expressions and atmosphere. If there were any missing or unclear parts of the recordings, the exercise specialist would revisit the participants to clarify their answers. Transcriptions and recordings were stored on the exercise specialist's personal computer using anonymous names

instead of real names of participants. In addition, signed consent forms and any documents included patients' information were stored in a locked storage place.

### Trustworthiness

To increase the trustworthiness of data, we have employed three different methods: reflective note, observation and member check. After each interview, the exercise specialist reflected on their performance as an interviewer. Mistakes and important lessons learnt were recorded in a reflective note, while methods to improve the quality and depth of interviews were practised before the next interview. A sufficient amount of time was spent observing participants before and during HSCT treatment to understand the context of interview. To increase the reliability of the findings, interviews took place over 6 weeks as participants underwent treatment. The transcript and summary of each interview were confirmed by participants to ensure these transcriptions and summaries correctly reflected what they intended to say or express.

### Data analysis

Transcripts were analysed using the following process: (1) transcripts were read several times and checked for accuracy by comparing them to records and field notes; (2) the researcher (YMS) searched for similarities and differences in participant attitudes and experiences during the exercise intervention and highlighted words and sentences that seemed meaningful; (3) units of meaningful text were coded systematically; (4) extracts were organised into categories conceptually. The exercise specialist (YMS) could expand, condense, rename, collapse or reorganise coded contents of meaning to discover linkages and themes. To ensure reliability, other researchers (BJY, JYJ) reviewed and commented on coding categories. Any discrepancies were resolved through discussion and verification of additional data.

## RESULTS

The average duration of hospital stay for HSCT was 6 weeks. During the hospital stay, participants were instructed to participate in inpatient exercise. Compliance with the exercise programme ranged from 12% to 79%, based on logs (table 1). Physical, psychological

and environmental factors were identified as perceived barriers to exercise. Facilitators of exercise included will-power, ease and simplicity of exercise, convincing explanations and supervised support by exercise specialists. These themes, corresponding subthemes and meaningful comments are outlined in tables 2 and 3.

### Exercise barriers

#### Physical aspects

Side effects such as nausea, vomiting and decreased nutritional intake were considered exercise barriers. Patients experienced a lack of energy and fatigue once treatment started, largely attributable to the significant decrease in food intake caused by the aforementioned symptoms. These barriers made routine exercise difficult. Participants described the lack of energy as a complete and uncontrollable lethargy. Many reported that even standing was challenging due to severe nausea, malaise, and physical and emotional exhaustion. Although patients understood the need for exercise during HSCT, they reported that these physical limitations hindered regular participation (table 2, quotes 1–4).

#### Psychological aspects

Physical conditions during HSCT often influenced psychological symptoms. Participants showed strong interest in exercise before starting HSCT treatment. However, desire and interest decreased once intensive HSCT treatment started. Symptoms and side effects were worse than anticipated. One participant with less than a 30% compliance to the exercise programme had anxiety attacks due to feelings of social isolation in the transplant unit, making him severely unstable. Another participant with 12% compliance reported that the emotional stress was much greater than expected. Participants described isolated life during HSCT as 'a place where time stops, a solitary cell or a prison' when describing psychological distress (table 2, quotes 5 and 6).

#### Environmental aspects

A reason for poor exercise compliance was a lack of motivation from medical personnel and/or negative information from other patients undergoing HSCT. Participants felt that encouragement by the haematologist would have improved compliance with exercise (table 2, quotes 7 and

**Table 1** Characteristics of participants

Identifier	Sex	Age (years)	Diagnosis	Type of HSCT	Exercise compliance (%)
Participant 1	Male	40–50	MM	Autologous	30
Participant 2	Male	50–60	MM	Autologous	39
Participant 3	Female	40–50	MM	Autologous	71
Participant 4	Female	30–40	MM	Autologous	12
Participant 5	Female	50–60	MM	Autologous	12
Participant 6	Female	20–30	DLBCL	Autologous	79

DLBCL, diffuse large B-cell lymphoma; HSCT, hematopoietic stem cell transplantation; MM, multiple myeloma.

**Table 2** Barriers to exercise programme

	Subtheme		Meaningful quotes	Participants
Physical aspects	Nausea and vomiting	1	Treatment made me lethargic and I vomited so often, it was impossible to exercise. I just hope the nausea gets better. That's all I think about.	1, 2, 3, 4, 5, 6
	Sore throat	2	Stomatitis and sore throat kept me from exercising regularly. The pain made me think that I would rather die.	1, 3, 4, 5, 6
	Reduced appetite	3	Meal times are the most frightening—07:00, 12:00 and 18:00. I am so afraid of meal times because I puke every time I eat. It is uncontrollable.	1, 2, 3, 4, 5, 6
	Lack of energy/fatigue	4	I don't think I can handle exercise, because I don't have the energy—no energy at all. I was on an intravenous medication for 25 days.	1, 2, 3, 4, 5, 6
Psychological aspects	Decreased willpower	5	I have no desire to exercise and actually I don't feel like doing anything. I know that I should be able to handle exercise, but don't want to.	1, 2, 3, 4, 5
	Anxiety due to isolated life	6	I'm just stuck here, so I'm going crazy. It's not because of cancer, but because it is frustrating that I don't feel stable. I am so frustrated.	1, 2, 4, 5
Environmental aspects	Negative stories from other patients	7	I heard that he doesn't like exercise too.	1, 2, 4
	No encouragement from oncologist	8	If the oncologist had talked about the benefits of exercise, I would have participated more. It would have been good if the oncologists had recommended exercise when I was first admitted to the hospital.	1, 2, 4, 5

8). Another environmental factor was negative information from other patients in the immune room about the exercise programme. However, participants who received adequate motivation from the oncologist and positive opinions about exercise from other patients were more motivated to be compliant with exercise. Some of the isolated transplantation ward was divided into a private transplant unit where patients could hear negative or positive comments about exercise from other patients and caregivers. These comments seemed to influence motivation to participate in exercise.

### Facilitators to exercise program

#### Willpower

Desire to exercise was the most important facilitator, identified only among participants with exercise compliance greater than 70%. Participants compliant with exercise reported trying to cope with the psychological stress by focusing on positive thoughts and outcomes. One female participant reported that she tried to focus on the present rather than the past, and accepted the need to adjust to life as a cancer survivor. Her new goal was to recover from treatment and she felt that exercise would help her to achieve that goal; thus, she had a strong desire to exercise. Another female participant also reported compliance with exercise because her goal was to walk without difficulty at discharge. Participants who emphasised the importance of a positive outcome of exercise tried to complete the exercise programme without complaining about impediments, side effects and symptoms during

treatment. They highlighted the importance of focusing on positive outcomes and self-motivation to practice healthy behaviours. For these participants, willpower was essential to overcome impediments caused by HSCT (table 3, quotes 1–3).

#### Easy and simple exercise

Safety, ease and simplicity can increase motivation to complete an exercise programme by alleviating the psychological burden. Participants were unwilling to learn unfamiliar exercises claiming they were exhausted by treatment. Those with poor compliance reported that unfamiliar exercise was a reason for low compliance. However, those with good compliance reported they were familiar with exercises and had better attitudes toward participation. Those not used to exercise were also less likely to be compliant. Therefore, as previous exercise experiences affect exercise behaviour during HSCT, it is important to make an exercise programme that is safe and simple to motivate participants (table 3, quotes 4–6).

#### Convincing explanation

Clear explanation of the importance of exercise was also identified as one of facilitators to exercise programme. Participants were more willing to exercise when detailed and specific information on the benefits was provided. They were more likely to change attitudes and behaviours toward exercise when the importance to HSCT was provided by the haematologist rather than the exercise specialist. Recommendation by the haematologist reassured participants that

**Table 3** Facilitators to exercise programme

	Subtheme		Meaningful quotes	Participants
Willpower	Strong will to overcome current difficulties	1	I think it's important to have willpower. I keep getting a fever and had one this morning, but once the fever went down, I was determined to exercise. I think willpower makes a big difference.	3–6
	Focusing on positive thoughts	2	Why me? I tried so hard not to complain because I am sick now and I cannot change this fact. No one in my family had cancer. What's more, multiple myeloma is incurable. Although I had a hard time, I thought to myself that it could have been worse.	3–6
	Goal-oriented attributes	3	The problem with a lot of patients is that they spend time self-pitying, trying to figure out why they got sick. That's not the point. If you're already sick, you should focus on what to do in order to get better. For me, exercise is one of the things I can do to achieve my goal of getting better. This is my goal, and I should act accordingly.	3–6
Easy and simple exercise	Safe content	4	I am scared to move around a lot because there were two occasions when I almost fell. It made me realise that I shouldn't move around like I used to before I became sick. However, basic stretching in this program was easy to do, so it was not burdensome. If the exercise program is difficult, patients will not want to do it.	1–3
	Simple content	5	It's complicated to memorise the sequence of movements. If the content is simple, patients will be more compliant.	1, 2, 3, 6
	Mastery of movement	6	In my case, exercise movements were easy to learn because I used to take Pilates lessons. The movements were similar and easy for me to follow. It's annoying and troublesome to do something unfamiliar.	3–6
Convincing explanation	Specific explanation about the importance of exercise	7	What motivates me is that I must exercise to eat something. I heard that exercise helps the organs function. They told me to exercise to alleviate the diarrhoea that occurs due to the high dose of chemotherapy. The only way out is to exercise—ha ha. So, I exercise. They told me that exercise may help the digestive system. I thought I should exercise for the organs to become more active. I think I should move around more.	1, 2, 3, 6
	Success stories of other patients	8	I have already experienced what other patients are now experiencing. I think that is why they seem to trust my story. When I describe the benefits of exercise to other patients, my experience may be a source of motivation. I think it is easier for them to understand.	1, 3, 5, 6
	Recommendation of oncologist	9	This morning my professor (medical oncologist) told me that I should exercise more. Hearing that made me think that I should exercise more. I forgot the exercise order but tried to follow the basic movements by looking at the handout.	1, 2, 3, 6
Supervised support from the exercise therapists	Regular visits	10	Visits by the therapists made it easier to perform the exercise. I think it was really helpful as it made me exercise with less difficulty. This allowed me to continuously participate in the exercise program.	2, 3, 5, 6
	Encouraging talks	11	The encouragement I received from exercise therapists when I was having a hard time doing the exercise alone helped me to carry on. Encouraging words (motivational talks) might not have been that important, but really helped me to stay determined.	1, 2, 3, 5, 6

exercise was beneficial. Hearing success stories of other cancer or transplant survivors prompted better attitudes toward exercise. Explanations by medical personnel were as important as positive feedback about exercise from other patients (table 3, quotes 7–9).

#### Supervised support by exercise specialists

Regular visits by specialists were also identified as one of the facilitators to the exercise programme. Although participants had difficulty in implementing the exercise programme without assistance, instruction and guidance by the exercise specialists helped motivate patients to move and exercise. Participants preferred a supervised programme rather than

self-directed exercise. Participants reported that positive encouragement from specialists enabled them to think of themselves not only as objects of clinical attention but also as human beings. They perceived exercise specialists as allies during extended HSCT (table 3, quotes 9 and 10).

#### DISCUSSION

This study provided in-depth information on participant experiences during an inpatient exercise intervention while undergoing HSCT. Barriers, as well as facilitators to exercise during hospitalisation for HSCT, were identified.

Physical, psychological and environmental factors were identified as barriers to exercise. Facilitators included willpower, ease and simplicity of exercise, convincing explanations from the haematologist and supervised support from exercise specialists.

HSCT treatment caused side effects such as vomiting, stomatitis, fever, sore throat and appetite loss. High-dose conditioning chemotherapy affects multiple organ systems<sup>22</sup> and leads to lethargy, which was the most prominent barrier to exercise. Lethargy and extreme exhaustion result from symptoms and side effects of HSCT,<sup>23</sup> and influences the psychological state. These symptoms are common among patients with cancer undergoing high-dose conditioning chemotherapy; however, unique to HSCT is the need for isolation to prevent infection. Being isolated in the transplant unit affects communication between patients and haematologists as well as between patients and exercise specialists. Since specialists cannot have physical contact with participants during exercise, providing instruction was challenging and further affected the compliance rate. Participants experienced anxiety and discomfort during HSCT, and severe mental disturbances in some cases, in line with previous study findings.<sup>24</sup> Although all participants in the current study experienced challenges and barriers to exercise, the compliance rate varied, as did the ability to overcome challenges.

Different theories have been proposed to explain the determinants of exercise behaviours in cancer survivors, including the Theory of Planned Behaviour (TPB) by Ajzen,<sup>25</sup> as well as other theories reported in exercise oncology.<sup>26–27</sup> According to TPB, behavioural intent is a primary determinant of such behaviour. Intent is often determined by three independent constructs: attitude, subjective norm and perceived behaviour control. Numerous studies have applied TPB to explain exercise behaviour in cancer survivors,<sup>28–30</sup> including patients with cancer following high-dose chemotherapy and bone-marrow transplant.<sup>31</sup> Our study observed that exercise compliance decreased when participants perceived a lack of support from the haematologists or inadequate explanation about the benefit of exercise during HSCT treatment. Explanation from the haematologist may influence participants' attitudes toward exercise as well as the subjective norm. We and others previously demonstrated that cancer survivors who receive an exercise recommendation from the oncologist are likely to increase their physical activity,<sup>32–33</sup> even when tired or exhausted. An exercise recommendation and explanation of the benefits may show cancer survivors that their oncologists are confident in their ability to exercise during a difficult treatment procedure.<sup>33–34</sup> Therefore, an exercise recommendation and explanation of the benefits may influence all three aspects of TPB. This theory is in line with the findings in our study that participants with poor compliance felt they would have participated in an exercise programme more if the benefits had been explained more clearly by the haematologists.

Another interesting finding of our study was the influence of other patients. In the transplant unit, patients can hear conversations with medical personnel, family and exercise specialists. We found that intent to exercise significantly decreased when other patients shared negative attitudes and comments toward exercise. Neighbouring patient attitudes toward exercise may have influenced injunctive subjective norms (perception of what important others think of exercise) and descriptive subjective norms (what other people in a similar situation think of exercise). Furthermore, neighbouring patient attitudes toward exercise may also influence perceived behaviour control. Participants who heard negative comments on exercise from neighbouring patients may have thought that the inability to exercise during HSCT meant that 'I probably cannot and should not' exercise.

An important finding of this study is that although participants were involved in the same exercise programme, fundamental attitudes toward exercise during treatment varied. Several participants had high motivation as well as good compliance with exercise. These participants reported that attitudes toward self-motivation to recover could have an impact on participation in the exercise programme. They tried to overcome negative situations and made efforts to improve their health through exercise. This finding is in agreement with a previous study showing that suppression is a coping strategy used to regulate negative thoughts.<sup>35</sup> In addition, goal-oriented tendencies and strong willpower led these patients to regularly participate in the exercise programme. Menshadi *et al.*<sup>36</sup> reported that patients with lymphoma used goal-oriented strategies to overcome cancer-related side effects. In the current study, participants with these strong behaviour intentions had notably higher compliance with exercise than those who did not.

We identified three facilitators in our study: strong willpower, simplicity and ease of exercise, and convincing explanations. Our participants reported that specific explanations about the importance of exercise, as well as success stories of other patients, were facilitators of exercise during HSCT. Lack of explanation from the haematologist about the benefits was a barrier to exercise, but participants felt that specific and clear explanations would influence compliance. Clear and specific explanations seemed to influence instrumental attitude (perceived health benefit) rather than affective attitude (perceived enjoyment). Based on our interviews, participants exercised not because it was enjoyable, but because they believed it was beneficial. Therefore, clear and specific explanations about the benefits of exercise would influence intent to exercise as well as subjective norms.

Another facilitator of exercise was ease and simplicity of content. Because participants had severe fatigue and symptoms such as nausea and vomiting, implementing difficult and complicated exercise would have interfered with compliance. Even though the exercise programme in the current study was relatively easy, it might not have been simple for participants to follow, and as a result,

participants were still not very compliant; thus, providing simpler exercise may necessarily improve compliance. Our study also noted that past exercise experience and mastery might have influenced compliance. An aspect of TPB is perceived behaviour control, which includes self-efficacy (confidence in one's ability to exercise) and perceived control. Indeed, Courneya *et al*<sup>31</sup> reported that attitude toward exercise and perceived behaviour control explained 68% of the variance in exercise intention in patients with cancer following high-dose chemotherapy and bone marrow transplantation. Greater compliance with exercise among participants with previous experience suggests that this influenced self-efficacy and perceived control over exercise behaviour. However, even participants without previous exercise experience may be able to increase self-efficacy and perceived behaviour control when provided not only with simple and easy exercises to follow, but also adequate exercise instruction before starting HSCT. Although providing more instruction before the start of treatment may help participants increase compliance with exercise, it may not solve all problems. One difficulty in implementing an exercise programme in patients undergoing HSCT is that the specialist cannot be in the transplant unit. We previously conducted an inpatient exercise programme for patients with colorectal cancer who underwent colectomy and found compliance rates of more than 90%.<sup>37</sup> Although exercising immediately after curative surgery can be difficult, the presence of the specialist at the bedside helped patients comply with the exercise programme. In the current study, specialists visited participants to encourage exercise, but often found them sleeping or unwilling to communicate with the specialists over the intercom. In this setting, it was very difficult to provide good exercise instruction. However, participants still reported that visits by the exercise specialist and instruction over the intercom encouraged them to be more compliant with exercise and to overcome emotional distress and feelings of isolation. HSCT patients frequently experience impaired physical function, leading to impaired QoL and even depression.<sup>38</sup> Knowing that patients with cancer often regard healthcare providers as allies,<sup>39</sup> supervised exercise rather than unsupervised exercise may be a better modality in patients who underwent HSCT. Therefore, to increase exercise compliance, haematologists, nurses and exercise specialists should work together to develop a clearly defined system to implement daily exercise in patients undergoing HSCT.

A limitation of this qualitative study was the small number of participants. Therefore, it is difficult to generalise the findings of our study to a broader patient population undergoing HSCT. However, the purpose of this study was not to generalise the results but rather to contribute to the understanding of factors associated with compliance during inpatient exercise for patients undergoing HSCT. In addition, the transplant unit setting may vary among hospitals. In our hospital, some patients were in the same room but separated by dividers, and could

hear conversations. This setting may have influenced the results. Nonetheless, we believe that the current study provides a unique perspective based on in-depth interviews of patients undergoing HSCT. For future studies, it is necessary to develop an exercise programme that minimises exercise barriers and maximises facilitators of exercise for patients undergoing HSCT based on findings from the current study. Then, randomised controlled trial should be conducted to test the efficacy of tailored exercise programme for HSCT patients. Although our study has several limitations, our study is novel in several ways. First, our study was the first, to our knowledge, which described HSCT patients' positive and negative experiences as they were undergoing exercise programme. Second, compliance data in the current study for each participant put more meaning into identified barriers and facilitators of exercise programme. Lastly, multiple interviews while our participants were still undergoing exercise programme made our data unique.

In conclusion, our descriptive qualitative study may have identified barriers and facilitators associated with exercise participation during HSCT. Participants experienced perceived physical and psychological barriers to participation in exercise programme during HSCT including nausea, vomiting, sore throat, reduced appetite, decreased willpower and anxiety due to a feeling of isolation. Participants also experienced environmental factors which negatively influenced participation in exercise programme included negative opinions of other neighbouring patients toward exercise and lack of encouragement from the haematologist. Facilitators included ease and simplicity of exercise, clear and specific explanations of the benefits of exercise from the oncologist, and supervision by exercise specialists. Participants also reported that hearing success stories of other patients who underwent HSCT would help them to be more compliant with exercise. Our study suggests that a supervised exercise programme recommended by the haematologist in an exercise-friendly setting, with positive feedback from medical personnel, other HSCT survivors and exercise specialists, may be optimal for exercise adherence in this setting.

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**Data availability statement** Data are available upon reasonable request. All interviews were conducted and recorded in Korean language. Raw data (scripts) will be available upon request on the specific area of interest.

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