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Frailty and Self-Management Factors among Hematopoietic Stem Cell Transplantation (HSCT) Recipients in Jordan: A Cross-Sectional Study

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ABSTRACT

Background: Despite advances in supportive care for HSCT, frailty remains a significant concern among HSCT recipients, affecting their quality of life and long-term outcomes. A better understanding of the self-management factors associated with physical activity and frailty is particularly needed among HSCT populations in Jordan. ***Purpose*:** The study aimed to examine the prevalence of frailty among Jordanian HSCT recipients. It also aimed to examine the relationships between exercise self-efficacy and social support, as self-management factors, with physical activity and frailty. ***Methods***: A convenient sample of 136 HSCT recipients (≥18 years old) was recruited for this cross-sectional correlational study. Participants completed validated questionnaires on exercise self-efficacy, social support, and physical activity. Frailty was measured using the Fried Frailty Phenotype. Three brief open-ended questions were included and analyzed using content analysis to provide contextual insights. ***Results***: The prevalence of frailty was 41.3%. Age (OR: 1.11; 95% CI 1.03-1.19), marital status (OR: 10.61; 95% CI: 1.25-89.51), and the presence of graft-versus-host-disease (GVHD) (OR: 20.03; 95% CI: 2.78-143.39) were associated with frailty. Higher exercise self-efficacy was associated with higher physical activity (χ^2 = 85.95, $p < 0.001$) and lower frailty (OR: 264.9, 95% CI: 18.79-3734.5, $p < 0.001$), while social support showed no significant association ($p > 0.05$). ***Conclusion*:** Frailty prevalence among Jordanian HSCT recipients was substantially higher than that reported in Western populations. Future research should prioritize integrating frailty screening into standard pre-HSCT assessments for risk stratification and developing culturally tailored interventions to mitigate frailty-related risks. ***Implications for Nursing*:** Integrating physical frailty screening into routine HSCT assessments and providing targeted education for healthcare professionals, including nurses, is highly recommended.

Keywords: Hematopoietic stem cell transplant, Frailty; Physical activity, Exercise self-efficacy, Social support.

What does this paper add?

1. It provides evidence that frailty is highly prevalent among Jordanian HSCT recipients.
2. It demonstrates that exercise self-efficacy is associated with higher levels of physical activity and a lower likelihood of frailty.
3. It emphasizes the importance of frailty assessment pre- and post-HSCT and targeted education for healthcare professionals.
4. It highlights the role of cultural norms and engagement of patients, families, and healthcare teams in interventions.

Introduction

Hematopoietic Stem Cell Transplantation (HSCT) is a curative or life-extending treatment for various hematological malignancies, including leukemia, lymphoma, and multiple myeloma (Mohanraj et al., 2021). HSCT recipients often do not regain full health even when their disease is cured or controlled. They face increased risks of treatment-related toxicity, including fatigue, cardiovascular disease, graft-versus-host disease (GVHD), psychological challenges, functional decline, and limitations in daily activities (Pamukcuoglu et al., 2019; Rashid et al., 2023), which may contribute to frailty even in younger HSCT recipients (Arora et al., 2016).

Frailty is a clinical condition characterized by decreased physiological reserve and functional ability, leading to increased risk of adverse health outcomes, such as falls, disability, and mortality (Fried et al., 2001). Beyond that, physical frailty is associated with lower survival, higher non-relapse mortality, and greater post-HSCT toxicities (Sung et al., 2021). Recent evidence suggests that approximately 10% to 32% of HSCT recipients in the United States are classified as frail after undergoing HSCT (Arora et al., 2016; Rashid et al., 2023). Despite its clinical significance, data on frailty among HSCT recipients in the Middle East, particularly in Jordan, remains limited.

Prior studies have consistently demonstrated an inverse association between physical activity and frailty after HSCT (Mohanraj et al., 2021; Suominen et al., 2022), with higher activity levels linked to lower frailty prevalence. Despite the known benefits of physical activity, several barriers limit HSCT recipients' ability to engage in regular physical activity during and after transplantation, including fatigue, fear of injury, low motivation, disease relapse, and limited family and medical support (Abo S et al., 2022; Purdy et al., 2023). Studies conducted in Western populations have shown that higher self-efficacy and stronger social support are associated with better health outcomes among HSCT recipients, including improved survival, reduced readmissions, and enhanced physical, emotional, and social functioning (Amonoo et al., 2021; Rotz et al., 2022). While self-efficacy and social support have been examined in relation to quality of life and survival outcomes, their association with objectively measured frailty among HSCT recipients, particularly in Middle Eastern populations, remains understudied.

To address this gap, this study aimed to examine the relationship between self-management factors (exercise self-efficacy and social support) and frailty among HSCT recipients in Jordan. Understanding how these factors influence physical activity as self-management behavior and frailty as a health outcome is essential for developing targeted interventions. Specifically, this study aimed to: (1) determine the prevalence of frailty among Jordanian HSCT recipients beyond 100 days post-HSCT; (2) assess the associations between exercise self-efficacy, social support, and physical activity; and (3) examine whether frailty is predicted by exercise self-efficacy and social support.

Conceptual Framework

This study was guided by the Individual and Family Self-Management Theory (IFSMT) (Ryan & Sawin, 2009), which provides a comprehensive framework for understanding how contextual factors (e.g., age, gender, cancer diagnosis, HSCT type, GVHD, time since HSCT) and self-management process factors (e.g., exercise self-efficacy, social support) influence self-management behaviors (e.g., physical activity) and health outcomes (e.g., frailty) (Figure 1). Prior studies have reported significant associations between age, cancer diagnosis, HSCT type, and GVHD with both physical activity and frailty (Arora et al., 2016; Rashid et al., 2023). Self-efficacy is also considered a predictor of physical activity in patients with hematological malignancies (Amonoo et al., 2021; Rotz et al., 2022). Social support affects the motivation of cancer patients and their families to engage in self-management behaviors (Kear et al., 2017). Lower levels of exercise

self-efficacy and social support may prevent individuals and their families from engaging in self-management behaviors, which can directly affect the health outcomes of HSCT recipients.

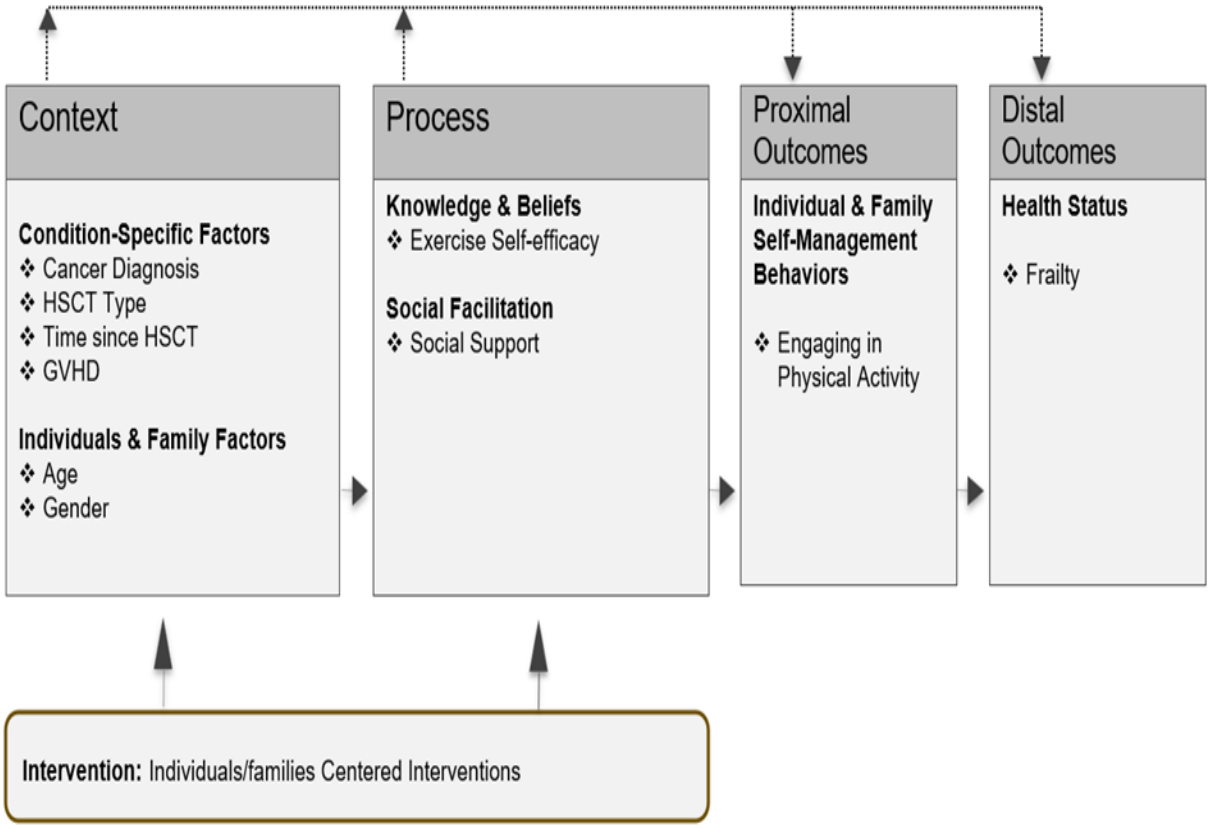

Figure 1. The individual and family self-management theory (IFSMT)

Methods

Design, Sample, and Setting

This study employed a non-experimental, cross-sectional correlational design with a convenient sample and was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist. Data was collected at a specialized tertiary cancer center in Jordan. Eligible participants met the following criteria: (a) had received an autologous or allogeneic HSCT and were at least 100 days post-HSCT with no evidence of disease; (b) diagnosed with leukemia, lymphoma, multiple myeloma, or myelodysplastic syndromes (MDS); (c) aged 18 years or older; (d) able to ambulate independently or with assistive devices (e.g., a cane, crutch, or walker); (e) not hospitalized; and (f) able to read and write Arabic. Exclusion criteria included: (a) progressive neurological or autoimmune disease; (b) musculoskeletal comorbidities; and (c) major psychiatric conditions that could interfere with study participation. A priori power analysis indicated a minimum sample size of 111 participants, based on effect sizes (odds ratios) from previous studies (Jeon et al., 2022; Tsai et al., 2022), with a power of 0.80 and an alpha of 0.05.

Instruments

The study questionnaire consisted of two components. The first part included participants' sociodemographic and medical characteristics, such as age, gender, marital status, income (USD/ month), education level, employment status, diagnosis, HSCT type, and presence of GVHD. The second part included validated instruments measuring exercise self-efficacy, social support, physical activity, and frailty. Weight (in kilograms) and height (in centimetres) were measured, and body mass index (BMI) was calculated. These variables were included as covariates in the analyses to control for their potential influence on the study outcomes.

All instruments were used with appropriate

permission or were open access; permission was obtained from the authors of the validated Arabic versions of the Medical Outcomes Study Social Support Survey (Alaloul et al., 2021), and the Exercise Self-Efficacy Scale (Darawad et al., 2018), while the International Physical Activity Questionnaire (Short Form) is available in Arabic as an open-access tool (Craig et al., 2003).

Exercise Self-efficacy

The Exercise Self-Efficacy (ESE) instrument includes 18 items rated from 0 (not at all confident) to 100 (highly confident). Participants rated their confidence level in their ability to engage in exercise (Bandura, 2006). The overall ESE score was calculated as the mean of all items, with higher scores indicating greater self-efficacy (Darawad et al., 2018). The scale has excellent internal consistency, with Cronbach's alpha consistently above 0.95 in prior studies (Everett et al., 2009; Shin et al., 2001). The ESE scale is available in Arabic and demonstrated excellent internal consistency among Jordanian patients with chronic illnesses in a prior study (Cronbach's alpha = 0.89) (Darawad et al., 2018). In this study, internal consistency was excellent (Cronbach's $\alpha = 0.99$).

Social Support

Medical Outcomes Study Social Support Survey (MOS-SSS) is a 19-item scale comprising four subscales: emotional/informational support (8 items), tangible support (4 items), affectionate support (3 items), positive social interactions (3 items), and one additional item assessing overall support (1 item) (Sherbourne & Stewart, 1991). Item response options ranged from 1 (none of the time) to 5 (all the time), with higher scores indicating greater levels of social support. Cronbach's alpha of the original scale was 0.91 (Sherbourne & Stewart, 1991). This scale has been translated into Arabic, and the internal consistency in a sample of Jordanian HSCT survivors had a Cronbach's alpha value of 0.93 (Alaloul et al., 2021). In this study, the Cronbach's alpha of the MOS-SSS scale was 0.95.

Physical Activity

Physical activity (PA) was measured using the International Physical Activity Questionnaire (IPAQ) short form (Craig et al., 2003). The scale includes seven items assessing the frequency, duration, and intensity of physical activity over the past 7 days, including vigorous activity, moderate activity, walking, and sedentary behavior. The scale also included a question on sedentary time. This study used the official Arabic short version of the IPAQ, and scores were calculated according to the IPAQ guidelines (Craig et al., 2003). In this study, Cronbach's alpha was 0.85.

Frailty

Fried Frailty Phenotype (FFP) (Fried et al., 2001), which includes assessing five criteria: unintentional weight loss, exhaustion, weakness, slow gait, and low physical activity. A modified version of the FFP was used in this study, in which the Timed Up and Go (TUG) test replaced the original 15-foot walk test to assess slowness. The TUG test was selected due to its feasibility in clinical oncology settings and its established validity in assessing mobility and frailty-related outcomes among HSCT recipients (Pamukcuoglu et al., 2019; Rashid et al., 2023). Participants received a point for each of the five criteria. The cumulative frailty score (0-5) was obtained, and each subject was scored (ordinal level) as non-frail (0), pre-frail (1-2), or frail (3-5).

Unintentional weight loss was assessed by the following question: "In the past year, have you lost more than 10 lb (4.5 kg) unintentionally (i.e., no diet or exercise)?" An answer of "yes" met the criterion for frailty in this category, adding one point to the overall assessment of physical frailty (Fried et al., 2001).

Self-rated exhaustion was measured using two items from the Center for Epidemiologic Studies Depression Scale (CES-D Scale): "I felt that everything I did was an effort" and "I could not get going." Patients were asked, "How often did you feel this way in the last week?" (0 = rarely or none of the time; 1 = some or a little of the time; 2 = a moderate amount of the time; 3 = most of the time). Exhaustion was scored when the patient answered "2" or "3" to either of these questions (Fried et al., 2001).

Weakness was measured using a JAMAR Digital Hand Dynamometer, a handheld device that measures the maximum isometric grip strength of an individual's hand and forearm muscles (Fried et al., 2001). The average of three trials from the dominant hand was calculated, and grip strength scores were evaluated according to the FFP criteria, which use cutoff points adjusted for sex and body mass index to assess weakness (Fried et al., 2001).

Slow gait was measured using the Timed Up and Go (TUG) test. Each participant was asked to sit in a standard chair, then rise, walk 3 meters, turn around, walk back, and sit down again. A stopwatch was used to measure the time to complete the task. The timer started when the participant initiated the standing-up process and stopped once he/she sat down again. The less time of the two trials was used to calculate the TUG score. Participants' results were compared with age- and sex-specific normative reference values (Kear et al., 2017).

Low Physical Activity was assessed using the International Physical Activity Questionnaire (IPAQ) as described above (Craig et al., 2003).

Qualitative Measurement

In addition to the quantitative measures, participants answered three open-ended questions addressing their health concerns after HSCT, challenges related to physical activity, and the influence of cultural beliefs and social relationships on their ability to remain active. These questions were administered at the end of the survey to provide contextual insights that were not captured by the quantitative measures alone.

Procedure

Participants were recruited through flyers placed in the adult HSCT outpatient clinic waiting area. Individuals who expressed interest provided written informed consent prior to participation. Surveys and frailty assessments were completed in a private examination room, with a trained member of the research team available to respond to questions and conduct the frailty assessment. Upon completion, participants were notified of any unanswered items and informed that responses remained optional.

Data Analysis

Data was analyzed using SPSS, version 29. Descriptive statistics summarized demographic, clinical characteristics, and study variables (means and standard deviations for continuous variables; frequencies and percentages for categorical variables). Frailty was assessed across demographic variables using a one-way ANOVA with age and chi-square tests for all other variables. Assumptions of normality and homogeneity of variance were assessed and met for ANOVA, and Tukey's HSD post hoc tests were used to determine which age group comparisons were statistically significant. The distributions of exercise self-efficacy, social support, and physical activity were highly skewed; therefore, they were dichotomized into two categories: low vs. moderate/high to address non-normality and facilitate interpretation. Chi-square tests examined associations among exercise self-efficacy, social support, and physical activity. Binomial logistic regression models assessed predictors of frailty, including exercise self-efficacy, social support, and relevant covariates. The multivariate assumptions were evaluated, and the absence of multicollinearity and influential outliers was confirmed. Frailty was dummy coded as frail vs. non-frail/pre-frail (reference category). Model fit was evaluated using deviance statistics and Nagelkerke R^2, and results were reported as odds ratios with 95% confidence intervals. Statistical significance was set at $p < .05$. Open-ended responses were analyzed using content analysis (Drisko & Mascki, 2016). Responses were repeatedly reviewed for familiarity, and the principal investigator carefully coded meaningful statements. Similar codes were grouped into main categories. Coding and category decisions were reviewed with a co-author and refined through continuous comparison for consistency and accurate representation.

Ethical Considerations

Institutional Review Board approval was obtained from the University of Wisconsin-Milwaukee (IRB # 25.066) and King Hussien Cancer Center (IRB # 24KHCC208SP), and written informed consent was obtained from all participants. Participant confidentiality was maintained throughout the study, and all data was de-identified and securely stored in accordance with institutional guidelines. Participation was voluntary, and participants were informed of their right to withdraw at any time without any consequences.

Results

Sample Characteristics

Of the HSCT recipients approached, 140 agreed to participate in the study, and 136 enrolled and completed all study activities. The participant characteristics and their associations with frailty are presented in Table 1. On average, participants were approximately 44 years old (SD = 13.43), male (64%), married (77.9%), had a monthly income of less than $350 (42.6%), unemployed (55.1%), and had a high school education or less

(53.6%). More than a half of the participants (55.1%) were over 12 months post-HSCT, diagnosed with leukemia (58.1%), underwent allogeneic HSCT (71.3%), and did not experience GVHD (60.3%).

Table 1. Participant characteristics overall and across frailty levels

Variables	Total N = 136	Non-frail n = 38 (27.9%)	Pre-frail n = 42 (30.8%)	Frail n = 56 (41.3%)	Statistic	*p*
Age in years; Mean (SD)	43.96(13.43)	39 (11.41)[a]	45 (13.34)[ab]	46 (14.12)[b]	*F*=3.586	0.030
Gender					$\chi2$=0.281	0.869
Male	87 (64%)	23 (60.5%)	27 (65.9)	37 (64.9%)		
Female	49 (36%)	15 (39.5%)	14 (34.1%)	20 (35.1%)		
Marital Status					$\chi2$=1.675	0.433
Single/Other	30 (22.1%)	11 (28.9%)	7 (17.1%)	12 (21.1%)		
Married	106(77.9%)	27 (71.1%)	34 (82.9%)	45 (78.9%)		
Income (USD)					$\chi2$=6.446	0.168
<$350	58 (42.6%)	20 (52.6%)	13 (31.7%)	25 (43.9%)		
$351- 649	54 (39.7%)	13 (34.2%)	22 (53.7%)	19 (33.3%)		
≥$650	24 (17.7%)	5 (13.2%)	6 (14.6%)	13 (22.8%)		
Living Area					$\chi2$=1.263	0.532
Inside C	62 (45.6%)	15 (39.5%)	18 (43.9%)	29 (50.9%)		
Outside C	74 (54.4%)	23 (60.5%)	23 (56.1%)	28 (49.1%)		
Education					$\chi2$=9.120	0.332
Middle	24 (17.6%)	8 (21.1%)	3 (7.3%)	13 (22.8%)		
High	49 (36%)	11 (28.9%)	19 (46.3%)	19 (33.3%)		
Diploma	10 (7.4%)	2 (5.3%)	4 (9.8%)	4 (7%)		
	41 (30.2%)	15 (39.5%)	12 (29.3%)	14 (24.6%)		
Undergraduate	12 (8.8%)	2 (5.3%)	3 (7.3%)	7 (12.3%)		
Graduate						
Post-HSCT					$\chi2$=6.128	0.047
<12 months	61 (44.9%)	11 (28.9%)	23 (56.1%)	27 (47.4%)		
>12 months	75 (55.1%)	27 (71.1%)	18 (43.9%)	30 (52.6%)		
Employment					$\chi2$=2.370	0.883
Full-time Part-time	27 (19.9%)	10 (26.3%)	7 (17.1%)	10 (17.5%)		
	16 (11.8%)	5 (13.2%)	5 (12.2%)	6 (10.5%)		
Retired	18 (13.2%)	4 (10.5%)	7 (17.1%)	7 (12.3%)		
Not working	75 (55.1%)	19 (50%)	22 (53.6%)	34(59.7%)		
Diagnosis					$\chi2$=1.725	0.786
Leukemia	79 (58.1%)	21 (55.3%)	22 (53.6%)	36 (63.2%)		
Lymphoma	37 (27.2%)	10 (26.3%)	12 (29.3%)	15 (26.3%)		
MM	20 (14.7%)	7 (18.4%)	7 (17.1%)	6 (10.5%)		
HSCT type					$\chi2$=2.215	0.330
Allo-HSCT	97 (71.3%)	27 (71.1%)	26 (63.4%)	44 (77.2%)		
Auto-HSCT	39 (28.7%)	11 (28.9%)	15 (36.6%)	13 (22.8%)		
GVHD					$\chi2$=39.636	<0.001
Yes	54 (39.7%)	4 (10.5%)	10 (24.4%)	40 (70.2%)		
No	82(60.3%)	34 (89.5%)	31 (75.6%)	17 (29.8%)		

Note. [ab] Groups sharing the same superscript do not differ significantly according to Tukey's HSD post hoc test, p <0.05. *Abbreviations:* C: Capital (Amman). MM: Multiple Myeloma. HSCT: Hematopoietic Stem Cell Transplantation. Allo: Allogenic. Auto: Autologous. GVHD: Graft Versus Host Disease.

Prevalence of Frailty

The prevalence of frailty among HSCT recipients was 41.3%, compared with non-frail (27.9%) and pre-frail (30.8%) (Figure 2). A one-way ANOVA showed a significant difference in age across frailty categories (F = 3.586, *p* =0.030). Tukey's HSD post hoc analysis revealed that participants classified as non-frail (M = 39.16, SD = 11.41) were significantly younger

than those classified as frail (M = 46.30, SD = 14.12; *p* =0.029). Frailty prevalence was similar between patients less than and greater than 12 months post-HSCT; however, pre-frail patients were significantly more likely to be within 12 months post-HSCT, while the number of non-frail patients increased after 12 months (χ^2 = 6.13, *p* =0.047). Additionally, frail recipients were significantly more likely to have GVHD compared with non-frail and pre-frail patients (χ^2 = 39.64, *p* <0.001). No significant differences were observed in gender, marital status, education, income, employment, or living area among the three frailty groups (Table 1).

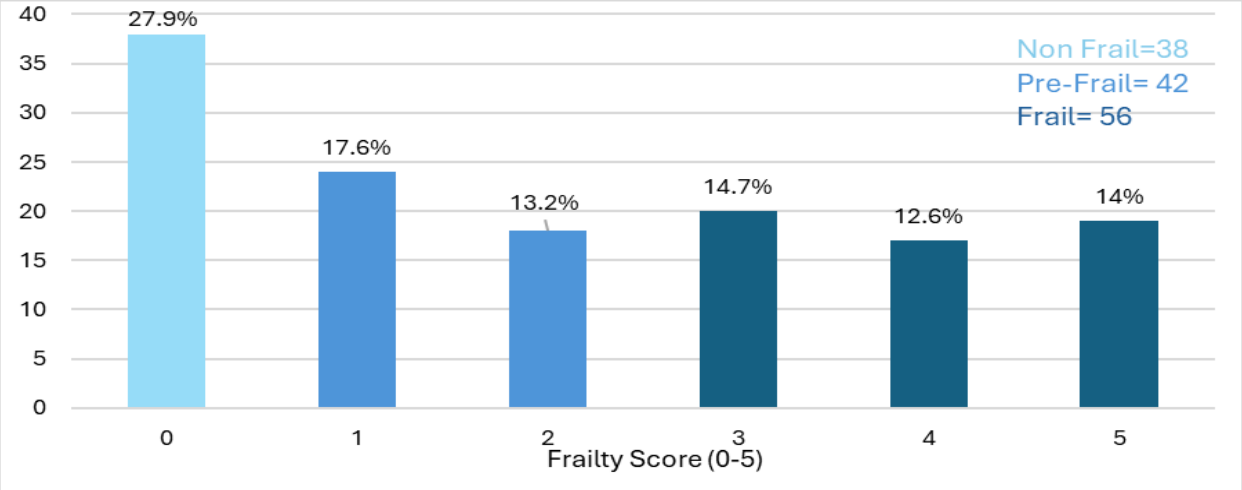

Figure 2. Prevalence of frailty
Fried frailty criteria: frail ≥ 3, pre-frail =1-2, and non-frail =0

Prevalence of Self-Management Process Factors and Physical Activity

Descriptive statistics for exercise self-efficacy, social support, and physical activity are presented in Table 2. Of the sample, 45.5% (n = 62) had moderate/high exercise self-efficacy, and 54.4% (n = 74) had low exercise self-efficacy. Most of the sample (91.2%, n = 124) had moderate/high social support, with only 8.8% (n=12) reporting low social support. There was a near-equal distribution of physical activity levels based on IPAQ score, with 48.5% (n = 66) having moderate/high physical activity and 51.5% (n = 70) with low physical activity.

Relationships between exercise self-efficacy and social support with physical activity are depicted in Table 2. A statistically significant association was found between exercise self-efficacy and physical activity (χ^2 = 85.95, *p* <0.001), with individuals with higher exercise self-efficacy being more likely to report moderate/high levels of physical activity. However, there was no statistically significant relationship between social support and physical activity.

Table 2. Relationships between exercise self-efficacy and social support with physical activity

	Moderate/High Physical Activity n = 66 (48.5%)	**Low Physical Activity n = 70 (51.5%)**	**χ^2**	**p**
Exercise Self-Efficacy			85.95	<.001
Moderate/High; n = 62(45.5%)	57 (91.9%)	5 (8.1%)		
Low; n = 74 (54.4%)	9 (12.2%)	65 (87.8%)		
Social Support			0.248	.618
Moderate/High; n = 124 (91.2%)	61 (49.2%)	63 (50.8%)		
Low; n = 12 (8.8%)	5 (41.7%)	7 (58.3%)		

Factors Predicting Frailty

Logistic regression analysis indicated that exercise self-efficacy was significantly associated with frailty (OR = 264.9, 95% CI: 18.79-3734.4, p <0.001) (Table 3). The wide confidence interval suggests variability in the estimate and should be interpreted with caution. HSCT recipients with low exercise self-efficacy had markedly higher odds of frailty compared with those with higher self-efficacy, after controlling for other variables. Age also emerged as a significant predictor, with each additional year increasing frailty odds by 11% (OR = 1.11, 95% CI: 1.03-1.19, *p* =0.006). Single participants had higher odds of frailty compared with married participants (OR = 10.61, 95% CI: 1.25-89.51, p =0.03). Finally, recipients who reported GVHD post-transplant had significantly higher odds of frailty compared with those without GVHD (OR = 20.03; 95% CI: 2.79-143.39, *p* =0.003).

Table 3. Logistic regression predicting the likelihood of reporting frailty

	B	S.E.	OR (95% CI)	p
Age	0.104	0.038	1.110 (1.030, 1.195)	0.006
Marital Status	2.362	1.088	10.617 (1.259, 89.515)	0.030
Presence of GVHD				
No	Ref.			
Yes	2.997	1.004	20.032 (2.798, 143.396)	0.003
Exercise Self-Efficacy				
High	Ref.			
Low	5.579	1.350	264.928 (18.794, 3734.55)	<0.001
Social Support				
High	Ref.			
Low	-0.0111	0.957	0.895 (0.137, 5.843)	0.907

Note. Frailty code: 0 = non-frail/pre-frail; 1 = frail. Omnibus test: $\chi 2 = 110.871$, $P < 0.001$, Nagelkerke $R^2 = 0.751$.

HSCT Recipients' Perspectives on Health and Physical Activity

Analysis of the open-ended responses identified five main categories: health concerns, physical activity challenges, family influence, healthcare provider influence, and cultural/community influence (Table 4). Many participants reported health challenges after HSCT, most commonly fear of disease relapses and GVHD. Engagement in physical activity was limited due to persistent fatigue and symptoms, such as numbness or stiffness. Cultural norms and limited community resources restricted opportunities to stay active. Family members often acted protectively, which at times discouraged physical activity due to concerns about infection or injury. Participants also noted that healthcare providers focused mainly on medical management, offering little guidance on the importance of physical activity.

Table 4. Main categories of factors influencing physical activity and frailty

Categories	Subcategories	Quote Examples
Health Concerns	Fear of relapse or GVHD worries	"My biggest worry was the disease coming back. I thought about relapse every time I felt exhausted." / "I feared the treatment side effects, especially if GVHD appeared."
Physical Activity Challenges	Fatigue and weakness or Physical symptoms (numbness, stiffness)	"Between treatments and side effects, there was not much energy left for exercise." / "My hands and feet sometimes feel numb, which makes walking for long periods difficult."
Family Influence	Overprotective behavior or Discouraging physical activity	"My family kept telling me to avoid going outside, because they were afraid, I would catch an infection." / "Even when I wanted to take a short walk, my mother would insist I stay in bed to save my strength."
Healthcare Provider Influence	Lack of guidance or Focus on medical outcomes only	"My doctor rarely mentioned exercise. All our talks were about lab results and medications." / "The follow-up visits were always about blood counts, not about how to get back into normal activities."
Cultural/Community Influence	Lack of community resources	"There are no local programs or safe spaces for people recovering from transplants to exercise."

Discussion

This study is the first to examine the prevalence of frailty and its associated factors among Jordanian HSCT recipients. Overall frailty prevalence among Jordanian HSCT recipients was 41.3%, higher than that reported in previously published studies in Western countries (Arora et al., 2016; Rashid et al., 2023). Furthermore, pre-frailty prevalence was 30.8%, indicating that a substantial proportion of HSCT recipients may be in an early stage of frailty (e.g., low muscle strength, weakness, or exhaustion). This pre-frail sample represents a transitional and reversible stage between robust and frail status, providing an opportunity for early intervention, such as the design of a structured physical activity program, strength training, or supportive care specifically for these patients. These strategies can be applied before transplantation, during hospitalization, and after HSCT to prevent progression to frailty and optimize patient outcomes (Hegde & Murthy, 2018). The higher prevalence observed in this study may reflect differences in healthcare systems and socio-cultural contexts. Western populations have access to structured healthcare systems and rehabilitation programs following HSCT (Leite et al., 2024). In contrast, Jordanian patients face limited access to resources necessary for physical recovery, along with socio-cultural constraints, which together may heighten their risk of frailty (Hayajneh & Rababa, 2021). Differences may also reflect methodological variations in assessing frailty. Few studies have used subjective and objective assessment (i.e., Fried's criteria) (Pamukcuoglu et al., 2019; Rashid et al., 2023), compared to others using only subjective assessment tools (e.g., Clinical Frailty Scale, Vulnerable Elders Survey-13) (Mohanraj et al., 2021).

Regarding self-management process factors, more than a half of the participants reported low confidence in their ability to exercise, consistent with findings from other HSCT studies (Suominen et al., 2022; Abo S. et al., 2018). In contrast, most participants reported strong social support, differing from previous Western-based studies (Liang et al., 2020; Norskov et al., 2021). In Arabic and Islamic countries, strong family ties and cultural values may contribute to higher and more consistent levels of social support (Alaloul et al., 2016), with patients receiving support from extended family members and community members compared to Western patients, where support may only be from immediate family (e.g., spouse and adult children) or formal systems (e.g., hired caregivers, social workers) (Donelan et al., 2002). Additionally, our findings are consistent with prior research among Jordanian HSCT survivors, where social support was a crucial factor in alleviating difficulties and providing emotional and functional support (Alaloul et al., 2015). While exercise self-efficacy and social support have been studied in HSCT populations, no study has examined their association with frailty, either globally or among Jordanian recipients.

HSCT recipients with increased exercise self-efficacy were more likely to engage in physical activity after HSCT, supporting the importance of self-efficacy in promoting physical activity self-management behaviors (Bergkvist et al., 2015) and suggesting that exercise self-efficacy, as a self-management process, should be an essential component of interventions aimed at promoting physical activity in the HSCT population. Our study found that lower exercise self-efficacy was associated with frailty, consistent with prior studies (Parisek et al., 2021). Moreover, results are consistent with previous research in other populations (i.e., cardiovascular disease, chronic kidney disease, and older adults), which found significant bidirectional associations between exercise self-efficacy and frailty (Jemenez-Zazo et al., 2022; Won et al., 2023). This suggests that low self-efficacy may be associated with the progression of frailty. In contrast, frailty can impact the ability to engage in physical activity, creating a cycle that reinforces both conditions. Our study demonstrated the importance of exercise self-efficacy in the context of physical activity as a self-management behavior that impacts frailty as a health outcome, informing the development of targeted interventions to enhance exercise self-efficacy and minimize frailty risk.

This study found no associations between social support and either physical activity as a self-management behavior or frailty as a health outcome, contrasting with other international HSCT studies (Amonoo et al., 2021; Rotz et al., 2022). In Jordanian society, social support may, in some contexts, act as a barrier to engaging in physical activity (Hayajneh & Rababa, 2021), with family members or caregivers believing that encouraging exercise could expose the patients to adverse risks (e.g., falling or other injuries),

especially among older adults or those with chronic diseases. This interpretation is supported by the open-ended responses in our study, where participants reported barriers, such as fear of injury or infection, limited access to exercise facilities, and overprotective behaviors from family members who discouraged activity due to concerns about falls or other injuries. This cultural difference may relate to the lack of significant findings regarding the relationship between social support and frailty. However, there are reported inconsistencies in the association between social support and frailty across different populations, with many studies reporting a significant positive relationship among older adults (Gale et al., 2018; Jin et al., 2022). In contrast, a study conducted among patients with cancer found no significant association between social support and frailty, a finding attributed to the high proportion of married participants, which likely reflected consistent family support (Tsai et al., 2022). A similar explanation may apply to our study, as most participants were married, which may have resulted in relatively stable levels of social support, reducing the likelihood of detecting an association with frailty. In addition, older adults often experience a decline in social networks due to retirement, the loss of a spouse or peers, or reduced social engagement (Gale et al., 2018; Wu & Sheng, 2019). This study's sample consisted of younger or middle-aged adults, who may have stronger social networks (e.g., spouses, children, coworkers, or online communities) contributing to the elevated levels of social support in this study.

The information obtained from the open-ended questions aligned well with our quantitative findings, providing complementary evidence that enhances understanding of the challenges faced by HSCT recipients. HSCT recipients reported multiple challenges, including physical symptoms, such as fatigue, weakness, numbness, and stiffness. These experiences align with recent studies showing that post-transplant symptom burden continues to be one of the most persistent barriers to activity during recovery (Abo S. et al., 2022; Purdy et al., 2023; Abo S. et al., 2018). In addition, limited guidance from healthcare providers, who often focused primarily on medical outcomes, was another barrier. Many felt that clinical discussions focused mainly on medical outcomes, leaving them unsure which activities were safe. Similar concerns have been documented in recent research, in which HSCT survivors frequently report a lack of clear, individualized advice on physical activity (Purdy et al., 2023). At the community level, participants highlighted a lack of accessible resources, including structured exercise programs and safe spaces suitable for HSCT recipients with low immunity. These findings align with recent literature, which highlights environmental constraints as a continuing challenge for this population (Abo S. et al., 2022; Purdy et al., 2023). The consistency between the study findings and recent evidence underscores the need for multi-level, culturally appropriate strategies involving patients, families, and healthcare providers in supporting safe and sustainable physical activity and reducing frailty risk.

Implications for Nursing

The results of this study highlight the importance of incorporating frailty screening into the standard pre-HSCT assessment in clinical settings. Recent research has shown that adding frailty screening to the standard pre-HSCT workup can help in risk stratification and improve HSCT outcomes (Arora et al., 2016; Rashid et al., 2023; Hegde & Murthy, 2018). In addition, the study emphasizes the importance of educating healthcare professionals, including physicians, nurses, and other medical workers, about the signs and symptoms of frailty and assessment tools to identify frail patients before and after HSCT. Prior research indicates gaps in the utilization of evidence-based education and training of healthcare workers in assessing, preventing, and managing frailty (Kojima et al., 2019; Windhaber et al., 2018). Our findings also support the need for greater attention to the role of self-efficacy in managing frailty among HSCT recipients. Moreover, the findings underscore the need for clinicians to integrate cultural norms and expectations when working with HSCT recipients and to assess exercise beliefs and social support.

Directions for Future Research

Future research should explore the longitudinal trajectory of frailty among Jordanian HSCT recipients to understand its progression before, during, and after transplantation. Findings from these study highlight opportunities to reduce frailty risk by enhancing exercise self-efficacy and promoting regular physical activity. Existing interventions in cancer and HSCT populations, such as structured exercise programs, goal setting, and education, have demonstrated benefits for improving self-efficacy (Abo S. et al., 2018; Hacker et

al., 2017). However, the applicability of such programs within the Jordanian cultural context warrants careful consideration. A more holistic approach may be needed, involving patients, caregivers, and healthcare providers. Culturally sensitive education about the importance of physical activity could help dispel misconceptions, reduce fear, and encourage safe participation. Including caregivers is critical, as their perceptions often influence patient behavior. Therefore, targeted interventions should provide practical guidance on when and how to safely resume physical activity, ideally beginning before transplantation to better prepare HSCT recipients and mitigate frailty risk.

The study findings also raise questions about the psychosocial mechanisms underlying frailty in Jordanian HSCT recipients. One of the five domains of the Fried Frailty Phenotype is self-rated exhaustion, which is assessed by using two items from the Center for Epidemiologic Studies Depression Scale (Fried et al., 2001). These items reflect low energy levels, which are commonly associated with depressive symptoms. In this study, the exhaustion domain was significantly associated with physical activity among Jordanian HSCT recipients, suggesting that underlying depressive symptoms may play a key role in the development of frailty. Further research is needed to explore how psychological factors, such as depression, can contribute to frailty in HSCT populations.

Although this study did not find a significant association between social support and frailty among Jordanian HSCT recipients, future research should examine social support using multidimensional frameworks that incorporate caregiving-specific measures and reflect the cultural meaning of care roles. Employing mixed method approaches to capture the lived experiences of HSCT recipients and their caregivers would provide a deeper insight into how social support is perceived and how it influences physical functioning in this population.

Strengths and Limitations

Strengths of this study include the use of a guiding theoretical framework (IFSMT) and the use of objective measures, such as hand-grip strength and the Timed Up and Go test, which enhance internal validity and reduce reliance on self-report. Limitations include the cross-sectional design, which precludes causal inference and limits understanding of changes in frailty over time. Using convenience sampling may also introduce selection bias and restrict generalizability. Finally, the sample primarily included HSCT recipients with hematologic malignancies and does not represent those with non-malignant conditions, such as aplastic anemia or sickle cell disease.

Conclusion

This study is the first to examine the prevalence and correlations of frailty among Jordanian HSCT recipients. Frailty was strongly associated with exercise self-efficacy, age, marital status, and GVHD. The study findings highlighted the importance of self-management factors and contextual influences in frailty risk. Therefore, there is a need to develop interventions that strengthen exercise self-efficacy, promote physical activity, and address GVHD-related limitations, delivered in culturally sensitive ways and involving caregivers, to help reduce the risk of frailty and improve long-term outcomes. Future research should prioritize integrating frailty screening into standard pre-HSCT assessments for risk stratification, alongside educating healthcare professionals on frailty assessment and its clinical implications to mitigate frailty-related risks.

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Conflict of Interests

The authors hereby certify that this material, which they now submit for the journal, is entirely their own work and that no conflict of interests has to be declared. The authors used AI-assisted technologies for editing, and the research team reviewed the manuscript to ensure accuracy.

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