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Factors associated with Self-reported Physical and Mental Health after Hematopoietic Cell Transplantation

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Abstract

Hematopoietic cell transplantation (HCT) is an intensive treatment for hematologic malignancies that has the potential to cure disease or prolong life, but also to impair quality of life for survivors. Earlier studies have suggested a variety of factors to be associated with physical and mental health after HCT. In this study we evaluated demographic and clinical factors before and after transplant and selected psychosocial factors after transplant, to explore their association with self-reported physical and mental health. We studied a cohort of 662 survivors at a median of 6.6 years after HCT. Pre-HCT demographic and clinical factors accounted for only a small amount of the variance in physical and mental health post-transplant (3% and 1%, respectively). Adding post-HCT clinical variables to the pre-transplant factors accounted for 32% and 7% of physical and mental outcomes, respectively. When both clinical and psychosocial factors were considered, better physical health after HCT was associated with younger age, race other than white, higher current family income, currently working or being a student, less severe transplant experience (not having GVHD), fewer current comorbidities, higher Karnofsky status, less social constraint, less social support, and less trait anxiety. This multivariate model accounted for 36% of the variance in physical health with the psychosocial variables contributing very little. When both clinical and psychosocial factors were considered, better mental health after HCT was associated with more severe transplant experience, less social constraint, greater spiritual well-being, and less trait anxiety. This multivariate model accounted for 56% of the variance in mental health, with the psychosocial factors accounting for most of the variance. These data suggest that clinical factors are explanatory for much of the post-HCT physical health reported by HCT survivors but for very little of self-perceived mental health. These observations provide insights into identification of factors that would allow recognition of at-risk patients as well as factors amenable to intervention.

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Introduction

As survival rates have increased with cancer treatment, greater attention has turned to the quality of life (QOL) of survivors. Disease and treatment both have the potential to affect the physical and emotional status of long-term survivors. The presence of comorbid medical conditions and psychosocial factors may also influence outcomes. Psychosocial factors, such as personality traits or social support, also have the potential to affect, buffer or modify self-perceived quality of life.

Hematopoietic cell transplantation (HCT) is a very intensive therapy for hematologic malignancies and some solid tumor cancers. Earlier studies have suggested several factors to be associated with overall, physical, or emotional health-related quality of life after HCT: age at transplant (1–9), employment status at transplant (1), gender (1,3,7,10,11), educational status (5,7), marital status (1,12,13), family function at time of transplant (12,13), social support (13,14), pre-HCT QOL (14,15), higher medical risk (14), transplant type (2,9,14), intensity of the conditioning regimen (5), time after transplant (1,3,7,11), acute or chronic GVHD (3,9, 12,14–16), osteoporosis or other sequelae (3,11,16), need for continued medications (16), and relapse (16). For children, family functioning and individual resources such as optimism and social skills, socioeconomic status, and more intensive therapy were important, whereas age (17) and gender were not (18). In various studies, the influences of such factors were inconstant, including such factors as intensity of conditioning regimen (19). In parallel, in studies of leukemia survivors who were not transplanted, gender and education were noted to influence quality of life (10). The inconsistency of the findings in various studies may be due to methodological shortcomings such as small sample size, use of convenience samples, variability in case mix at single centers and the use of different instruments to assess the outcomes of interest.

Using a large, randomly selected, stratified sample of HCT survivors, we examined patient, clinical, disease, and treatment factors both prior to and after transplant to identify factors associated with physical and mental health outcomes. We additionally assessed post-HCT psychosocial factors to determine their relative contribution to these outcomes. Our goal was to identify such risk factors that would allow recognition of at-risk patients and those factors amenable to intervention in order to facilitate the development and implementation of clinical interventions to enhance QOL, targeting those HCT recipients most vulnerable for poor post-transplant quality of life.

Patients and Methods

Patients

Patients were randomly selected from eligible survivors at 40 centers that were participating in data reporting to the Center for International Blood and Marrow Transplant Research (CIBMTR). Patients had to be at least 18 years old at time of transplant, receiving a myeloablative conditioning regimen, recipient of no more than one transplant, and alive free of relapse at least one year after transplant, able to read or write English, and been transplanted for one of four cancers (acute leukemia, lymphoma, chronic myelogenous leukemia, or breast cancer). Eligible survivors were stratified by disease, transplant type, number of years post transplant, and intensity of prior therapy. The data in this analysis were collected as part of a large multicenter study of the long-term quality of life of cancer/HCT survivors and these analyses have not been previously reported. Results describing the quality of life of the survivors compared with controls were previously described, including details of survivor characteristics, study procedures, and institutional review board approval (20,21), as well as the experiences of the spouses (22). This report focuses on determining what factors might influence the physical and emotional outcomes of the survivors. The characteristics of the patients are described in Table 1.

Methods

After consent, data were collected by written questionnaires and computer assisted telephone interviews (CATIs) as described earlier (20). A variety of patient, disease, psychological, social, and treatment factors were examined to determine their association with the outcomes of physical and emotional well-being. Some of the factors were assessed at time of HCT, others after HCT at the time of QOL assessment; some were assessed at both time points.

Outcomes assessed

Self-reported physical health was measured by the Physical Component Summary (PCS) score of the Medical Outcomes Study (MOS) 36-Item Short Form Health Survey (SF-36) (23). Self-reported mental health was assessed by the Mental Component Summary (MCS) summary score of the SF-36.

Demographic factors

included age at HCT, gender, race, marital status, occupational status, family income at time of survey, type of health insurance at survey, and education at survey.

Clinical factors

Comorbid conditions present before and after transplant were derived from data reported to the CIBMTR and were categorized post-hoc using as a framework the Hematopoietic Cell Transplant – Comorbidity Index (HCT-CI) scale (24,25). Since assessment of severity of the condition could not be consistently determined from the reports, comorbid conditions were categorized as either present or not present. After transplant, any comorbid conditions that could be attributable to graft versus host disease (GVHD) were deleted, since they were counted as part of GVHD, assessed separately. Karnofsky performance status was assessed by the clinical transplant team at the time of the study (26).

Disease factors included the type of disease and intensity of prior therapy. Patients were assigned to one of two categories of pre-transplant treatment intensity based on the status and duration of their disease pre-transplant. The less intense treatment group included patients transplanted for chronic phase CML within one year of diagnosis, acute leukemia or lymphoma in first complete remission, or adjuvant treatment of high risk Stage II or III breast cancer. The more intense treatment group included those transplanted for chronic phase CML > 1 year after diagnosis, accelerated or blast phase CML, acute leukemia or lymphoma beyond first remission or metastatic breast cancer. The rationale was that patients with early stage disease or disease of shorter duration, in general, received less therapy than those with more advanced or more longstanding disease and were less likely to come to transplant with prior treatment related toxicities.

Transplant factors included transplant type (autologous or allogeneic) and the severity of transplant experience. Transplant treatment severity was categorized as low severity (autologous transplant), intermediate severity (allogeneic transplant without chronic GVHD), and high severity (allogeneic transplant with chronic GVHD). The distance between transplant center and the patient's residence at the time of HCT and time since transplant were measured. The use of TBI in the transplant conditioning regimen was also assessed.

Psychosocial factors

The following psychosocial factors were measured at the time of assessment of QOL for this study. Social support was measured by the Duke-UNC Functional Social Support Questionnaire (27). Social constraint, the degree to which participants feel constrained in sharing their HCT-related thoughts and feelings with others, was measured by The Social Constraints Scale (28), Trait anxiety, a measure of the individual's disposition for anxiety, was assessed by the Trait-Anxiety subscale of the Spielberger State-Trait Anxiety Inventory (29) at the time of study. Spiritual well-being was assessed by the Functional Assessment of Chronic Illness Therapy - Spiritual Well-Being scale (FACIT-Sp) (30). The Life Orientation Test (LOT) was used to assess the level of dispositional optimism (31). Although trait anxiety and optimism were measured at the same time as the QOL assessment, one could argue they have potential predictive power since they are considered enduring characteristics.

Analysis

Univariate analyses were first conducted to investigate the association of individual factors of interest with the SF-36 PCS and MCS, followed by multivariate analyses where all significant factors were included in the same models. We specifically investigated whether the factors at time of HCT and the factors at time of study made different contributions to the SF-36 PCS and MCS, respectively.

Three different types of factors were investigated in the analyses, including demographic factors (age and marital status at HCT, gender, race at the time of HCT and after HCT, education, marital status, occupational status, family income, and health insurance), clinical factors (comorbidities before and after HCT, type of malignant disease, intensity of treatment before transplant, type of transplant, TBI in the transplant conditioning regimen, and severity of transplant experience), and psychosocial factors assessed at the time of the study (social support, social constraint, trait anxiety, optimism, and spiritual well-being). In addition, time since transplant and distance from transplant center to residence of patient were included.

For univariate analyses, t-tests were performed to investigate the associations of dichotomous factors (e.g., gender) with the SF-36 PCS and MCS, and ANOVA was used to investigate the associations of categorical factors (e.g., education) with the SF-36 PCS and MCS. For the categorical factors, we also compared the mean scores of each pair of the categories using a Bonferroni correction for the p-value. For continuous variables (e.g., social support), Pearson's correlation coefficients were calculated to demonstrate their association with SF-36 PCS and MCS.

For multivariate analyses, regression models were performed using the ordinary least squares approach by including variables which were statistically significant in the univariate analyses. Three analytic models were proposed to sequentially investigate the association of each factor with the SF-36 PCS and MCS and its changing association after accounting for other factors in the model. Model 1 included demographic and clinical factors before and at time of HCT alone. Model 2 included demographic and clinical factors after HCT at the time of study in addition to the factors being included in Model 1. Model 3 further included psychological factors at the time of study in addition to the factors being included in Model 2.

All analyses were performed using the STATA 10.0. An alpha level of < 0.05 was used to estimate the level of statistical significance. No adjustment for multiple comparisons was made because of the exploratory nature of this study.

Results

Descriptive characteristics of the patients

Table 1 summarizes the various patient, clinical, disease, and transplant characteristics of the patients at the time of transplant and at time of study. Table 2 summarizes the descriptive statistics for the psychosocial variables and the self-reported physical and mental health outcome variables at the time of study (some of these have previously been reported in 20). MCS and PCS scores did not correlate with each other (r = 0.13). MCS and PCS are standardized scores, so 50 is normative with 10 points in either direction equal to one standard deviation (see http://www.sf-36.org/tools/sf36.shtml). Thus, survivors' MCS scores were "normal" compared to standard population and PCS were lower but not by a full SD.

Factors associated with current self-reported physical and mental health

Tables 3–5 describe the univariate associations of demographic and clinical factors before and after transplant (Tables 3 and 4, respectively) and psychosocial factors (Table 5) with the physical and mental health status of the survivors.

Better self-reported physical health was associated with younger age, race other than white, absence of comorbidities before or after transplant, less intense prior therapy, autologous (rather than allogeneic) transplant, higher current educational attainment, currently working or attending school, higher family income, having private (rather than public) insurance, higher current Karnofsky score, and the transplant experience being less severe. For pairwise group comparisons, survivors of age <35 years reported significantly better PCS compared to those with age >50 years (adjusted P < 0.005)(Table 3). For transplant experience, survivors with low and intermediate severity reported significantly better PCS compared to those with high severity, respectively (adjusted P < 0.017) (Table 4). Current psychosocial factors associated with physical health included more social support, less social constraint, greater dispositional optimism, lower trait anxiety, and higher spiritual well-being.

Better self-reported mental health was associated with absence of comorbidities before or after transplant, currently working, being in school or being retired, higher family income, and a higher Karnofsky score. For pairwise group comparisons, survivors who were not working reported more impaired MCS compared to those who were retired or were working (including students), respectively (adjusted P < 0.017). Survivors with family incomes less than $20,000 reported more impaired MCS compared to those whose family incomes were $20,000–$40,000, $40,000–$60,000, $60,000–$80,000, and > $80,000, respectively (adjusted P < 0.005)(Table 4). Psychosocial factors associated with mental health included more social support, less social constraint, greater dispositional optimism, lower trait anxiety, and higher spiritual well-being.

Multivariate models of variables that account for variance in self-reported physical health

Table 6 summarizes 3 multivariate models developed for physical functioning. In Model 1 (which examined demographic and clinical factors present before HCT), we found younger age (age <40), race other than white, and less intensive prior therapy to be associated with better post-HCT physical health. However, only 3% of the variance was explained by this model. In model 2 (which examined factors in model 1 plus demographic and clinical factors present after transplant at the time of the study), we found race other than white, higher family income (family income ≥$20,000), working or being in school, less severe transplant experience (absence of GVHD), absence of comorbidities at time of study, and higher Karnofsky score were associated with better physical health. Much more of the variance was explained in this model, but it still accounted for only 32% of the variance. In model 3 (which examined the psychosocial factors added to model 2), we found younger age (age<35), race other than white, higher family income (family income ≥$20,000), working or being in school, less severe transplant experience, absence of current comorbidities, higher Karnofsky score, less social constraint, less social support, and less trait anxiety to be associated with better physical health. Thus, the inclusion of psychosocial variables resulted in only an incremental increase in variance accounted for (the model explained 36% of the variance).

Multivariate models of variables that account for variance in mental health

Table 6 summarizes the 3 multivariate models developed in the same manner as above for self-reported mental health. In model 1, older age (age >50 years compared to most age groups <50 years) and fewer comorbidities at the time of transplant were associated with higher levels of emotional well-being. However, only 1% of the variance was explained by this model. In model 2, older age (age >50 years compared to most age groups <50 years), higher family income (≥ $20,000), working, being in school or being retired, and having a higher Karnofsky score were associated with better emotional well-being. Only 7% of the variance was explained in this model. In model 3, high severity of transplant experience (allogeneic HCT with chronic GVHD), less social constraint, higher spiritual well-being, and lower trait anxiety were associated with greater mental health. This model explained 56% of the variance.

Discussion

Efforts to enhance QOL are critical to the long-term management of the HCT recipient. However, enhancement of post-HCT QOL requires knowing not only QOL deficits likely to occur, but also risk factors for specific QOL deficits. Identification of such risk factors can enhance theoretical understanding of how individuals adapt to life-threatening disease and treatment and, more pragmatically, can focus clinical resources upon patients most at risk for poor QOL.

Several demographic and clinical factors that are readily available to transplant clinicians were found to be significantly associated with long-term physical or mental QOL. These included age, race, income, intensity of transplant treatment experience, current work, presence of comorbidities, and performance status. For the most part, these are similar to factors identified in earlier studies. Important to note, younger age (<35 years) was associated with better physical health while age did not influence mental health, similar to findings in another study (9), which also did not show a decline in social QOL with older age (and it actually was higher with older age in that study). Surprisingly, race other than white was associated with better physical health but was not associated with mental health. The number of minority transplant survivors in this study (n = 56, mostly Hispanic and African American) was too small to do exploratory analysis reflecting the small numbers of minorities undergoing HCT (32). A similar finding in solid organ transplant survivors (the so-called “Hispanic paradox” with better renal graft survival in Hispanic transplant recipients) has been noted (33); this observation warrants further exploration in future studies. The intensity of transplant experience affected physical and mental health in opposite ways. More intense transplant experience (allogeneic HCT complicated by chronic GVHD) not surprisingly was associated with poorer physical health but perhaps surprisingly was associated with better mental health. This contrasts with other studies that found that GVHD was associated with poorer physical, psychological, social, spiritual QOL, and/or return to work using other measurement instruments (9,13–15). Those studies focused primarily on early adaptation, in contrast to this study with longer follow-up, and some studies suggest full recovery may take 3–5 years (14,34). The explanation for our findings is not obvious. The notion that mastery over intense experiences confers benefits in emotional well-being and psychological growth is a concept supported by other studies, including another analysis of data from this study (21). However, there are other alternative possibilities. Subjects with greater treatment or illness severity may change their internal standard and use this new standard to determine their perceptions of QOL, especially mental aspects. So-called response shift has been described in cancer survivors (35). Other studies suggest that expectations may have been different in patients receiving more intense therapy (allogeneic HCT): patients with more realistic expectations might be more accepting of their limitations since they were expecting a rougher time (36,37). Being “retired” had opposite effects on physical and mental health: it was associated with worse physical health but there was a trend to better mental health. The explanation for an association with better mental health is unclear.

Several notable differences in our findings from earlier studies should be mentioned. Although being married has been found in some earlier studies to be associated with better QOL (1,12, 13), we did find not this to be the case. However, we found, as other studies have noted (12, 13,14,), social support and the quality of the support (less social constraint) are quite important. These findings suggest that there may be multiple sources of support (eg, from family or friends) that may be as important as having a spouse. Gender has been noted in multiple other studies to be associated with post-transplant QOL (1,3,7,10,11,14,31), but in this study, gender was not associated with either physical or mental health.

The demographic and clinical observations routinely monitored by transplant practitioners were fair in being associated with self-reported physical health. This was similarly noted in self-reported and practitioner-assessed Karnofsky scores (38) and presence of GVHD (9) in HCT survivors. However, demographic and clinical factors accounted for very little of the variance in long-term mental health (<10%). This emphasizes the independence of these mental and physical health outcomes ($r = 0.13$). Other studies suggest similar findings. For example, one study did not find an association between transplant type or chronic GVHD with physical limitations nor any association between type of transplant or medical risks prior to transplant with depression (14). However, other studies suggest allogeneic HCT and especially chronic GVHD are associated with poorer mental health (9,14,15,39)

For physical health, a combination of demographic and clinical factors before and after transplant accounted for much more of the variance (32%) observed. The psychosocial assessments added little additional value in explaining the variance of physical QOL. It remains uncertain whether assessment of psychological variables prior to HCT would be more useful in predicting physical health (14). Of interest, race other than white was associated with higher physical health (but not associated with mental health). The reason for this finding is unclear. Also of interest is the seemingly anomalous finding of less social support being associated with greater physical health (in contrast to a lack of association with greater mental health). Of note, the coefficients are quite low and in univariate analysis, the association was in the opposite direction; this suggests that a relationship with other factors in the multivariate model may have influenced this finding. This finding also suggests that the quality of social interaction (as assessed by social constraint) may be more important that the actual perceived presence of social support. Of note, there was a correlation between social support and social constraint ($r = -0.43$).

For mental QOL, neither demographic nor clinical factors explained much of the variance (<10%). Several social or psychological factors were highly associated with better mental QOL and were of much greater utility in explaining the mental QOL variance (56%). . Our results suggest that those prone to anxiety and experiencing social constraint from others are at risk for poorer mental health outcomes. Fortunately, these factors are amenable to intervention. Several longitudinal studies of HCT QOL suggest assessment of family and social support (13,14) and mental health (15) can predict mental health later after HCT.

Spiritual well-being was associated with better mental health. This emphasizes the potential usefulness of including spiritual well-being in assessment and treatment planning considerations. Surveys suggest the health care team often underestimates the extent to which patients desire help addressing spiritual needs (40,41). Yet, studies indicate that interventions, can improve physical, emotional, and spiritual QOL (42–45) . Health practitioners can assist with a patient's spiritual needs when setting goals and planning treatment. The NCI "Spirituality in Cancer Care" website offers suggestions for intervention: (http://www.cancer.gov/cancertopics/pdq/supportivecare/spirituality/HealthProfessional/page6).

Although dispositional optimism was associated with both physical and mental health in univariate analyses, it was not in the multivariate models. Optimism, a personal resource, may mediate the stress response: expectation of a successful outcome promotes active engagement and goal-striving (46). Low optimism has been associated with denial, distancing, behavioral disengagement, and cognitive avoidance (47–48). In cancer patients, optimism has been found to be related to lower distress through its association with increased acceptance/active coping (48). The reason we did not find optimism to be associated with mental and physical health may be due to an interaction with trait anxiety ($r = -0.70$).

Our data have several important limitations. Most notably, these are retrospective, the psychosocial assessments were obtained after transplant, and we do not have psychosocial data collected at the time of transplant. Longitudinal studies have been important in probing the utility of pre-HCT psychosocial assessments (9,13–15) and a longitudinal study is a stronger methodology to explore this, but it too has different kinds of limitations in terms of longer time for completion, shorter followup, and large dropout rates. Although survivors were randomly selected from a stratified list (by disease, type of transplant, time since transplantation, and intensity of pre-HCT treatment) of eligible survivors, only 74% could be contacted and of those contacted 94% participated (21). Thus, the participants may differ in unpredictable ways from all HCT survivors. These QOL assessments represent a snapshot in time, generally remote from the actual HCT, as opposed to describing dynamic QOL after HCT. Moreover, some of the current perceptions of survivors may be colored by their experiences after transplant. Finally, the psychosocial assessment was limited in scope and other psychosocial factors not assessed may also be as or more important to assess.

These data can be helpful to identify those at risk for suboptimal outcomes. The findings suggest that demographic and clinical factors before and after transplant are explanatory for much of the post-HCT physical health reported by HCT survivors but for very little of self-perceived mental health. The findings also suggest the opposite relationship with mental health scores, with the majority of variance accounted for by psychosocial variables and not by demographic or clinical variables. Given the importance of achieving both good physical and mental health post-HCT, equal weight should be given to assessment of such clinical and psychosocial variables to identify those patients in need for additional physical assistance and additional mental support, and to identify factors amenable to change. Fortunately, several promising interventions tested in non-HCT cancer patients could be applicable to HCT survivors (49–57) and other potential interventions are being evaluated in HCT patients (e.g., an exercise and stress management intervention, BMTCTN.net, protocol 0902). .

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Table 1

Patient, clinical, disease, and transplant characteristics of patients before and after HCT

a) Demographic and clinical factors at time of transplant

Variable	**N**	**Distribution (%)**
Patient Factors		
Age	662	
Mean (SD), years		42.1 (11)
Median (range), years		42.4 (18, 71)
< 35	182	28%
35–39	95	14%
40–44	106	16%
45–49	120	18%
>50	159	24%
Gender		
Male	411	62%
Female	251	38%
Race		
White	603	92%
Other	56	8%
Marital status	655	
Married/living with partner/committed	493	75.3
Other	162	24.7
Clinical Factors		
Comorbid conditions (dichotomized as present or not)	104	16%
Malignant disease at initial diagnosis, n (%)		
Acute leukemia (AML or ALL)		
Chronic leukemia (CML)	243	37%
Breast cancer	131	20%
Lymphoma (Hodgkin's disease or non-Hodgkin's lymphoma)	156	24%
	132	20%
Intensity of treatment before HCT		
Less intense	441	66.6
More intense	221	33.4
Type of transplant		
Allogeneic	272	41.1
Autologous	390	58.9

a) Demographic and clinical factors at time of transplant

Variable	N	Distribution (%)
TBI in transplant conditioning regimen	235	35.5

b) Demographic and clinical factors after transplant at time of QOL interview

Variable	N	Distribution (%)
Patient Factors		
Education	658	
High school or below	194	30
Some college or technical education	209	32
College degree (BA/BS)	122	18
Education beyond bachelor's degree	133	20
Marital status	659	
Married/living with partner/committed	483	73
Other	176	27
Occupational status		
Retired	75	11
Not working	100	15
Working or student	484	73
Family income		
<$20,000	70	11
$20,000–40,000	141	22
$40,000–60,000	156	24
$60,000–80,000	100	15
>$80,000	181	28
Insurance status	597	
Public	193	32
Private	387	65
No insurance	17	3
Clinical Factors		
Comorbid conditions	104	16%
Severity of transplant experience		
Low severity (autologous)	390	60
Intermediate severity (allogeneic without chronic GVHD)	168	26
High severity (allogeneic with chronic GVHD)	88	14
Time since transplant, in years, median, (standard deviation) (mean)	662	6.6 (3.1) (7.0)

b) Demographic and clinical factors after transplant at time of QOL interview

Variable	N	Distribution (%)
Distance between transplant center and residence (in miles) (standard deviation)	600	148 (317)

Acute myelogenous leukemia (AML), acute lymphoblastic leukemia (ALL), chronic myelogenous leukemia (CML), total body irradiation (TBI)

Table 2

Quality of life and psychosocial variables measured at time of survey.

Characteristic	Mean score	Standard deviation	Range
Psychosocial factors			
Social constraint	25.2	8.7	16, 60
Social support	32.0	7.0	8, 40
Optimism	21.3	5.6	1, 32
Trait anxiety	37.2	10.8	20, 73
Spiritual Well-Being	36.1	8.8	7, 48
Self-reported physical and mental health			
Physical health (PCS)*	44.5	11.6	6.4, 64.5
Mental health (MCS)*	50.6	10.4	10.1, 70.2

*MCS and PCS are standardized scores with 50 being normative

Table 3

Associations of patient, clinical, disease, and transplant factors **before transplant** with physical and emotional status in univariate analyses.

Variable	**PCS**		**MCS**	
	Mean score	**F/t-test**	**Mean score**	**F/t-test**
Patient Factors				
Age				
< 35a	46.2	3.57^{**}	49.7	2.31
35–39	45.3		49.7	
40–44	45.0		50.8	
45–49	44.4		50.0	
>50a	41.7		52.7	
Gender				
Male	45.0	0.95	51.3	1.28
Female	44.2		50.2	
Race				
White	44.2	2.19^{*}	50.6	0.49
Other	47.7		51.3	
Marital status				
Married/living with partner	44.7	0.75	50.7	0.05
Other	43.9		50.6	
Clinical Factors				
Comorbid conditions				
Yes	42.0	2.38^{*}	48.7	2.10^{*}
No	45.0		51.0	
Disease Factors				
Malignant disease				
Acute leukemia (AML or ALL)	44.2	0.51	50.2	0.46
Chronic leukemia (CML)	44.0		50.6	
Breast cancer	44.6		51.5	
Lymphoma (Hodgkin's disease or non-Hodgkin's lymphoma)	45.6		50.6	
Intensity of treatment before HCT				
Less intense	45.4	2.72^{**}	50.6	0.01
More intense	42.8		50.6	
Transplant Factors				

Variable	**PCS**		**MCS**	
	Mean score	**F/t-test**	**Mean score**	**F/t-test**
Type of transplant				
Allogeneic	43.4	2.00[*]	50.4	0.58
Autologous	45.2		50.8	
TBI in transplant conditioning regimen				
Yes	43.4	1.80	50.3	1.02
No	45.1		51.2	

[*] P<0.05;

[**] P<0.01;

[***] P<0.001

a: the pairwise comparison of mean scores among categories (subgroups) is statistically significant with Bonferroni correction for the p-value

Table 4

Associations of patient, clinical, disease, and transplant factors **after transplant** with physical and emotional status in univariate analyses.

Variable	**PCS**		**MCS**	
	Mean score or Pearson's correlation coefficient	**F/t-test**	**Mean score or Pearson's correlation coefficient**	**F/t-test**
Patient Factors				
Education				
High school or below	42.5a	4.98**	49.9	0.54
Some college or technical education	43.8		51.2	
College degree (BA/BS)	47.1a		50.8	
Education beyond bachelor's degree	46.0		50.7	
Marital status				
Married/living with partner/committed	44.9	1.61	51.1	1.81
Other	43.3		49.4	
Occupational status				
Retired	41.7b,d	74.63***	54.6	18.25***
Not working	33.4b,c		45.7	
Working or student	47.2c,d		51.1	
Family income				
<20,000	36.0e,f,g,h	14.69***	45.0	6.77***
20,000–40,000	42.8e		50.1	
40,000–60,000	45.9f		51.8	
60,000–80,000	47.0g		51.4	
>80,000	46.7h		51.9	
Insurance status				
Public	41.2	20.09***	50.1	0.93
Private	45.8		51.0	
Clinical Factors				
Comorbid conditions				
Yes	36.0	8.62***	48.4	2.44*
No	46.1		51.1	
Karnofsky score[§]	0.40***		0.14***	

Variable	**PCS**		**MCS**	
	Mean score or Pearson’s correlation coefficient	**F/t-test**	**Mean score or Pearson’s correlation coefficient**	**F/t-test**
Severity of transplant experience				
Low severity (autologous)	45.2	17.21***	50.8	0.21
Intermediate severity (allogeneic without chronic GVHD)	46.2		50.3	
High severity (allogeneic with chronic GVHD)	38.0		50.3	
Time since transplant (in years) §	0.07		0.01	
Distance between transplant center and residence (in miles) §	−0.01		0.02	

*P<0.05;

**P<0.01;

***P<0.001

§correlation coefficient

a,b,c,d,e,f,g,h,i,j,k,l,m,n,o,p: the pairwise comparison of mean scores among the categories (subgroups) with common letters is statistically significant with Bonferroni correction for the p-value

Table 5

Association of psychosocial factors assessed at the time of study with physical and emotional well-being in univariate analyses (Pearson's correlation coefficients).

Factors	Correlation with SF 36 PCS	Correlation with SF 36 MCS
Social support	0.08^{*}	0.47^{***}
Social constraint	-0.28^{***}	-0.39^{***}
Optimism	0.16^{***}	0.53^{***}
Trait anxiety	-0.23^{***}	-0.71^{***}
Spiritual well-being	0.14^{***}	0.59^{***}

[*] P<0.05

[**] P<0.01

[***] P<0.001

Table 6

Series of multivariate regression models testing the association of demographic, clinical, and psychosocial factors with post-transplant physical *and mental* health

Factors	PCS			MCS		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Beta	Beta	Beta	Beta	Beta	Beta
Demographic and clinical variables at time of HCT						
Age at HCT(Ref: > 50)						
< 35	4.10^{**}	2.21	2.89^{*}	-3.42^{**}	-2.90^{*}	0.14
35–39	3.04^{*}	0.62	2.05	-3.43^{*}	-3.19^{*}	−0.71
40–44	2.82	1.41	2.41	−2.31	−2.16	0.67
45–49	2.05	1.78	2.15	-3.11^{*}	-2.78^{*}	−0.70
Race (Ref: White)						
Other	3.32^{*}	3.11^{*}	3.09^{*}	1.13	1.79	−0.54
Intensity of prior treatment (Ref: less)						
More	-2.35^{*}	−0.13	−0.19	0.03	0.04	0.12
HCT comorbidities at HCT (Ref: No)						
Yes	−2.22	0.98	1.00	-2.85^{*}	−2.04	−1.43
Demographic and clinical variables at time of study						
Education at time of study (Ref: education beyond bachelor’s degree)						
High school or below		0.24	1.02		0.82	0.49
Some college or technical education		−0.31	0.27		1.18	0.39
College degree		1.32	1.07		0.58	0.38
Family income at						

Factors	PCS			MCS		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Beta	Beta	Beta	Beta	Beta	Beta
time of study occupational status at time of study (Ref: >$80,000)						
<$20,000		-5.04^{**}	-4.15^{**}		-5.02^{**}	−0.83
$20,000–40,000		−1.63	−1.08		−1.67	0.68
$40,000–60,000		−0.31	−0.39		−0.12	0.92
$60,000–80,000		1.09	1.07		−0.51	0.19
Occupational status at time of study (Ref: Working or student)						
Not working		-8.35^{***}	-7.51^{***}		-2.98^{*}	−0.22
Retired		-3.36^{*}	-3.72^{**}		2.63	1.86
Severity of HCT experience (Ref: low-autologous)						
Intermediate (allogeneic without chronic GVHD)		1.08	0.41		0.35	0.17
High (allogeneic with chronic GVHD)		-2.56^{*}	-2.65^{*}		1.45	2.10^{*}
HCT comorbidities at time of study (Ref: No)						
Yes		-6.62^{***}	-6.62^{***}		−0.97	0.39
Karnofsky score at last follow up		0.28^{***}	0.28^{***}		0.11^{*}	−0.005
Psychological variables at time of study						
Social constraint			-0.27^{***}			-0.11^{**}

Factors	PCS			MCS		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
	Beta	Beta	Beta	Beta	Beta	Beta
Spiritual well-being			−0.08			0.25[***]
Social support			−0.19[**]			0.10
Trait anxiety			−0.13[*]			−0.47[***]
Adjusted R^2	3%	32%	36%	1%	7%	56%

[*] $P<0.05$;

[**] $P<0.01$;

[***] $P<0.001$