JOURNAL OF ADOLESCENT AND YOUNG ADULT ONCOLOGY
Volume 5, Number 3, 2016

DOI: 10.1089/jayao.2015.0058

Psychometric Analysis of the Three-Factor Eating Questionnaire-R18V2 in Adolescent and Young Adult-Aged Central Nervous System Tumor Survivors

Maria C. Swartz, RD, PhD, MPH,[1] Karen M. Basen-Engquist, PhD, MPH,[2] Christine Markham, PhD, MA,[3] Elizabeth J. Lyons, PhD, MPH,[1] Matthew Cox, PhD, MS,[2] Joya Chandra, PhD,[4] Joann L. Ater, MD,[4] Martha A. Askins, PhD, MA,[4] Michael E. Scheurer, PhD, MPH,[5] Philip J. Lupo, PhD, MPH,[5] Rachel Hill, RD, BS,[6] Jeffrey Murray, MD,[6] Wenyaw Chan, PhD, MS,[7] and Paul R. Swank, PhD, MS[3]

Purpose: Adolescent and young adult (AYA)-aged central nervous system (CNS) tumor survivors are an understudied population that is at risk of developing adverse health outcomes, such as obesity. Long-term follow-up guidelines recommend monitoring those at risk of obesity, thus motivating the need for an eating behavior questionnaire. An abbreviated online version of the Three-Factor Eating Questionnaire (TFEQ-R18v2) has been developed, but its applicability to this population is not yet known. This study investigated the instrument's factor structure and reliability in this population.

Methods: AYA-aged CNS tumor survivors ($n = 114$) aged 15–39 years completed the TFEQ-R18V2 questionnaire online. Confirmatory factor analysis was used to examine the fit of the three-factor structure (uncontrollable eating, cognitive restraint, and emotional eating [EE]) and reliability (internal consistency of the TFEQ-R18v2). Associations between the three factors and body mass index (BMI) were assessed by linear regression.

Results: The theorized three-factor structure was supported in our population (RMSEA = 0.056 and CFI = 0.98) and demonstrated good reliability (α of 0.81–0.93). EE ($\beta = 0.07$, 95% CI 0.02–0.13) was positively associated with BMI, whereas the other two subscale scores were not.

Conclusion: The TFEQ-R18v2 instrument holds promise for research and clinical use among AYA-aged CNS tumor survivors. The instrument may be a useful tool for researchers to develop tailored weight management strategies. It also may be a valuable tool for clinicians to monitor survivors who are at risk of obesity and to facilitate referral. Our results also suggest that EE in this population should be further investigated as a potential target for intervention.

Keywords: diet, cancer care continuum, central nervous system (CNS) tumor, survivorship, prevention

Introduction

Central Nervous System (CNS) tumors, including brain and spinal cord tumors, are the second most common cancer among children (<15 years old)[1] and the seventh most common among adolescents and young adults (15–39 years old)[2] in the United States. Although 5-year relative survival continues to improve (73% for ages <20, 58% for ages 20–44),[3] childhood, adolescent, and young adult (AYA) CNS tumor survivors are at greater risk for developing chronic health conditions,[4,5] including endocrine disorders[6,7] and obesity,[8–11] compared with cancer-free populations.

Being overweight/obese is a major concern among childhood and AYA CNS tumor survivors even years after diagnosis,[9,12,13] because it may increase survivors' risk for developing obesity-related diseases such as metabolic syndrome[7] and

[1]Division of Rehabilitation Sciences, The University of Texas Medical Branch, Galveston, Texas.
[2]Department of Behavioral Science, The University of Texas MD Anderson Cancer Center, Houston, Texas.
[3]Department of Health Promotion and Behavioral Sciences, The University of Texas Health Science Center at Houston School of Public Health, Houston, Texas.
[4]Division of Pediatrics, The University of Texas MD Anderson Cancer Center, Houston, Texas.
[5]Department of Pediatrics, Baylor College of Medicine, Houston, Texas.
[6]Department of Hematology & Oncology, Cook Children's Medical Center, Fort Worth, Texas.
[7]Department of Biostatistics, The University of Texas Health Science Center at Houston School of Public Health, Houston, Texas.

dyslipidemia.[14] Unhealthy eating patterns are a risk factor for the development of obesity.[15] Studies have found that survivors consume a high-fat diet and fail to meet national dietary guidelines.[15–17] Given the unhealthy eating behaviors among survivors and the potential risk for being overweight/obese, the Children's Oncology Group recommends monitoring and counseling for childhood and AYA cancer survivors during long-term follow-up.[12]

In addition to the assessment of eating patterns, evaluation of eating behavior patterns has been used to understand the mechanisms contributing to obesity[18] and has also been used to develop targeted weight management interventions among cancer-free populations.[19–21] Therefore, an established self-reported eating behavior measure, such as the Three-Factor Eating Questionnaire (TFEQ), can be a useful tool for monitoring childhood and AYA CNS tumor survivors who are at risk for obesity.

The TFEQ measures uncontrollable eating (UE), cognitive restraint (CR), and emotional eating (EE) dimensions.[22] TFEQ is considered a robust measure, because the three-factor structure of TFEQ (i.e., TFEQ-R18,[23] TFEQ-R21,[24] and TFEQ-R18v2[22]) has been replicated and validated across various cancer-free populations[22, 23, 25,26] and across different delivery mechanisms such as paper versus online versions.[22] To our knowledge, there are no published studies that have evaluated the factor structure of the TFEQ in this high-risk population even though it has been used by two other studies among childhood and AYA CNS tumor survivors.[27,28]

Aside from the need to evaluate the psychometric properties of TFEQ when applied to a new population,[29,30] a recent study indicated greater risk for severe long-term neurocognitive impairment for CNS tumor survivors who received craniospinal irradiation compared with those who did not.[31] Such findings further motivated the need to evaluate whether survivors can understand the questions posed and complete the instrument to provide valid information. Thus, our primary aim was to examine the factor structure and reliability of TFEQ-R18v2 among childhood and AYA CNS tumor survivors. Second, we aimed at examining the relationship between TFEQ-R18v2 factors and self-reported body mass index (BMI). This was to determine whether or not latent factors were associated with BMI in this population as theorized.

Subjects and Methods

Study design and participants

We conducted a cross-sectional study by using web-based questionnaires. Childhood and AYA CNS tumor survivors were recruited in person and via mail or phone at two children's cancer centers in Texas. We also recruited them through flyers or online postings at other children's cancer hospitals, community organizations, and social media sources such as Facebook, Twitter, and Google+. Henceforth, we will refer to our study sample as AYA-aged CNS tumor survivors. Final eligibility was determined via phone screening. *Inclusion criteria* included: (1) AYA-aged CNS tumor survivors aged 15–39 at enrollment and diagnosed at age <39 years (following the National Cancer Institute's definition of AYA as aged 15–39 years[32]), (2) off therapy without relapse for at least 6 months, and (3) internet and phone access. *Exclusion criteria* included: (1) without legal guardians and (2) having significant cognitive and communication impairments (e.g., cannot provide their age). Participants provided consent (for those $\geq$18 years of age) or assent for those aged 15–17. Parental consent was also obtained for the minors. The institutional review board at UT MD Anderson Cancer Center and at Baylor College of Medicine approved this study. A total of 189 web-based questionnaire links were sent to those who consented, and 114 (60%) completed the web-based questionnaire. A total of five reminders per participant were made via phone calls, emails, and text messages in an attempt to increase participation rate.

TFEQ-R18v2

We provided each consented participant with the Assessment Center™ (www.assessmentcenter.net/) link via email. Each participant completed approximately 60 web-based questions. These 60 questions included demographic variables (Table 1 and the original TFEQ-R18v2.[22] The details of TFEQ-R18v2 have been published elsewhere.[22] Briefly, the UE subscale measures loss of control over eating (nine items). The CR subscale assesses consciously choosing to restrict food intake (three items). Lastly, the EE subscale measures responding to negative emotions by eating (six items).[22] The TFEQ-R18v2 items have four-point response scales ranging from definitely true (score = 4) to definitely false (score = 1). Raw scores are commonly converted into scaled scores of 0–100.[33] Higher scaled scores for each subscale suggest greater UE, CR, or EE characteristics.[33] TFEQ-R18v2 showed evidence of factorial validity in a previous study of who participated in the 2006 National Health and Wellness Survey. The comparative fit index (CFI) was 0.96. The internal consistency showed an α of 0.89 for UE, 0.78 for CR, and 0.94 for EE factors.[22]

Analyses

Demographic characteristics were summarized by descriptive statistics. For those <18 years of age, the BMI interpretation depends on sex and age; thus, the BMI categories were determined by Centers for Disease Control and Prevention (CDC) BMI-for-age growth charts.[34] As for those $\geq$18 years of age, BMI categories were determined by CDC classifications.[34] Correlation analyses were performed to identify colinearity between all variables of interest.

Factor structure and reliability of TFEQ-R18v2

We used confirmatory factor analysis (CFA) for our primary aim of examining the factor structure and reliability of TFEQ-R18v2 among AYA-aged CNS tumor survivors. Specifically, M*plus* (version 7)[35] was used to determine whether or not the items comprising each factor—UE, CR, and EE from the TFEQ-R18v2—loaded on those factors without any modifications. Furthermore, we also computed standardized loadings for each parameter to compare our sample estimates with the published estimates (Table 3).[22] We treated the scores as ordinal variables. A robust mean and a variance-adjusted, weighted least-squares estimator were used to address the lack of normality for each item having a range from one to four. We standardized the latent factors by setting factor variance to one and freely estimated all items to factor coefficients for all CFA models.

The fit indices and cut-off values recommended by Suhr[36] and Brown[37] were used to evaluate model fit (Table 2). These included: chi-square (χ^2) goodness-of-fit, CFI, Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and weighted root mean square residual (WRMR). For goodness-of-fit evaluation using the chi-square test, a p value ≥ 0.05 for the chi-squares indicates that there are no significant differences between the observed and expected variance–covariance matrix. CFI takes sample size into consideration, whereas TLI considers model complexity. The CFI/TLI cut-off criterion for an acceptable model fit is ≥ 0.90.[36] RMSEA evaluates the residual variance in the model. It is recommended that RMSEA values be <0.06.[37] If RMSEA is ≥ 0.06 but ≤ 0.08, it is considered a mediocre fit.[37] For the WRMR, a value of <0.90 indicates a good model fit.[38] If the fit was considered acceptable, we then examined the parameter estimates and evaluated the standardized loadings of each item to the factors. We used the 0.40 cut-off value[39] and a p value ≤ 0.05 to determine whether the items have low loadings to the factors.

In addition to scale scores, factor scores were calculated for each of the three factors by using multivariate regression methods based on the best CFA solution's factor loadings and factor correlation.[40] This method provides a more accurate estimate, because it takes into consideration the correlation between factors as well as the correlation between observed variables.[40] Scale reliability, also known as the internal consistency of the instrument, was assessed by using composite (scale) reliability. The composite reliability is a CFA-based method that is used to evaluate subscales' internal consistency.[37] The composite reliability was derived based on the scores of the items within each factor.

Relationship between TFEQ-R18v2 factors and BMI

For the secondary aim of evaluating the association between eating behaviors and BMI among AYA-aged CNS tumor survivors, we constructed a multivariable linear regression model combining all latent factors—UE, CR, and EE—as predictors and BMI as the outcome. Significance was set at $p < 0.05$. Covariates of interest were gender, race, and age. However, those covariates with a $p \geq 0.05$ were removed manually one at a time by evaluating the changes in the Akaike's information criterion (AIC) and Bayesian information criterion (BIC) values. Due to the non-normal distribution for BMI, we computed nonparametric 95% confidence intervals (CI) for regression estimates by using bootstrap resampling with 10,000 samples. The distributions of scaled scores and factor scores of UE, CR, and EE were evaluated for floor and ceiling effects. Censored regressions were also conducted to account for floor or ceiling effects.

Finally, since AYA-aged CNS tumors are rare cancers, we also conducted a power and sample size analysis and found that a sample size of 110 would provide 80% power to show a difference between a good fit (RMSEA 0.05) and a poor fit (RMSEA >0.08) for the proposed CFA model.[41]

Results

Slightly more than half of the participants were women; the majority was non-Hispanic White. The mean age was approximately 27 years, with the majority being ≥ 18 years of age. Approximately 41% of participants were classified as overweight/obese. The EE mean scaled score was significantly higher among women than men, $t(101) = -3.57$, $p < 0.001$ (Table 1).

Evaluation of TFEQ-R18v2 factor structure

Table 2 provides a summary of the fit statistics from the CFA models that we had constructed to address the primary aim. The initial three factors CFA for the original TFEQ-R18v2 (model 1) showed a ''mediocre''[37] fit (RMSEA >0.06 but <0.08). An examination of residuals and modification indices indicated that an observed correlation between items 12 (''When I smell a sizzling steak or see a juicy piece of meat, I find it very difficult to keep from eating—even if I've just finished a meal.'') and 15 (''When I see something that looks very delicious, I often get so hungry that I have to eat right away.'') of the TFEQ-R18v2 was not entirely explained by the underlying latent factor. Since these two items assessed similar concepts of a participant's desire to eat when they observed desired food and there were only two such items, we proceeded to correlate these error terms.[37] By correlating the error terms of these items under the UE factor, the resulting model (model 2) indicated a significantly better fit [$\chi^2(1) = 11.9$, $p = 0.0006$]. Although the significant χ^2 result for model 2 suggested some lack of fit, it may not have been substantial since other fit indices showed a reasonable fit (CFI/TLI >0.90; RMSEA <0.06; and WRMR <1.0).[37] The composite reliability for UE, CR, and EE based on model 2 results was above the recommended minimum reliability of 0.70.[42] The composite reliability was 0.86 (95% CI: 0.81, 0.90) for the UE factor, 0.81 (95% CI: 0.75, 0.87) for the CR factor, and 0.93 (95% CI: 0.90, 0.96) for the EE factor.

Table 3 summarizes the standardized regression coefficient results from model 2 compared with published[22] results. In our sample, UE was significantly correlated with EE. Since the statistical significance level of the factor correlations in the previous study were not reported, we assumed similar findings based on the reported factor correlation estimates.[22] Z tests (with Bonferroni correction) showed that the majority of the standardized regression coefficients were similar to published results,[22] except item 10 (''When I feel lonely, I console myself by eating.''; $p < 0.003$) of the EE factor. In our sample, the factor loading for item 10 was significantly higher than the published estimate (Table 3).

Relationship between TFEQ-R18v2 factors and BMI

We conducted simple correlations between the scaled scores and the factor scores to confirm the use of the scaled scores. The correlation results indicated a strong correlation between the scaled scores and the factor scores (Table 4). Thus, the scaled scores were used to interpret the regression results. Both gender ($p = 0.91$) and age ($p = 0.79$) were dropped from the model because of a lack of significant association with BMI; the AIC/BIC also decreased after the removal of these covariates. The censored model did not indicate differences in estimates after accounting for floor effects of the CR and EE factors, so we report the results of only the uncensored analyses. The results indicated a significant positive association between EE and BMI based on both the scaled score and factor score models (Table 5). In addition, race/ethnicity also indicated a significant positive association with a BMI over and above the

Table 1. Participant Demographic and Clinical Characteristics ($N = 114$)

Characteristics	*N (%)*		
Gender			
Male	49 (43)		
Female	65 (57)		
Race/ethnicity			
Caucasian/White	78 (69.6)		
Hispanics	25 (22.3)		
African American/Black	5 (4.5)		
Asian	2 (1.8)		
Other	2 (1.8)		
18 years of age			
Yes	99 (86.8)		
No	15 (13.2)		
BMI categories[a]			
Underweight	3 (2.6)		
Normal	64 (56.1)		
Overweight	21 (18.4)		
Obese	26 (22.8)		
Diagnosis (Highlighting the top 5 out of 39 various diagnoses)			
Astrocytoma	27 (23.7)		
Medulloblastoma	17 (14.9)		
Glioma	10 (8.8)		
Pilocytic Astrocytoma/Juvenile Pilocytic Astrocytoma (JPA)	9 (7.9)		
Craniopharyngioma	5 (4.4)		
Other	46 (40.3)		
Diagnosis year			
1979–1989	11 (9.6)		
1990–1999	28 (24.6)		
2000–2009	51 (44.7)		
2010–2013	24 (21.1)		
Treatment			
Surgery, chemotherapy, and radiation	40 (35.1)		
Surgery and radiation	29 (25.4)		
Surgery	26 (22.8)		
Surgery and chemotherapy	10 (8.8)		
Radiation	6 (5.3)		
Watch and wait/no treatment	2 (1.8)		
Chemotherapy and radiation	1 (0.9)		
Recurrence			
No	90 (78.9)		
Yes	24 (21.1)		
Characteristics	*N*	*M*	*SD*
Mean age	114	27	7.2
Off treatment (Years)	114	8.2	7.3
Age at diagnosis	114	15	9.8
BMI[b]	114	26.1	6.3
BMI for 18 years and older	99	26.2	6.3
Uncontrollable eating (Scaled score range: 0–100)[c]	113	28.1	18.5
Male	48	25.3	18.8
Female	65	30.2	18.1
Cognitive restraint scale score[c]	114	40.1	28.1
Male	49	34.2	28.6
Female	65	44.4	27.2
Emotional eating scale score[c]	114	24.3	26.1
Male	49	14.7	15.7
Female	65	31.5	29.9

[a]For those <18 years of age, BMI categories were determined by CDC BMI-for-age growth charts; for those ≥18 years of age, BMI categories were determined by CDC classifications.

[b]BMI = weight (kg)/[height (m)]^2.

[c]The equation used to convert the raw scores into a scale score of 0–100 was: [(Raw sum score of each factor-Lowest possible raw score)/(Raw score range)]*100.[33]

BMI, body mass index; CDC, Centers for Disease Control and Prevention.

TFEQ factors. Using the scaled score results, we found that while holding UE, CR, and race/ethnicity constant, a 10-point higher score of EE was associated with a 0.7 kg/m^2 increase in BMI.

Discussion

Overall, this examination of the factor structure and reliability of TFEQ-R18v2 among a sample of AYA-aged CNS tumor survivors indicated a reasonably similar factor structure to that published by Cappelleri *et al.* using the data obtained from U.S. adults without a history of CNS tumors.[22] The fit indicators (CFI/TLI, RMSEA, and WRMR) showed a reasonable fit, and the composite reliability estimates were acceptable. Our CFI results from models one (CFI: 0.98) and two (CFI: 0.98) were also comparable to the results obtained by Cappelleri *et al.* from their clinical sample (CFI: 0.91) and web-based survey (CFI: 0.96).[22] Composite reliability findings for UE (0.86), CR (0.81), and EE (0.93) were similar to published results (UE was 0.89, CR was 0.78, and EE was 0.94).[22] Additionally, all of the factor loadings for each item were significantly associated with each of the purported latent factors.

Higher CR was not significantly associated with higher BMI in our sample, in contrast to findings from Hansen *et al.*[27] Hansen *et al.* found that CR was positively associated with BMI among acute lymphoblastic leukemia and brain tumor survivors aged 12–17 years old.[27] We may have different results, because our sample included a higher proportion of normal versus obese participants. Previous research indicated that the association between restrained eating behavior and BMI depends on the distribution of obese versus normal weight in the study samples.[22,43] Similar to Angle *et al.*,[25] who found that EE was positively associated with BMI among women aged 17–20 years old without history of cancer,[25] we also found a positive relationship between EE and BMI in our population. Overall, EE may be an important target for intervention based on the significant relationship with BMI. However, we cannot determine the directional relationship between BMI and these eating behavior latent factors in a cross-sectional study. According to previous research, EE and UE are associated with higher BMI among women.[44] Nevertheless, longitudinal studies found that BMI may also influence a person's eating behaviors.[26,45] Similar to Hansen *et al.*,[27] a significant association between race and BMI was found. Future studies are needed to explore variables that may moderate the relationship between TFEQ factors and BMI.

Based on our results, TFEQ-R18v2 may be a useful tool for researchers to use as a way to characterize eating behaviors[22,23,25] and develop tailored weight management strategies for AYA-aged CNS tumor survivors.[19,46] It is a promising tool for clinicians or oncologists to use to monitor AYA-aged CNS tumor survivors who are at risk of obesity and to facilitate early referral to behavioral services or dietary counseling.[12,47] With the advancement of electronic medical records and the increasing use of electronic communication formats, delivering the TFEQ-R18v2 via the web would allow patients the opportunity to complete the questionnaire before clinic visits.

Our study must be considered in the light of certain limitations. For instance, we were limited in our ability to review medical records to obtain height, weight, diagnosis, and treatment information. Although self-reported anthropometric information is weaker than objective measurement, it has

Table 2. Summary of CFA Model Fit Indices ($N = 114$)

Model	Chi square[a] χ^2	Chi square[a] *df,* p *value*	*CFI/TLI*[b]	*RMSEA*[c] *(90% CI)*	*WRMR*[d]
Model 1: TFEQ-R18v2 three factors CFA (Uncontrollable eating, cognitive restraint, and emotional eating) without correlated error terms	187.8	df = 132, $p = 0.001$	0.98/0.98	0.061 (0.039, 0.080)	0.783
Model 2: TFEQ-R18v2 three factors CFA (Uncontrollable eating, cognitive restraint, and emotional eating) with correlated error terms	177.8	df = 131, $p = 0.004$	0.98/0.98	0.056 (0.033, 0.076)	0.748

[a]For goodness-of-fit evaluation using chi-square test, a p value great than 0.05 for the chi-squares indicates that there are no significant differences between the observed and expected variance–covariance matrix.
[b]CFI takes into consideration the sample size, whereas TLI considers the model complexity. The CFI/TLI cut-off criterion for an acceptable model fit is ≥ 0.90.[36]
[c]RMSEA evaluates the residual variance in the model. It was recommended that RMSEA values be <0.06.[37] If RMSEA is >0.60 but <0.08, it is considered a mediocre fit.[37]
[d]For the WRMR, a value of <1.0 indicates a good model fit.[38]
CFA, confirmatory factor analysis; CFI, comparative fit index; RMSEA, root mean square error of approximation; TFEQ, three factor eating questionnaires; TLI, Tucker–Lewis index; WRMR, weighted root mean square residual.

Table 3. Comparing AYA-Aged CNS Tumor Survivors' Sample Standardized Regression Coefficient and Factor Correlation Estimates with the Published Results Presented by Cappelleri *et al.* (2009)[22] ($N = 114$)

Item	*Standardized estimate from model 2*	*Published estimate*	*Z-score*[a] *of published estimate vs. study estimate*	p *value <0.003*[b]
Uncontrollable eating				
TFEQ3	0.786 (0.046)[c]	0.760	0.57	0.57
TFEQ6	0.728 (0.052)[c]	0.680	0.92	0.36
TFEQ8	0.619 (0.067)[c]	0.671	0.78	0.44
TFEQ9	0.823 (0.050)[c]	0.755	1.36	0.17
TFEQ12	0.607 (0.073)[c]	0.677	0.96	0.34
TFEQ13	0.762 (0.047)[c]	0.735	0.57	0.57
TFEQ15	0.700 (0.054)[c]	0.781	1.50	0.13
TFEQ17	0.674 (0.059)[c]	0.612	1.05	0.29
TFEQ18	0.633 (0.066)[c]	0.498	2.05	0.04
Cognitive restraint				
TFEQ1	0.712 (0.057)[c]	0.686	0.46	0.65
TFEQ5	0.811 (0.048)[c]	0.759	1.08	0.28
TFEQ11	0.899 (0.055)[c]	0.777	2.22	0.03
Emotional eating				
TFEQ2	0.843 (0.034)[c]	0.786	1.68	0.09
TFEQ4	0.909 (0.025)[c]	0.860	1.96	0.05
TFEQ7	0.850 (0.033)[c]	0.855	0.15	0.88
TFEQ10	0.948 (0.018)[c]	0.874	4.11	<0.0003
TFEQ14	0.880 (0.033)[c]	0.853	0.82	0.41
TFEQ16	0.929 (0.02)[c]	0.896	1.65	0.10
Correlation between factors and correlated error terms				
UE with CR	−0.035 (0.106)	0.057	0.87	0.40
UE with EE	0.769 (0.051)[c]	0.772	0.06	0.95
CR with EE	0.157 (0.108)	0.113	0.41	0.68
TFEQ12 with TFEQ15	0.232 (0.069)[c]	N/A	N/A	N/A

[a]Z-score = (standardized estimate from our sample–published standardized estimate/estimated SE from our sample).
[b]A $p < 0.003$ was considered significantly different. We used the Bonferroni correction (0.05/18) to reduce chance findings with multiple comparisons.
[c]$p < 0.0001$.
AYA, adolescent and young adult; CNS, central nervous system; CR, cognitive restraint; EE, emotional eating; N/A, not applicable; SE, standardized estimate; UE, uncontrollable eating.

Table 4. Simple Correlation of the Scale Scores with Factor Scores for TFEQ-R18v2 Factors

	BMI	*Uncontrollable eating scaled score*	*Uncontrollable eating factor score*	*Cognitive restraint scaled score*	*Cognitive restraint factor score*	*Emotional eating scaled score*	*Emotional eating factor score*
BMI	1.000						
Uncontrollable eating scaled score	0.139	1.000					
Uncontrollable eating factor score	0.141	0.977[a]	1.000				
Cognitive restraint scaled score	0.142	–0.050	–0.041	1.000			
Cognitive restraint factor score	0.148	–0.037	–0.021	0.984[a]	1.000		
Emotional eating scaled score	0.241[a]	0.621[a]	0.713[a]	0.099	0.135	1.000	
Emotional eating factor score	0.204[a]	0.718[a]	0.821[a]	0.131	0.169	0.956[a]	1.000

[a]$p < 0.05$

been used to facilitate the reach of populations across large areas,[48] such as in this case to reach AYA-aged CNS tumor survivors throughout the United States. In addition, we were only able to determine the association between eating behavior latent factors and BMI with cross-sectional data, but we were not able to determine the causal relations between BMI and the eating behavior latent factors. These cross-sectional data also cannot address potential difficulties with long-term recall. Future studies are needed to evaluate the temporal relationship between the latent factors and BMI and to evaluate latent factors that are associated with 24-hr recalls among AYA-aged CNS tumor survivors. Lastly, the sample size was smaller than that typically found in psychometric studies, though we found that we had 82% power to detect poor or good fit of our CFA model by using RMSEA.[41] Moreover, other studies have also indicated that a sample of 100 is adequate when there are five or fewer latent constructs and each construct has at least three items.[49,50]

Our evaluation of the factor structure and reliability of TFEQ-R18v2 among AYA-aged CNS tumor survivors is only the first step in evaluating the generalizability of the TFEQ-R18v2. Given the similarity between findings with our clinic-based population and findings in Cappelleri *et al.*[22] with a nonclinic-based population, future research should explore measurement invariance between nonclinic-based AYA adults and AYA-aged CNS tumor survivors by simultaneously administering this measure to samples from both populations. A formal evaluation of measurement invariance will lend additional evidence to the generalizability of the TFEQ-R18v2.

In summary, our findings supported the three-factor structure of TFEQ-R18v2 among AYA-aged CNS tumor survivors. The TFEQ-R18v2 also indicated good reliability within this

Table 5. Relationship Between TFEQ-R18v2 Factors and BMI: Scaled Score Models and Factor Score Models ($N = 111$)

Model	*Standardized parameter estimate*	*Parameter estimate (SE)*[a]	p *value*	*95% CI (bootstrap)*[b]
Scaled score[c] model				
Intercept	3.63	22.82 (1.26)	<0.001	20.56, 25.61
Uncontrollable eating	–0.07	–0.02 (0.03)	0.48	–0.09, 0.04
Cognitive restraint	0.11	0.03 (0.02)	0.23	–0.02, 0.06
Emotional eating	0.30	0.07 (0.03)	0.01	0.02, 0.13
Race/ethnicity (White vs. Other)	0.24	3.31 (1.47)	0.02	0.82, 6.63
Factor score[d] model				
Intercept	3.96	24.89 (0.55)	<0.001	23.93, 26.09
Uncontrollable eating	–0.14	–0.95 (1.01)	0.35	–2.94, 1.05
Cognitive restraint	0.10	0.71 (0.73)	0.33	–0.88, 2.02
Emotional eating	0.33	2.36 (1.20)	0.05	0.02, 4.78
Race/ethnicity (White vs. Other)	0.23	3.18 (1.48)	0.03	0.64, 6.46

[a]With BMI as the outcome, we controlled for race/ethnicity; the best model was selected based on AIC/BIC results.
[b]We performed bootstrap sampling with 10,000 samples by using the 2.5 percentile and 97.5 percentile to construct the 95% confidence interval (CI) for BMI regression estimates.
[c]The equation used to convert the raw scores into a scaled factor score of 0–100 was: [(Raw sum score of each factor-Lowest possible raw score)/(Raw score range)]*100.[33]
[d]Factor scores were calculated for each factor by using the multivariate methods based on the best CFA solution's factor loadings and factor correlation.
AIC, Akaike's information criterion; BIC, Bayesian information criterion.

population. Results also suggested the generalizability of the TFEQ-R18v2 factor structure among AYA-aged CNS tumor survivors. TFEQ-R18v2 may be a useful tool to help improve the quality of cancer survivorship care by monitoring the eating behavior patterns of AYA-aged CNS tumor survivors who are at risk of obesity for targeted intervention. Given that an increasing number of survivors are transitioning their medical care from the oncology setting to the general care setting, our findings may have important clinical implications for the effective treatment of a highly vulnerable, understudied population.

Acknowledgments

This research was supported in part by a cancer prevention fellowship for Maria Swartz that was supported by the National Cancer Institute grant R25T (CA057730), Shine Chang, Ph.D., Principal Investigator; the National Institutes of Health for Maria Swartz through the University of Texas MD Anderson's Cancer Center Support Grant (CA 016672); the Patient-Reported Outcomes, Survey, and Population Research (PROSPR) Shared Resources, NCI funded (CA 16772) to MD Anderson Cancer Center; MD Anderson Children's Cancer Hospital ON to Life Program; Texas Children's Cancer Center; Cook Children's Hematology and Oncology Center; and the Center for Energy Balance in Cancer Prevention and Survivorship, Duncan Family Institute. Currently, Maria Swartz is being supported by the Comparative Effectiveness Research on Cancer in Texas grant (RP140020), funded by the Cancer Prevention and Research Institute of Texas and the National Institute on Disability, Independent Living and Rehabilitation Research, Department of Education (90AR5009). The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Cancer Institute or the National Institutes of Health.

The authors would like to thank their participants and the following individuals, clinics, and organizations for assisting them in their recruitment effort: Ignacia N. Ramirez, Adolescent and Young Adult Cancer Support, American Brain Tumor Association, American Cancer Society, American Childhood Cancer Organization inland Northwest, Alex's Lemonade Stand Foundation, Badger Childhood Cancer network, Brain and Spine Center at the UT MD Anderson Cancer Center, Brain Tumor Alliance, Candlelighters Childhood Cancer Foundation of Southern Arizona, Casey's Fund for Big Sky Kids Cancer Camp, Childhood Cancer Survivors Clinic at the UT MD Anderson Cancer Center, CURE Childhood Cancer Association, Childhood Cancer/Astrocytoma Awareness, Healthy Lives After Cancer: Young Adult Survivorship Program, Hope for Young Adults with Cancer, Jessica June Children's Cancer Foundation, Livestrong, MACC Fund-Midwest Athletes Against Childhood Cancer, Inc., Meghan's Miracle-One Million Voices for Childhood Cancer, Richi Childhood Cancer Foundation, Roswell Park's Adolescent and Young Adult Program, National Brain Tumor Society, Young Adult Cancer Survivors, Young Survival Coalition, and Ulman Cancer Fund.

Author Disclosure Statement

The authors declare that no competing financial interests exist.

References

1. Howlader N, Noone AM, Krapcho M, et al. (Eds). SEER Cancer Statistics Review, 1975–2011. Bethesda, MD: National Cancer Institute, 2014.
2. Bendel A, Beaty III O, Bottom K, et al.(Eds) Chapter 6: Centeral Nervous System Cancer. Bethesda, MD: National Cancer Institute, 2006.
3. Central Brain Tumor Registry of The United States. Fact Sheet 2012. Accessed January 4, 2013 from: http://www.cbtrus.org/factsheet/factsheet.html
4. Armstrong GT, Liu Q, Yasui Y, et al. Long-Term outcomes among adult survivors of childhood central nervous system malignancies in the Childhood Cancer Survivor Study. J Natl Cancer Inst. 2009;101(13):946–58.
5. Armstrong GT, Kawashima T, Leisenring W, et al. Aging and risk of severe, disabling, life-threatening, and fatal events in the Childhood Cancer Survivor Study. J Clin Oncol. 2014;32(12):1218–27.
6. Armstrong GT, Conklin HM, Huang S, et al. Survival and long-term health and cognitive outcomes after low-grade glioma. Neuro Oncol. 2011;13(2):223–34.
7. Chemaitilly W, Sklar CA. Endocrine complications in long-term survivors of childhood cancers. Endocr Relat Cancer. 2010;17(3):R141–R59.
8. Crom DB. Metabolic abnormalities in an adult survivor of pediatric craniopharyngioma. Oncolo N Y. 2008;22(8):43–6.
9. Lek N, Prentice P, Williams RM, et al. Risk factors for obesity in childhood survivors of suprasellar brain tumours: a retrospective study. Acta Paediatr. 2010;99(10):1522–6.
10. Mason PW, Krawiecki N, Meacham LR. The use of dextroamphetamine to treat obesity and hyperphagia in children treated for craniopharyngioma. Arch Pediatr Adolesc Med. 2002;156(9):887–92.
11. Tai E, Buchanan N, Townsend J, et al. Health status of adolescent and young adult cancer survivors. Cancer. 2012;118(19):4884–91.
12. Children's Oncology Group. Long-term follow-up guidelines for survivors of childhood, adolescent, and young adult cancers Arcadia, CA: 2013.
13. Samaan MC, Thabane L, Burrow S, et al. Canadian Study of Determinants of Endometabolic Health in ChIlDrEn (CanDECIDE study): a cohort study protocol examining the mechanisms of obesity in survivors of childhood brain tumours. BMJ Open. 2013;3(6): pii: e002869.
14. Adachi M, Muroya K, Asakura Y. Unfavorable lipoprotein profile in childhood cancer survivors with suprasellar brain tumors—a high Apo B level and increased small dense LDL-cholesterol. Childs Nerv Syst. 2009;25(6):669–75.
15. Stolley MR, Restrepo J, Sharp LK. Diet and physical activity in childhood cancer survivors: a review of the literature. Ann Behav Med. 2010;39(3):232–49.
16. Badr H, Paxton RJ, Ater JL, et al. Health behaviors and weight status of childhood cancer survivors and their parents: similarities and opportunities for joint interventions. J Am Diet Assoc. 2011;111(12):1917–23.
17. Demark-Wahnefried W, Werner C, Clipp EC, et al. Survivors of childhood cancer and their guardians. Cancer. 2005;103(10):2171–80.
18. Carter FA, Jansen A. Improving psychological treatment for obesity. Which eating behaviours should we target? Appetite. 2012;58(3):1063–69.
19. Gade H, Hjelmes J, Rosenvinge JH, Friborg O. Effectiveness of a cognitive behavioral therapy for dysfunctional

eating among patients admitted for bariatric surgery: a randomized controlled trial. J Obes. 2014;2014:6.
20. Nurkkala M, Kaikkonen K, Vanhala ML, et al. Lifestyle intervention has a beneficial effect on eating behavior and long-term weight loss in obese adults. Eat Behav. 2015; 18:179–85.
21. Svensson M, Hult M, van der Mark M, et al. The change in eating behaviors in a Web-based weight loss program: a longitudinal analysis of study completers. J Med Internet Res. 2014;16(11):e234.
22. Cappelleri JC, Bushmakin AG, Gerber RA, et al. Psychometric analysis of the Three-Factor Eating Questionnaire-R21: results from a large diverse sample of obese and non-obese participants. Int J Obes (Lond). 2009;33(6):611–20.
23. Karlsson J, Persson LO, Sjostrom L, Sullivan M. Psychometric properties and factor structure of the Three-Factor Eating Questionnaire (TFEQ) in obese men and women. Results from the Swedish Obese Subjects (SOS) study. Int J Obes Relat Metab Disord. 2000;24(12):1715–25.
24. Tholin S, Rasmussen F, Tynelius P, Karlsson J. Genetic and environmental influences on eating behavior: the Swedish Young Male Twins Study. Am J Clin Nutr. 2005;81(3): 564–9.
25. Angle S, Engblom J, Eriksson T, et al. Three factor eating questionnaire-R18 as a measure of cognitive restraint, uncontrolled eating and emotional eating in a sample of young Finnish females. Int J Behav Nutr Phys Act. 2009;6:41.
26. de Lauzon-Guillain B, Basdevant A, Romon M, et al. Is restrained eating a risk factor for weight gain in a general population? Am J Clin Nutr. 2006;83(1):132–8.
27. Hansen JA, Stancel HH, Klesges LM, et al. Eating behavior and BMI in adolescent survivors of brain tumor and acute lymphoblastic leukemia. J Pediatr Oncol Nurs. 2014;31(1): 41–50.
28. Holmer H, Pozarek G, Wirfalt E, et al. Reduced energy expenditure and impaired feeding-related signals but not high energy intake reinforces hypothalamic obesity in adults with childhood onset craniopharyngioma. J Clin Endocrinol Metab. 2010;95(12):5395–402.
29. McKenna SP. Measuring patient-reported outcomes: moving beyond misplaced common sense to hard science. BMC Med. 2011;9(1):1–12.
30. Raykov T, Marcoulides GA (Eds). Introduction to psychometric theory. New York: Routledge; 2011.
31. Brinkman TM, Krasin MJ, Liu W, et al. Long-term neurocognitive functioning and social attainment in adult survivors of pediatric CNS tumors: results from the St Jude Lifetime Cohort Study. J Clin Oncol. 2016. [Epub ahead of print]; DOI: 10.1200/jco.2015.62.2589.
32. National Cancer Institute. A Snapshot of Adolescent and Young Adult Cancers 2014. Accessed September 28, 2015 from: http://www.cancer.gov/research/progress/snapshots/adolescent-young-adult
33. Lauzon BD, Romon M, Deschamps V, et al. The three-factor eating questionnaire-R18 is able to distinguish among different eating patterns in a general population. J Nutr. 2004; 134(9):2372–80.
34. Centers for Disease Control and Prevention. About Adult BMI [Internet] Atlanta, GA: centers for Disease Control and Prevention, Division of Nutrition, Physical Activity, and Obesity; 2015. Accessed February 6, 2016 from: http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/
35. Muthén LK, Muthén BO (Eds). Mplus user's guide. Sixth ed. Los Angeles, CA: Muthén & Muthén; 1998–2011.
36. Suhr DD. Exploratory or Confirmatory Factor Analysis? Proceedings of the Thirty-first Annual SAS Users Group International Conference. Cary, NC: SAS Institute; 2006; pp. 1–16.
37. Brown TA. Confirmatory factor analysis for applied research. New York, NY: Guilford Press; 2006; pp. 86–88.
38. Yu C-Y, Muthen B, editors. Evaluation of model fit indices for latent variable models with categorical and continuous outcomes. Annual meeting of the American Educational Research Association, New Orleans, LA; 2002.
39. Bernard M. Validation of the general attitude and belief scale. J Ration Emotive Cogn Behav Ther. 1998;16(3):183–96.
40. DiStefano C, Zhu M. Understanding and using factor scores: considerations for the applied researcher. Pract Assess Res Eval.14(20):1–11.
41. Preacher KJ, Coffman DL. Computing power and minimum sample size for RMSEA. Computer software 2006. Accessed October 11, 2015 from: http://quantpsy.org/rmsea/rmsea.htm
42. Tavakol M, Dennick R. Making sense of Cronbach's alpha. Int J Med Educ. 2011;2:53–5.
43. Provencher V, Drapeau V, Tremblay A, et al. Eating behaviors and indexes of body composition in men and women from the Quebec family study. Obes Res. 2003;11(6): 783–92.
44. Hays NP, Roberts SB. Aspects of eating behaviors ''disinhibition'' and ''restraint'' are related to weight gain and BMI in women. Obesity. 2008;16(1):52–8.
45. Snoek HM, van Strien T, Janssens JM, Engels RC. Restrained eating and BMI: a longitudinal study among adolescents. Health Psychol. 2008;27(6):753.
46. Stunkard AJ, Messick S. The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. J Psychosom Res. 1985;29(1):71–83.
47. Gibson EL. The psychobiology of comfort eating: implications for neuropharmacological interventions. Behav Pharmacol. 2012;23(5–6):442–60.
48. Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev. 2007;8(4):307–26.
49. MacCallum RC, Widaman KF, Preacher KJ, Hong S. Sample size in factor analysis: the role of model error. Multivariate Behav Res. 2001;36(4):611–37.
50. Parker K, Mitchell S, O'Brien P, Brennan L. Psychometric evaluation of disordered eating measures in bariatric surgery patients. Eat Behav. 2015;19:39–48.

Address correspondence to:
Maria Chang Swartz, RD, PhD, MPH
Division of Rehabilitation Sciences
The University of Texas Medical Branch
301 University Boulevard
Galveston, TX 77555-0912

Email: mcswartz@utmb.edu