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Validation of a Milk Consumption Stage of Change Algorithm among Adolescent Survivors of Childhood Cancer

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Abstract

Objective—To assess the construct validity of a milk consumption Stages of Change (SOC) algorithm among adolescent survivors of childhood cancer ages 11 – 21 years (n = 75).

Methods—Baseline data from a randomized controlled trial designed to evaluate a health behavior intervention were analyzed. Assessments included a milk consumption SOC algorithm and hypothesized theoretical and behavioral predictors of SOC.

Results—Compared with survivors who expressed no readiness to change, those expressing readiness to change behavior for both 2 or 4 daily servings of milk reported more frequent milk consumption (p <; .001), greater dietary calcium intake (p = .006), and were more likely to meet age-specific recommendations for daily calcium intake (p = .01).

Conclusion and Implications—Results provide support for the construct validity of the milk consumption SOC algorithm relative to behavioral criteria. Research is needed to further examine algorithm validity with respect to theoretical predictors of SOC.

Keywords

cancer; pediatrics; survivors; milk consumption; bone health; stages of change

INTRODUCTION

Bone health problems are a common late effect of cancer treatment among childhood cancer survivors, including suboptimal bone density and clinical signs of osteopenia.[1] These problems are linked to stunted growth and increased risk for osteoporosis and fractures in adulthood.[1] Risk for bone health problems may be exacerbated by the fact that few survivors meet recommendations for bone health behaviors, such as consuming recommended levels of calcium daily.[2]

Although clinical signs of bone health problems do not typically appear until adulthood,[1] interventions encouraging bone health-promoting behaviors among young cancer survivors may help prevent or delay onset of bone health morbidities. A comprehensive approach to

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Supplemental Material
Milk consumption SOC algorithm

promoting bone health among young survivors includes consuming a balanced diet and engaging in healthful physical activity.[1] Increasing calcium and vitamin D intake through diet and supplementation are effective methods of improving bone density[3] and may reduce risk for fracture in high-risk groups.[4,5] For childhood cancer survivors, follow-up care guidelines encourage meeting age-specific recommended levels of calcium for optimal bone health.[1] Milk is a leading source of dietary calcium,[6,7] and interventions targeting milk consumption may be one important element of comprehensive approaches to reduce long-term risk for bone health problems in this vulnerable population.[1,8]

Recent data support the efficacy of a bone health behavior intervention for young cancer survivors, including milk consumption.[9] However, the impact could be enhanced by tailoring content to address survivors' individual needs for behavior change.[10] The Transtheoretical Model (TTM) provides a framework for tailoring interventions to an individual's readiness to change, positing that health behavior change occurs via five stages of change (SOC) from Precontemplation (no intention to change behavior within next 6 months) to Maintenance (performance of the recommended behavior for ≥ 6 months).[11] Transition between stages is dynamic and includes progression towards maintenance and relapse to earlier stages.[11]

The SOC approach has been applied to the study of dietary behaviors among young people, including milk consumption.[12-15] SOC is typically assessed using a staging algorithm, which characterizes individuals based on current behavioral practices, duration of practices, and intention to take action to change practices.[11] It is critical to first establish the construct validity of SOC algorithms designed to characterize SOC for the recommended health behavior. However, no such milk consumption algorithm has been validated among adolescent cancer survivors. We examined the construct validity of a SOC algorithm for consuming 2 and 4 daily servings of milk among adolescent survivors of childhood cancer. The algorithm is designed to provide a flexible tool to assess milk consumption and can be used with other sources of dietary information to tailor bone health interventions among young cancer survivors.

METHODS

Procedures

The Survivor Health and Resilience Education (SHARE) Program was a randomized controlled trial to test the efficacy of a multiple health behavior intervention among adolescent survivors of childhood cancer. Study methods and bone health behavior outcomes were reported previously.[9] The study included adolescents ages 11-21 years who were treated for cancer, ≥ 1 year post treatment and ≥ 1 year cancer-free. Participants were recruited from 2 local pediatric cancer centers; the Georgetown University institutional review board approved all procedures. Following participant assent and parental consent, participants completed a baseline assessment via 2 consecutive 30-minute telephone interviews.

Measures

Demographic characteristics included age, gender, race, household composition, and school performance (mostly A's or B's or other grades). Clinical characteristics included diagnosis of Leukemia (the primary cancer diagnosis) or another form of cancer, and years since diagnosis.

Theoretical predictors were derived from the TTM. Bone health knowledge was assessed as a proxy for consciousness-raising, the process of change that is critical to move individuals from Precontemplation to Contemplation by providing new information supporting behavior

change.[11] Using 6 multiple choice items adapted from the National Bone Health Campaign for children[16] and prior research,[17,18] knowledge was operationalized as a continuous variable indicating the number of items answered correctly (range 0 -6). Self-efficacy is an individual's confidence to engage in a behavior and is central to TTM.[11] Calcium consumption self-efficacy was assessed using 11 Likert-type items adapted from prior research.[19] Responses were summed to create a total score with higher values reflecting greater self-efficacy (range 0 – 55; Cronbach's $\alpha = 0.86$).

Milk consumption behaviors were assessed using 2 items adapted from the National Bone Health Campaign.[16] Milk consumption frequency was measured by asking "*How often would you say you drink milk*?" Responses ranged from (1) 'never' to (4) 'always' and a continuous variable was created for analyses. The second item asked "During a normal day, do you drink at least 4 glasses of milk?"

Calcium intake was measured with the 5-Step Multiple Pass 24-hour recall method.[20] This method asked participants to describe everything that s/he ate/drank for a 24-hour period, when and where foods were eaten, and details of each food, and reviews information to confirm accuracy. Calcium intake in milligrams [mg] was derived using NutritionistPro, a third-party software program that converts dietary data into nutritional information. We analyzed a continuous variable for overall calcium intake and a dichotomous variable indicating whether participants met age-specific dietary calcium guidelines.[21]

An algorithm originally developed among adult women was used to assess SOC for consuming 2 and 4 daily servings of milk (see supplemental file).[22] The algorithm assessed criteria for each of the TTM stages,[11] defining a standard serving of milk as one cup.[23] Questions assessed participants' current behaviors and readiness to consume 2 and 4 daily servings of milk. We created a 3-level variable with the following categories: (1) No readiness to change: Precontemplation or Contemplation for 2 cups and Precontemplation for 4 cups; (2) Readiness 2 cups: Preparation, Action, or Maintenance for 2 cups and Precontemplation for 4 cups; (3) Readiness 2 and 4 cups: Preparation, Action, or Maintenance for 2 cups and Contemplation, Preparation, Action, or Maintenance for 4 cups. These categories were created based on the distribution of participants across SOC (Figure 1) and to reflect levels of readiness to change for both behaviors. For example, participants in Precontemplation or Contemplation for 2 cups and Precontemplation for 4 cups expressed little or no readiness to change either behavior. In comparison, those in Preparation, Action, or Maintenance for 2 cups and Contemplation or beyond for 4 cups expressed some readiness to change both behaviors, or were achieving behavioral goals.

Analyses

Construct validity is established by examining associations between the focal construct and related predictors.[24] To examine the algorithm's construct validity, we used bivariate analyses to assess relationships among SOC and clinical and demographic characteristics, and behavioral and theoretical predictors. None of the clinical and demographic characteristics were associated with SOC, therefore our final analyses were unadjusted bivariate F-tests and χ^2 tests of associations between SOC and behavioral and theoretical predictors of interest.

RESULTS

Participant Characteristics

Table 1 displays participant characteristics, and Figure 1 illustrates survivors' SOC for two and four daily servings of milk. For the combined outcome, 24% of survivors ($n = 18$) expressed no readiness to change (Figure 1). Sixteen (21%) expressed readiness to change

behavior for 2 daily servings of milk, and 55% (n = 41) expressed readiness to change behavior for both 2 and 4 daily servings of milk.

Predictors of Stage of Change

Compared with survivors who expressed no readiness to change and those who only expressed readiness to change for 2 daily servings of milk, those who reported readiness to change for both 2 and 4 servings reported significantly more frequent milk consumption (p < 0.001, Table 1). Similarly, survivors who expressed readiness to change for 2 and 4 servings were the most likely to report consuming ≥ 4 servings of milk on a normal day (n = 17, 42%, p = 0.01) and to meet dietary calcium recommendations (n = 16, 39%, p = 0.01; Table 1). Finally, survivors who reported readiness to change for both 2 and 4 servings of milk consumed significantly greater milligrams of dietary calcium (*Mean* = 1135.4 mg, *SD* = 523.6 mg), compared with those who expressed no readiness to change milk consumption behavior (*Mean* = 702.5 mg, *SD* = 346.4 mg, p = 0.006).

DISCUSSION

Adolescent survivors of childhood cancer are at an increased risk for bone-related morbidity,[1] but evidence supporting interventions to promote bone health behaviors for this population, such as milk consumption, remains limited.[9] The TTM has been widely used to inform behavioral interventions targeting dietary behaviors[25] and the impact of interventions to promote milk consumption among young survivors could be enhanced by tailoring content to individual survivors' SOC.[10] Our findings provide preliminary support for the construct validity of a milk consumption SOC algorithm based on behavioral criteria, and highlight important topics for research.

Adolescent survivors who expressed readiness to change for consuming 2 and 4 daily servings of milk reported more frequent milk consumption, were more likely to drink 4 servings of milk a day, and consumed more dietary calcium. These findings are consistent with prior studies that sought to validate the algorithm for use in other populations, such as college-age young adults.[14,15] We used the 24-hour recall method to measure dietary calcium consumption which is a significant methodological improvement over prior studies using less robust measures of calcium intake.[14,15,22] The algorithm also incorporates several validity-enhancing strategies, including using simple behavioral goals, applying a clear SOC classification scheme, and specifying objective behaviors to avoid misclassification.[26]

We did not observe associations between SOC and knowledge or self-efficacy. This finding may be because our measures for these constructs were not based directly on the TTM, but were developed to capture broader bone health constructs.[27] We also evaluated validity based on a combined SOC outcome for 2 and 4 daily servings of milk, rather than examining these behaviors separately. This may have affected our ability to detect differences based on theoretical constructs. It is critical that future studies demonstrate the validity of the algorithm relative to constructs derived more specifically from TTM, such as processes of change and decisional balance.[26] Future studies can build from this work by examining milk consumption behaviors independently.

Our findings highlight other important considerations for future studies seeking to develop bone health behavior interventions targeting young cancer survivors. While milk is a primary source of dietary calcium, survivors may consume a variety of calcium-rich foods to improve bone health (e.g., leafy green vegetables). Young survivors in later SOC were more likely to meet recommendations for daily calcium consumption, but just over one quarter met recommendations. A comprehensive approach to bone health interventions that motivates young survivors to consume a variety of bone health-promoting foods and engage

in healthful physical activity appears needed to reduce survivors' risk for bone health morbidity.[9] Future studies in this area may also warrant comparing self-report behavioral assessments to objective measures of bone health (e.g., bone density scans). That our assessment did not differentiate between types of milk (e.g., non-fat milk, whole milk) is an important consideration to address in future studies, as some commonly-consumed forms of milk may have negative health effects (e.g., milk flavored with sugar).[7]

Our findings should be interpreted in light of study limitations. The small sample restricted our ability to analyze construct validity separately for both milk consumption behaviors and limits generalizability of findings. The broad age range of survivors may have spanned distinct developmental periods, which could influence our findings. We relied on self-report assessments, some of which were not developed based on the TTM or were brief and adapted from prior work (e.g., milk consumption frequency).

Implications for Research and Practice

Despite study limitations, our findings provide preliminary support for the validity of the milk consumption SOC algorithm among adolescent survivors of childhood cancer relative to behavioral criteria. Additional research is needed to evaluate the construct validity of the algorithm relative to TTM constructs (e.g., processes of change) among larger, more diverse samples. Interventions that take a broad approach by motivating young survivors to consume milk and a variety of other healthful foods and engage in other bone health-promoting behaviors may be ideal to reduce the risk for bone health morbidity in this vulnerable population and could be informed using this SOC algorithm.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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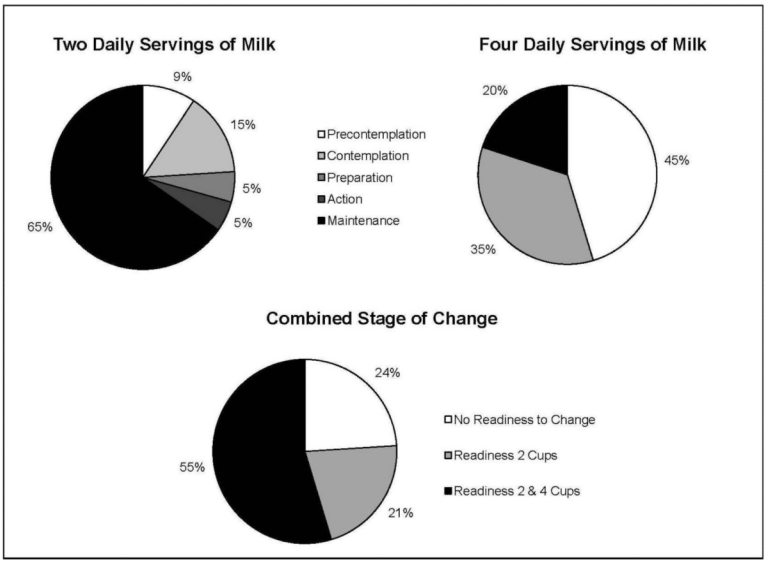

Figure 1.
Milk consumption stages of change among adolescent survivors of childhood cancer (n = 75)

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Table 1

Sample characteristics and associations with milk consumption stages of change

	Sample	Combined Stage of Change			
	(*n* = 75)	No Readiness To Change (*n* = 18)	Readiness 2 Cups (*n* = 16)	Readiness 2 & 4 Cups (*n* = 41)	*P*-value
Demographics					
Age (years; Mean [SD])	14.2 (2.4)	14.9 (2.9)	13.3 (2.4)	14.2 (2.2)	0.16
Race					0.17
White	75%, 56	61%, 11	69%, 11	83%, 34	
Non-White	25%, 19	39%, 7	31%, 5	17%, 7	
Gender					0.13
Male	48%, 36	50%, 9	69%, 11	39%, 16	
Female	52%, 39	50%, 9	31%, 5	61%, 25	
Household Composition					0.75
2 Parent Home	83%, 62	78%, 14	88%, 14	83%, 34	
Other	17%, 13	22%, 4	12%, 2	17%, 7	
School Achievement					0.52
Mostly A's/B's	76%, 57	67%, 12	75%, 12	81%, 33	
Other	24%, 18	33%, 6	25%, 4	19%, 8	
Clinical Characteristics					
Primary Diagnosis					0.95
Leukemia	52%, 39	50%, 9	50%, 8	46%, 19	
Other Type	48%, 36	50%, 9	50%, 8	54%, 22	
Years Since Diagnosis *(Mean [SD])*	9.0 (3.4)	8.2 (3.5)	9.4 (3.3)	9.1 (3.4)	0.57
Theoretical Predictors					
Bone Health Knowledge *(Mean, [SD])*	2.9 (0.9)	2.1 (1.2)	2.3 (1.1)	2.3 (1.1)	0.72
Calcium Self-Efficacy *(Mean, [SD])*	38.9 (7.9)	36.6 (8.0)	39.1 (6.5)	39.7 (8.2)	0.37
Behavioral Predictors					

	Sample	Combined Stage of Change			
	(*n* = 75)	No Readiness To Change (*n* = 18)	Readiness 2 Cups (*n* = 16)	Readiness 2 & 4 Cups (*n* = 41)	*P*-value
Milk Consumption Frequency *(Mean, [SD])*[a]	2.1 (0.89)	2.4 (0.85)[1]	2.7 (0.95)[1]	3.3 (0.74)[2]	<.001
Normal Day ≥ 4 Glasses of Milk	28%, 21	6%, 1	19%, 3	42%, 17	0.01
Meets Recommended Calcium Intake[b]	27%, 20	6%, 1	19%, 3	39%, 16	0.02
Calcium Intake (mg) *(Mean, [SD])*[a]	991.0 (509.0)	702.5 (346.4)[1]	945.4 (502.1)[1,2]	1135.4 (523.6)[2]	0.006

Note. Unless noted, cells display % and *n*. SD = Standard Deviation.

[a]Means with different superscript numbers differ at $p < 0.05$ after adjustment for multiple comparisons.

[b]*P*-value from Fisher's exact χ^2

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