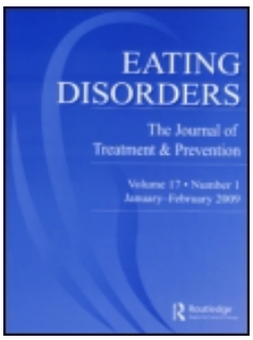

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Eating Disorders
The Journal of Treatment & Prevention

ISSN: 1064-0266 (Print) 1532-530X (Online) Journal homepage: https://www.tandfonline.com/loi/uedi20

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To cite this article: Margaret A. Powers, Sara Richter, Diann Ackard & Cheryl Craft (2016) Development and validation of the Screen for Early Eating Disorder Signs (SEEDS) in persons with type 1 diabetes, Eating Disorders, 24:3, 271-288, DOI: 10.1080/10640266.2015.1090866

To link to this article: https://doi.org/10.1080/10640266.2015.1090866

EATING DISORDERS
2016, VOL. 24, NO. 3, 271–288
http://dx.doi.org/10.1080/10640266.2015.1090866

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Development and validation of the Screen for Early Eating Disorder Signs (SEEDS) in persons with type 1 diabetes

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ABSTRACT

This study's objective was to develop and validate an instrument to identify those at risk of developing an eating disorder (ED) in persons with type 1 diabetes. The Screen for Early Eating Disorder Signs (SEEDS) instrument was developed using a multi-phase process including focus groups, cognitive interviews, and mailed questionnaires. Factor analysis revealed 20 items across three factors (Body Image, Feelings, Quality of Life) demonstrating strong psychometric properties. Scoring guidelines and interpretation are provided. SEEDS is a brief (20-item; 2–5 minutes to complete), self-administered, screen designed for use in clinical practice or research to identify or confirm suspicions of ED risk and does not include weight-control behavior items.

Eating disorders are debilitating, challenging medical conditions (American Psychiatric Association, 2013) that have very high mortality rates (Ajetunmobi, Taylor, Stockton, & Wood, 2013; Suokas et al., 2013). When an eating disorder co-exists with type 1 diabetes the challenges of treating both the eating disorder and diabetes becomes more complicated. (Gagnon, Aime, Belanger, & Markowitz, 2012). For example, while type 1 diabetes requires precision with daily counting of carbohydrate grams, monitoring energy expenditure, calculation of insulin doses, and frequent glucose level measurement to achieve diabetes management goals, eating disorder treatment often discourages such detailed monitoring and precise behaviors. This dissonance of treatment creates additional psychological stress and tension that can leave the dually diagnosed patient more medically and psychologically compromised (Colton, Olmsted, Daneman, & Rodin, 2013; Gagnon et al., 2012).

Eating disturbances and disorders have been found to be more common among youth with type 1 diabetes than among their peers without diabetes and to cause substantial reduction in quality of life (Ackard et al., 2008;

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Wade, Wilksch, & Lee, 2012; Young et al., 2013). When eating and body image disturbances progress into full threshold eating disorders, individuals with type 1 diabetes are more likely to have impaired metabolic control and increased risk of diabetic retinopathy (Rydall, 2002; Wisting, Frøisland, Skrivarhaug, Dahl-Jørgensen, & Rø, 2013). Those who specifically restrict insulin to manage their weight have an increased rate of diabetes complications and an increased mortality risk (Goebel-Fabbri et al., 2008).

Development of an eating disorder, unlike that of type 1 diabetes, typically involves a slow progression of signs and symptoms that reach full diagnostic criteria over time (Hanlan, Griffith, Patel, & Jaser, 2013; Powers et al., 2012). Early screening of eating and body image disturbances is recommended for people with type 1 diabetes, but not routinely performed, meaning symptoms often go undetected by family, friends, and health professionals (Crow, Keel, & Kendall, 1998; Hanlan et al., 2013; Kelly, Howe, Hendler, & Lipman, 2005; Wisting et al., 2013; Young et al., 2013). In a recent study it was found that the average amount of time between type 1 diabetes diagnosis and an eating disorder diagnosis was 10 years among those with both diagnoses (Powers et al., 2012). As individuals with type 1 diabetes are typically seen by healthcare or endocrinology professionals several times each year, there are regular opportunities to screen patients for problematic eating and weight/shape concerns and to intervene to prevent symptom progression (Chiang, Kirkman, Laffel, & Peters, 2014; Hanlan et al., 2013; Young et al., 2013).

Questionnaires designed to identify persons with eating disturbances are available. However, general eating disorder questionnaires are not sensitive to the influence of type 1 diabetes on eating patterns; an expert panel found that 50% of items in the EDE-Q and 6.6% on the EDI-3 could be highly influenced by having type 1 diabetes (Powers et al., 2013). For example, most or all persons with type 1 diabetes would consider their diabetes when responding to the question on the EDE-Q "Have you been deliberately trying to restrict the amount of food you eat to influence your shape or weight?" Furthermore, general eating disorder screens include items that could inadvertently suggest unhealthy weight-control methods such as self-induced vomiting and laxative use. Diabetes-specific screening tools for eating disorders have been developed yet include additional items that could be unintentionally suggestive of dangerous behaviors among those with type 1 diabetes such as asking about insulin omission for weight-loss purposes (Markowitz et al., 2010; Rodin, Craven, Littlefield, Murray, & Daneman, 1991; Zuijdwijk et al., 2014).

Our collaborative clinical and research teams addressing issues pertinent to eating disorders assert that detection of *precursors* to eating disturbances is more valuable than measuring the *presence* of eating disorder behaviors. Furthermore, early detection offers the greatest

opportunities for prevention interventions. In addition, our team believes that a brief screen should be easy for patient completion, convenient for staff administration, and carry meaningful interpretation to support regular use during adolescence and young adulthood when patients are already at peak risk for eating disorder development (Stice, Marti, Shaw, & Jaconis, 2009). Given the absence of such an innocuous measure, there is a critical need for a screen that does not inadvertently suggest weight-control practices and could be used by health care professionals working with people with type 1 diabetes. The purpose of the current study was to develop and validate a screening instrument to identify early eating disorder signs in people with type 1 diabetes.

Methods

A multi-source, multi-phase process (see Figure 1) was used to create the Screen for Early Eating Disorder Signs (SEEDS) instrument. All study procedures and phases were approved by the Park Nicollet Health Services (PNHS) Institutional Review Board.

Development of initial screen

Conduct focus groups

Semi-structured focus groups and interviews were conducted with 16 persons dually diagnosed with type 1 diabetes and an eating disorder (described elsewhere [Powers et al., 2015]; for descriptive information see Table 1) to identify content for the screen. An analysis of the transcripts revealed five principal themes relevant to type 1 diabetes and eating disorder diagnoses: feeling different, difficulty with control and coping, body image, feelings, and quality of life.

Initial screen created

Content for the screen items was derived from the focus groups while Higgins Self-Discrepancy Theory (Higgins, 1987; Strauman, Vookles, Berenstein, Chaiken, & Higgins, 1991), which focuses on the disparity between the "actual" ("general") self and the "ideal" self, was selected to guide the structure of the screen. Four to six items were developed for each of the five principal themes identified from the focus groups (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Two parts to each item were created/generated; respondents answered from "actual" and "ideal" perspectives. Larger discrepancies between "actual" and "ideal" self-ratings could indicate greater distress leading to psychopathology.

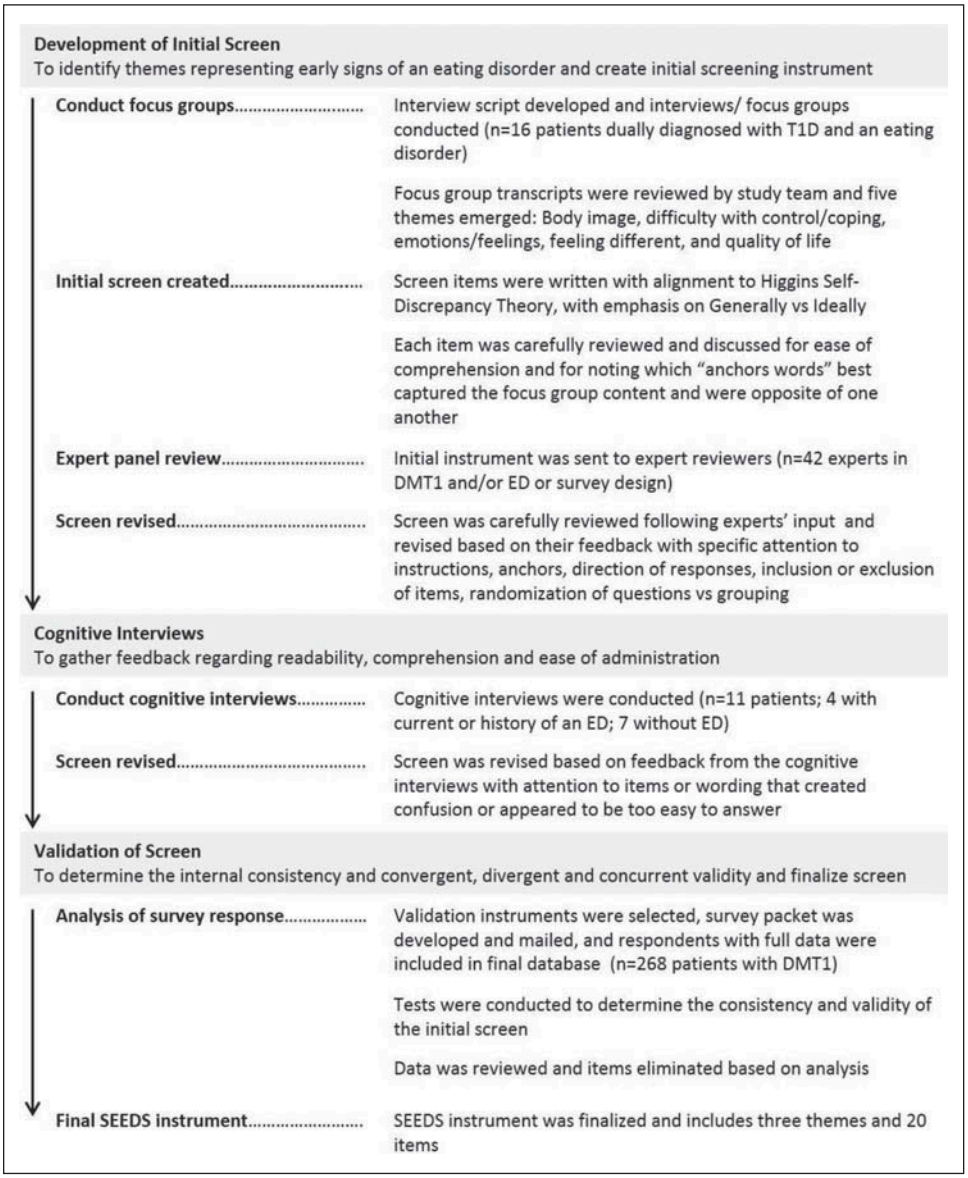

Figure 1. Process of screening instrument development.

Expert panel review and screen revised

The initial draft of SEEDS included 24 two-part items. Feedback on the initial draft was obtained from an expert panel of 32 health care professionals and researchers with experience in the eating disorder-type 1 diabetes dual diagnosis field from the United States and Canada and two experts in survey design. Based on suggestions from the experts, the

Table 1. Demographic and clinical characteristics of participants across study phases.

	Focus groups (N = 16) [1]	Cognitive interviews (N = 11)	Validation of screen (N = 268)
N (%) female	16 (100.0%)	9 (81.8%)	153 (57.1%)
N (%) Caucasian	15 (93.8%)	11 (100%)	243 (91.0%)
N (%) unmarried	12 (75.0%)	-—	-—
Age in years, mean (SD)	28.6 (11.2)	18.5 (4.1)	19.2 (9.2)
N (%) 12–14 years	0 (0%)	2 (18.2%)	80 (29.9%)
N (%) 15–17 years	2 (12.5%)	3 (27.3%)	99 (36.9%)
N (%) $\geq$ 18 years	14 (87.5%)	6 (54.5%)	89 (33.2%)
Age at type 1 diabetes diagnosis, years, mean (SD)	14.4 (9.1)	9.2 (4.4)	8.8 (6.0)
HbA1C %, mean (SD) *	8.8% (2.0)	9.7% (2.4)	8.4% (1.6)
HbA1C mmol/mol, mean (SD) *	73 (21.9)	83 (26.2)	68 (17.5)

Notes: [1] Findings from the focus groups have been published elsewhere (see Powers, Richter, Ackard, & Cronemeyer, 2015).

* HbA1C values were available within 6 months of the focus group dates for 13 (81.3%) participants; of these, only 2 participants (2/13; 15.4%) had HbA1C values ≤ 7.0%.

screen was revised to include 30 items, each with two parts across the five themes identified by focus group participants.

Cognitive interviewing

Conduct cognitive interviews

Individual cognitive interviews of approximately 1 hour in duration were conducted to ensure understanding of the meaning of items and how to complete the screen. Cognitive interviewing is a process used in measurement development to discover the thought processes and reactions of the person answering/reviewing the questions and materials. A semi-structured guide was used with 11 patients with type 1 diabetes (81.8% female; 100% Caucasian; average age 18.5 years (SD = 4.1); 4 with current or past eating disorder (Eating Disorder Not Otherwise Specified) and 7 with no eating disorder history; for further description, see Table 1). Participants signed a study consent/assent prior to the cognitive interviews and were paid an honorarium for their participation.

Slight modifications to the screen were made throughout the cognitive interviewing process. After 11 interviews, suggestions for improvement were exhausted and cognitive interviewing was concluded. Overall, the introduction, some statements and response anchors were revised. Thirty, two-part items were retained despite many participants questioning the value of the "ideally" questions given that most participants indicated that they wanted a high level of the positive attribute associated with each "ideally" item.

Validation of screen

Eligible participants for validation of SEEDS included all persons with type 1 diabetes who received at least one diabetes or general health care visit in the past

2 years at PNHS, were aged 12 years or greater and were identified through a query of the health system's electronic medical record. The sample stratification was intentionally over-weighted for adolescents (Stice et al., 2009). The eligible participants (N = 730) were mailed a packet of study materials that included a description of the study and explanation that completing and returning the materials acknowledged their consent; for participants <18 years, the materials were sent to their parent/guardian to give to their child if they so chose. A reminder card was sent 10 days later, followed by a second packet in an additional 10 days if there had been no response. Upon receipt of the completed survey packet a thank you letter and honorarium were sent to the participant or the parent/guardian. Date of birth and most recent HbA1c value with date were abstracted from the consenting patient's electronic medical record.

A total of 279 individuals with type 1 diabetes returned the survey packet (38.2% response rate). Responders were more likely than non-responders to be female (57.3% vs. 46.6%, p = .005) and Caucasian (87.5% vs. 79.4%, p = .014); there were no differences between responders and non-responders on age at recruitment or HbA1c values closest to time of mailing. Of the responders, 11 had missing data, resulting in 268 participants with complete, usable data (see Table 1 for further description of those with complete data).

Convergent validity measures

Seven measures with sound psychometric properties, selected based on their use with males and females, adolescents and adults, and availability in the public domain, were used for convergent validation.

The Center for Epidemiological Studies Depression Scale (CESD; Radloff, 1977) includes 20 items with a 4-point rating scale to assess symptoms of depression over the past week; higher scores indicate greater levels of depression and scores of 16 or greater suggest high depression (Radloff, 1977).

The Diabetes Distress Screening Scale (DDS2; Fisher, Hessler, Polonsky, & Mullan, 2012; Polonsky et al., 2005) uses two items and a 6-point rating scale to capture the severity of feeling overwhelmed and failure with diabetes care. An average score of 3 or more indicates high distress, less than 2 suggests little or no distress and scores in between signal moderate distress (Fisher et al., 2012).

The Eating Disorder Examination-Questionnaire version 6 (EDE-Q; Fairburn & Beglin, 2008) has 31 items (four subscales: dietary restraint, weight concerns, shape concerns, eating concerns) measuring eating disorder behaviors, thoughts, and feelings about body across a 28-day period (Carter, Stewart, & Fairburn, 2001; Mond, Hay, Rodgers, & Owen, 2006).

The General Self-Efficacy Scale (GSES; Schwarzer & Jerusalem, 1995) includes 10 questions and a 4-point scale to assess the sense of self-efficacy; it has been found to be helpful in measuring adherence to diabetes

management recommendations (Schwarzer & Luszczynska, 2005). Higher scores indicate greater self-efficacy.

The Multidimensional Perfectionism Scale (MPS; Frost, Marten, Lahart, & Rosenblate, 1990) assesses perfectionist traits across 35 items (rated on a 5-point scale) and six subscales (concern over mistakes, personal standards, parental expectations, parental criticism, doubts about action, organization). Higher scores indicate greater perfectionism.

The Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965) includes 10 items and a 4-point scale to assess attitudes toward self. Higher scores indicate higher self-esteem.

The Satisfaction with Life Scale (SLS; Diener, Emmons, Larsen, & Griffin, 1985) uses five items on a 7-point scale to measure happiness and overall satisfaction with one's life. Higher scores indicate greater satisfaction with life.

Statistical analysis

The main analysis goals were to assess the psychometric properties of SEEDS regarding data quality, internal structure/dimensionality, internal consistency reliability, and construct validity. To evaluate data quality, descriptive summaries were generated for each SEEDS item and the frequencies examined for missing data, floor and ceiling effects, and response patterns to the "generally"/"ideally" pairs. The suitability of data was evaluated using Bartlett's test of sphericity, the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) and examining the correlation matrix. To inform internal structure/dimensionality, principal components analysis (PCA) was performed on the "generally"/"ideally" pair differences and the "generally" responses and scree plots were examined (criteria for retaining components were an eigenvalue > 1, $> 5\%$ of variance explained and clinical usefulness). Exploratory factor analysis with promax rotation was conducted to examine factor loadings of items and communalities (criteria for retaining items were rotated factor loadings ≥ 0.5 on one and only one factor, communality ≥ 0.30, item/factor interpretability and usefulness). Internal consistency reliability was measured by Cronbach's alpha for the questionnaire overall and each subscale as well as corrected item-total correlations and Cronbach's alpha if the item was deleted. Cronbach's alpha ≥ 0.50 was considered moderate consistency and ≥ 0.70 was considered high consistency. Construct validity was comprised of convergent and divergent validity testing. Pearson's product-moment correlations were used to assess convergent validity between SEEDS subscales and externally validated measures. Divergent validity was assessed by evaluating the relationship between SEEDS subscales and demographic and clinical information. Correlation coefficients $\geq |0.70|$ indicated high convergent validity and $\leq |0.30|$ indicated high divergent validity. Participants with missing data were excluded from

analyses. p values < .05 were considered statistically significant. Analyses were conducted using SAS 9.3 software (SAS Institute Inc., Cary, NC).

Scoring

A two-step approach was taken to determine SEEDS cut-off scores for low, moderate, and high risk of an eating disorder. The first step established the likelihood of each participant currently having an eating disorder diagnosis based on the *DSM-5* eating disorder diagnostic criteria, previous research using the EDE-Q responses as proxies to the DSM-5 criteria (Berg et al., 2012) and previous work on the influence of having type 1 diabetes on responses to the questions in the EDE-Q (Powers et al., 2013). Specifically, each participant was categorized into one of three eating disorder diagnostic categories based on their body mass index and EDE-Q responses as proxies to the *DSM-5* eating disorder criteria (for mapping strategy, see Supplemental Table 1): *Probable Eating Disorder* (Anorexia Nervosa, Bulimia Nervosa, Binge Eating Disorder, Other Specified Eating Disorder and Unspecified Eating Disorder categories based on adapted diagnostic criteria), *Possible Eating Disorder* (individuals who report eating disorder symptoms but do not currently meet criteria for a full threshold eating disorder), and *No Eating Disorder* (no symptoms of an eating disorder).

The second step identified SEEDS cut-off scores for levels of eating disorder risk using the eating disorder diagnostic categories from the first step. Specifically, SEEDS subscale and total scores were summarized for the eating disorder diagnostic categories. It was hypothesized that participants in the *Probable Eating Disorder* category would have the highest SEEDS scores while participants in the *No Eating Disorder* category would have the lowest SEEDS scores and that these summaries of SEEDS scores by eating disorder diagnostic category could inform three levels of eating disorder risk: Low risk, Moderate risk and High risk. It should be noted that SEEDS cut-off scoring does not diagnose an eating disorder; rather identifies level of risk.

Results

Factor analysis

Based on participant feedback from the cognitive interviews and supported by descriptive summaries revealing substantial ceiling effects, the "ideally" responses were dropped from consideration in the factor analysis. Using only the "generally" items, the data were found to be suitable for PCA (Bartlett's test of sphericity p value < .001; KMO value = 0.942; and many correlation coefficients > |0.30|). PCA suggested a three-factor model with three

components having an eigenvalue > 1, explaining 78.7%, 16.9% and 4.4% of the variance respectively. Evaluation of the scree plot confirmed that three factors were appropriate. Correlation coefficients between the three factors were moderate to high (factor 1 vs. factor 2 = 0.49; factor 1 vs. factor 3 = 0.57; and factor 2 vs. factor 3 = 0.70). As the factors were correlated, an exploratory factor analysis with promax rotation was conducted. Within these three factors, corrected item-total correlations were strong: correlations between items and the *Body Image* subscale ranged from 0.67 to 0.84; for the *Feelings* subscale ranged from 0.55 to 0.80; and for the *Quality of Life* subscale ranged from 0.62 to 0.72. Additionally the ceiling and floor effects of each subscale were favorably small (*Body Image* 1.43% ceiling, 1.43% floor; *Feelings* 0.00% ceiling, 0.00% floor; *Quality of Life* 2.15% ceiling, 0.00% floor).

The 20 items retained in the final SEEDS instrument were divided almost equally among the three factors leaving one factor with six items and two factors with seven items (see Table 2). The items in the first factor, *Body Image*, related to body shape, size, weight and appearance. The second factor, *Feelings*, included items about mood and feeling. The third factor, *Quality of Life*, is comprised of items related to self-worth, value, and quality of life. The final version of SEEDS is free for clinical and research use (see Figure 2 and www.internationaldiabetescenter.com).

Table 2. Final SEEDS items and rotated factor loadings.

SEEDS item	Factor 1: Body image	Factor 2: Feelings	Factor 3: Quality of life
How often do you think about your body shape and size?	.89*	−.01	−.14
How satisfied are you with your body size?	.88*	−.02	.05
How satisfied are you with your body shape?	.84*	.03	.07
How often do you compare how you look to those around you?	.74*	−.06	−.03
How satisfied are you with how you look?	.70*	.08	.22
How do you feel when others around you talk about body shape and size?	.65*	.05	.12
How would your family members describe your mood most of the time?	.02	.89*	−.17
How do you describe your mood?	.07	.73*	.13
How would your friends describe you?	−.25	.63*	.16
How well do you manage your stress?	.13	.63*	.09
How do you usually feel?	.01	.62*	.27
How do you describe your moods?	.13	.60*	.06
How well do you handle your feelings?	.08	.59*	.17
How often do you feel your life is valuable?	.02	.04	.82*
How much do you think you matter to your friends?	−.01	.06	.66*
How much do you think you matter to your family?	.04	−.03	.65*
How satisfying is your life?	.04	.21	.63*
How often do you think you meet the expectations your family has for you?	.17	.12	.52*
How well do you fit in with your friends?	−.05	.29	.51*
How often do you feel in control of your life?	.08	.29	.51*

Note. * Values ≥ 0.50; the asterisk indicates on which of the three factors/subscales the item loads.

SEEDS

These questions ask about you, your life and your health.
Please read each question carefully and answer honestly. Mark your answer by filling in one circle.

1.	How do you usually feel?	Very sad	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very Happy
2.	How would your friends describe you?	Grumpy	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Cheerful
3.	How often do you compare how you look to those around you?	All the time	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Not at all
4.	How well do you fit in with your friends?	Not very well	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very well
5.	How often do you feel in control of your life?	Never	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Always
6.	How satisfied are you with how you look?	Very dissatisfied	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very satisfied
7.	How satisfying is your life?	Very unsatisfying	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very satisfying
8.	How well do you handle your feelings?	Poorly	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very well
9.	How would your family members describe your mood most of the time?	Grumpy	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Cheerful
10.	How often do you feel your life is valuable?	Never	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Always
11.	How well do you manage your stress?	Poorly	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very well
12.	How often do you think about your body shape and size?	All the time	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Not at all
13.	How do you describe your mood?	Grumpy	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Cheerful
14.	How satisfied are you with your body shape?	Very dissatisfied	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very satisfied
15.	How satisfied are you with your body size?	Very dissatisfied	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very satisfied
16.	How do you describe your moods?	Up and down	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Steady
17.	How much do you think you matter to your family?	Not at all	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very much
18.	How do you feel when others around you talk about body shape and size?	Uncomfortable	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Comfortable
19.	How much do you think you matter to your friends?	Not at all	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Very much
20.	How often do you think you meet the expectations your family has for you?	Never	O_7	O_6	O_5	O_4	O_3	O_2	O_1 Always

Figure 2. Screen for Early Eating Disorder Signs (SEEDS) instrument. © Park Nicollet Institute. All rights reserved. See www.internationaldiabetescenter.com.

Final SEEDS instrument: Reliability and validity

SEEDS demonstrates excellent psychometric properties including sound reliability (Cronbach's alpha: Overall = 0.95, *Body Image* = 0.92, *Feelings* = 0.90, and *Quality of Life* = 0.90) and strong convergent and divergent validity attributes (see Table 3). For convergent validity, SEEDS subscales were highly and significantly

Table 3. Pearson correlation coefficients between SEEDS and other measures and variables used to determine convergent and divergent validity.

SEEDS construct or total score	Convergent validity	r (*p* value)	Divergent validity	r (*p* value)
Body image	EDE-Q shape concerns subscale	+ 0.863 (< .001)	Current age	+ 0.231 (.001)
	EDE-Q weight concerns subscale	+ 0.846 (< .001)	Age at T1D diagnosis	+ 0.115 (.055)
Feelings	CES-D (Depression) Scale	+ 0.743 (< .001)	Current age	+ 0.177 (< .001)
	Rosenberg Self-Esteem Scale	- 0.729 (< .001)	Age at T1D diagnosis	+ 0.077 (.200)
Quality of life	Satisfaction with Life Scale	-–0.772 (< .001)	Current age	+ 0.277 (< .001)
	Diabetes Distress Screening Scale	+ 0.452 (< .001)	Age at T1D diagnosis	+ 0.133 (.027)
	Rosenberg Self-Esteem Scale	- 0.815 (< .001)		
SEEDS total score	EDE-Q Dietary Restraint	+ 0.491 (< .001)	Current age	+ 0.266 (< .001)
	EDE-Q Eating Concerns	+ 0.616 (< .001)	Age at T1D diagnosis	+ 0.132 (.032)
	EDE-Q Shape Concerns	+ 0.726 (< .001)		
	EDE-Q Weight Concerns	+ 0.706 (< .001)		

correlated (all p < .0001) with independent measures of same or similar themes (observed correlations ranged from +0.47 between the SEEDS *Quality of Life* factor and the Diabetes Distress Screening Scale to +0.86 between the SEEDS *Body Image* factor and the EDE-Q Shape Concerns subscale; inverse correlations ranged from −0.73 for the SEEDS *Feelings* factor and the Rosenberg Self-Esteem scale to −0.82 for the SEEDS *Quality of Life* factor and the Rosenberg Self-Esteem scale). For divergent validity, subscales were appropriately poorly correlated (all < |0.30|; range from 0.09 to 0.28) with two demographic values (current age and age at type 1 diabetes diagnosis) conceptually unrelated to SEEDS factors.

Final SEEDS instrument: Scoring

Total and subscale scores for SEEDS were calculated as the sum of scores across items (20 items each with 1–7 point Likert scale). Total scores range from 20 to 140. Subscale scores range from 6 to 42 for the *Body Image* subscale and from 7 to 49 for the *Feelings* and *Quality of Life* subscales. Lower scores indicate low or no eating disorder risk; moderate scores indicate possible risk and higher scores indicate greater risk for an eating disorder. The average total SEEDS score (and SD) for the validation sample was 63.2 (22.4) with a range from 23 to 135 and a median score of 58.0. The average subscale score (and SD) for *Body Image* was 22.4 (9.2), for *Feelings* was 22.6 (8.2), and for *Quality of Life* was 18.3 (8.4).

After assigning participants into eating disorder diagnostic categories (see Supplementary Table 1), 7.8% were assigned to the *Probable Eating Disorder*

category, 34.0% to the *Possible Eating Disorder* category, 58.2% to the *No Eating Disorder* category and 0.8% could not be assigned due to missing data. As anticipated, total SEEDS scores were lowest for the *No Eating Disorder* category (mean = 52.3; *SD* = 15.6) and highest for the *Probable Eating Disorder* category (mean = 85.3; *SD* = 21.0), indicating SEEDS scores behave as expected and are positively associated with the presence of disordered eating and weight/shape concerns. Thus, the total SEEDS score can be used to inform levels of eating disorder risk.

SEEDS scoring cutoffs for Low, Moderate, and High Risk were set, respectively, at ≤ 1 standard deviation, > 1 to ≤ 2 standard deviations, and > 2 standard deviations above the mean of the total SEEDS score for the *No Eating Disorder* diagnostic category (rounded to the nearest integer). Specifically, scores ≤ 68 defined those with Low Risk, scores 69 to 84 defined those with Moderate Risk, and scores ≥ 85 defined those with High Risk (see Table 4).

Using these SEEDS cut-off scores, there were 174 (64.9%) participants with Low Risk, 42 (15.7%) with Moderate Risk and 52 (19.4%) with High Risk of

Table 4. Eating disorder risk: SEEDS scoring interpretation and clinical recommendations.

SEEDS scoring category and SEEDS total score	SEEDS scoring interpretation and clinical recommendations
Low risk *SEEDS total score ≤ 68*	This individual appears to have minimal risk for an eating disturbance. However, we recommend regular screening, at least annually, to detect meaningful changes that may arise during adolescence and adulthood. In addition, we encourage opportunities for regular discussion at appointments by asking open-ended questions such as, "Tell me something that has been going well in your life? What areas of your life cause you stress or worry?"
Moderate risk *SEEDS total score 69–84*	This individual may have concerns present in his or her life that have been found in the literature to be associated with eating disturbances. Further discussion is recommended to inquire about areas of concern that may include body dissatisfaction, difficulty managing feelings, and compromised quality of life. We recommend asking open-ended questions such as, "What level of satisfaction do you have with your looks? In what situations do you have the most trouble with your feelings? What level of satisfaction do you have with your life?" Follow-up discussions and further assessment of eating disorder risk are encouraged at future appointments within a year.
High risk *SEEDS total score ≥ 85*	This individual has strong concerns present in his or her life that have been found in the literature to be associated with eating disturbances. Further discussion is highly recommended to inquire about body dissatisfaction, difficulty managing feelings, and compromised quality of life; an evaluation for the presence of an eating disorder may be indicated. We recommend asking open-ended questions such as, "What level of satisfaction do you have with your looks? In what situations do you have the most trouble with your feelings? What level of satisfaction do you have with your life?" and considering a referral for an eating disorder evaluation. Follow-up discussions and further assessment of eating disorder risk are strongly encouraged at future appointments within a year.

an eating disorder. As an additional confirmation of the scoring, we compared the SEEDS risk category for each participant to their assigned eating disorder diagnostic category (*No, Possible* or *Probable Eating Disorder*). Of those participants in the *No Eating Disorder* category, 85.1% were identified by SEEDS as Low Risk, 10.4% as Moderate Risk, and 4.6% as High Risk, meaning SEEDS accurately ruled out those with no currently active eating disorder. Of those participants in the *Possible Eating Disorder* category, 41.8% were identified by SEEDS as Low Risk, 22.0% as Moderate Risk and 36.3% as High Risk. Finally, of those in the *Probable Eating Disorder* category, 19.1% were identified by SEEDS as Low Risk, 28.6% as Moderate Risk and 52.4% as High Risk. Thus, the SEEDS total score cut-offs appropriately identified 81.0% of those with a probable eating disorder diagnosis as either moderate or high risk according to SEEDS, and identified 85.1% of those with no eating disorder diagnosis as low risk according to SEEDS.

Discussion

This study developed and validated a non-suggestive screen for early eating disorder signs initially for use among individuals with type 1 diabetes. The use of this screen is critically important for several reasons: 1) complications and mortality increase when someone has type 1 diabetes and an eating disorder (Goebel-Fabbri et al., 2008; Rydall, 2002; Wisting et al., 2013); 2) the complexity of the treatment regimen increases dramatically when both conditions are present (Colton et al., 2013; Gagnon et al., 2012); 3) general eating disorder questionnaires include items that could be misinterpreted by individuals with type 1 diabetes (Powers et al., 2013); and 4) general eating disorder and diabetes-specific questionnaires that are presently available include suggestive behaviors (insulin omission, laxative use) (Markowitz et al., 2010; Rodin et al., 1991; Zuijdwijk et al., 2014). Specifically for diabetes-specific questionnaires, the SCOFF (Hill, Reid, Morgan, & Lacey, 2010) and its version modified for diabetes (mSCOFF), have solid psychometric properties yet include questions suggestive of specific behaviors to reduce weight (e.g., "Do you make yourself sick because you feel uncomfortably full?" and "Do you ever take less insulin than you should?"). Furthermore, none of these generic or diabetes-specific instruments detect eating disorder symptoms before the individual is engaging in those symptoms, and they may unintentionally increase knowledge and promotion of unhealthy weight management. Thus, the current multi-phase research focused on identification of *early* eating disorder signs and sought a solution for identifying at-risk individuals.

The current study relied on the wisdom of numerous sources of information across multiple phases of construct and item development and was successful in its aims. SEEDS is a brief (20-item; 2–5 minutes to complete),

self-administered screen designed for use in clinical practice or research to identify or confirm suspicions of early eating disorder risk. SEEDS has strong psychometric properties, and includes three factors relevant to eating disorders: Body Image, Feelings, and Quality of Life. Although many agree that routine screening of disordered eating among individuals at higher risk is important (such as those with type 1 diabetes; Crow et al., 1998; Hanlan et al., 2013; Kelly et al., 2005; Wisting et al., 2013; Young et al., 2013), the current researchers are not aware of any psychometrically-sound screens that are designed to detect *precursors* to eating disorder symptoms. The aim of SEEDS is to fill this critical void.

The use of a screen for detecting early eating disorder risk in clinical settings provides several opportunities. First, completion of SEEDS may help health care professionals start conversations with individuals with and without type 1 diabetes about body image, management of feelings and stress, and overall quality of life. Although patients with type 1 diabetes are more regularly seen by physicians than their peers without chronic conditions, the length of appointments may seem too brief to discuss topics of importance outside of diabetes management as health care professionals aim to meet health care and patient demands. Thus, this brief screen may help facilitate important discussions related to weight, shape/size and body image, emotional health, and overall life satisfaction.

Second, regular administration of SEEDS may identify education and training topics for staff. For example, if scores on the SEEDS Feelings factor are regularly low within a clinic population, diabetes and other health educators may choose to provide focused interventions on managing feelings and stress. Interventions could be provided on an individual, group or family format, and be instrumental in mitigating a variety of psychological concerns.

Third, and the primary aim of the SEEDS instrument, is to identify those individuals who may be at moderate or high risk for an eating disorder *prior to* the commencement of weight-control behaviors that can significantly compromise physical and psychological health. As stressed earlier and particularly relevant to the current study population, the dual diagnosis of type 1 diabetes and an eating disorder significantly compromises the treatment and physical health of the individual. Early identification and intervention are critical toward reducing the significant morbidity and mortality associated with the dual diagnosis (Chiang et al., 2014). We have provided suggestions on open-ended, probing, and non-suggestive questions for health care professionals to use with patients based on their level of eating disorder risk (see Table 4).

Finally, we encourage discussions pertaining specifically to diabetes care, such as asking patients to describe difficulties they are experiencing with incorporating diabetes care into their lifestyle and daily activities, managing

dietary recommendations, following their insulin administration protocol, and navigating changes to their body, including but not limited to changes in body shape and size. Asking these questions may open the door for thoughtful and helpful discussions between the patient and healthcare professional while avoiding direct questions that could suggest the need for weight loss or dietary restriction.

SEEDS was methodically developed with strong reliance on patient input and with thorough and critical review by a panel of experts. SEEDS is unique in its aim to identify precursors to the onset of eating disturbances and has been validated for use among individuals with type 1 diabetes. The use of a sample of male and female patients with type 1 diabetes, along with the dual diagnosis subset of those with type 1 diabetes and an eating disorder, augments the quality of the constructs and richness of items. We encourage the use of SEEDS in longitudinal prospective studies to determine its overall precision in identifying level of risk and to verify cut-off scores. Additionally, since there are no specific diabetes-related items in SEEDS, future research could examine the utility of SEEDS in other high-risk populations as well as the general population of adolescents with the same aim—to identify those at risk of developing an eating disorder so early intervention can be initiated.

Conclusion

This study utilized a carefully constructed methodology to develop a valid screen for early eating disorder signs that is convenient for use in clinical settings without suggesting weight management behaviors that could influence eating disorder development. SEEDS includes 20 items across three themes—Body Image, Feelings and Quality of Life—and demonstrates sound psychometric properties. Future research should explore the use of SEEDS to evaluate the utility of this screen to identify at-risk individuals.

Acknowledgements

Thank you to the study participants for sharing their experiences, and to Rebecca Passi, MS, RD, Cassie Miller, BS, and Kimberly Gunyou, RD for study coordination.

Funding

This work was supported by a grant from the Park Nicollet Foundation. The study is registered through ClinicalTrials.gov (NCT00948311).

Supplemental

A supplemental file for this article that identifies the strategy by which DSM-5 diagnostic criteria were mapped to self-report instruments and other metrics for use in determining eating disorder status is available at the publisher's website, at http://10.1080/10640266.2015.1090866

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