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The Factor Structure of the Anorexia Nervosa Inventory for Self-Rating in a population-based sample and derivation of a shortened form

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Abstract The Anorexia Nervosa Inventory for Self-Rating (ANIS) was the first instrument covering aspects of the general psychopathology of eating disorders alongside eating attitudes, but its factorial integrity in non-clinical samples has not yet been investigated. Thus, this report is aimed at assessing the factorial structure of the ANIS with different methods of extraction and rotation. Data from a population-based random sample of German-speaking Italian schoolgirls aged 11–20 years (n = 1402) were used. The instruments included the ANIS and the Eating Behaviour Severity Scale. The internal consistency (Cronbach's α of the ANIS and four of its subscales was 0.70–0.88; however, reliability of the subscales "Sexual Anxieties" and "Obsessive–Compulsive Traits" was doubtful in non-clinical female adolescents. The original six factors were convincingly replicated by maximum likelihood extraction and principal component analysis. As some items and subscales showed weaknesses, a shortened 20-item version was derived containing the subscales "Figure Consciousness", "Feelings of Inadequacy", "Adverse Effects of Meals", and "Bulimia". All items showed factor loadings > 0.50 and item-total-correlations between 0.30 and 0.80. Internal consistency of the ANIS-20 total scale (0.90) was remarkable as it was for the subscales (0.70–0.85); discriminant validity as assessed by a cross-validational approach (random split-half samples) was not affected by this abbreviation. In conclusion, both the original ANIS and the ANIS-20 are psychometrically sound instruments. Because brevity is important in screening studies, the short form is recommended.

Key words Anorexia nervosa · Inventory for Self-Rating · Factor analysis · Discriminant analysis · Adolescent girls · Population at risk

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Introduction

The Anorexia Nervosa Inventory for Self-Rating (ANIS), a German instrument, has been developed by Fichter and Keeser (1980) for the assessment of anorexic attitudes and symptoms by self-report. By tackling some dimensions of the general psychopathology found in eating disordered (ED) subjects, the ANIS was the *first* ED instrument assessing more than crude eating attitudes. As a first step of test construction the initial pool (152 items) was restricted after discussions with experts and anorexia nervosa (AN) patients. Then, relying on two female AN groups (n = 55 severe and 29 less severe cases, mean age ca. 24 years), a group of female high school student controls (n = 117; age 20 ± 1.6 years), and the combined group of cases and controls (n = 201) the remaining 48 items were subjected to factor analysis applying maximum likelihood extraction followed by Varimax rotation. Because the two clinical samples were small, the final factor structure was based on the combined samples of AN and controls. Apart from item 8, which was considered to be clinically meaningful, only items with factor loadings > 0.40 were retained. This left 31 items forming six subscales covering figure conscious and weight-phobic behaviour (FIG), feelings of inadequacy (INAD), obsessive-compulsive traits (OBS), adverse effects of meals and drive to vomit after eating (ADV), fear of sexual intimacy (sexual anxieties, SEX), and loss of control over eating; i.e. bulimia (BUL). This factor solution accounted for a total of variance of 60% in controls, and 70–72% in AN patients, severe AN cases and the combined samples. Both in anorexics and controls subscale intercorrelations were significant, except for OBS and SEX. In anorexics the internal consistency (Cronbach's α) of the ANIS and its subscales was above 0.84 with the exception of OBS (α = 0.66). In controls, reliability was somewhat lower: 0.87 (FIG), 0.85 (INAD), 0.57 (OBS), 0.68 (ADV), 0.64 (SEX), 0.82 (BUL) and 0.89 (total score). Similarity rotation of the final factor solution revealed high congruence coefficients with those for anorexics (r = 0.96) and controls (r = 0.88), and un-

derlines construct validity of the ANIS. Its discriminant validity became evident by the high rate of correct classifications of controls vs severe AN cases based on the total score (88%), or total score and additional weight parameters (94.8%). Furthermore, criterion validity of the ANIS is indicated by significant correlations of several subscales with weight parameters: in controls weight showed a positive relation to FIG and BUL, and in AN cases inverse correlations were found with FIG and SEX. However, interview validation placed some doubt on the validity of the subscales OBS and BUL, lacking congruence with the respective sections of the Structured Interview for Anorexia and Bulima nervosa (Fichter et al. 1991).

Since most of its subscales exhibit sufficient reliability and validity, the ANIS has been widely used in German-speaking countries for diagnostic purposes and treatment follow-up (Fichter 1985; Rathner 1986; Rathner et al. 1993), and in epidemiological studies (Rathner and Messner 1993; Rathner and Rumpold 1994; Rathner et al. 1995). Recently, norms for German-speaking female adolescents have been presented (Rathner and Rainer 1997). In addition, it has been applied in Dutch (Weeda-Mannak and Drop 1985; Weeda-Mannak et al. 1983), Hungarian (Rathner et al. 1995), Greek (Fichter et al. 1983), and Turkish (Fichter et al. 1988) versions. An English version is available (Fichter 1990).

Despite its wide use, the psychometric soundness of the ANIS has only been proven regarding internal consistency and concurrent (Rathner and Messner 1993) and convergent/divergent validity (Rathner and Rumpold 1994). Replicative factor analytic studies on the ANIS are still lacking both in clinical and non-clinical samples. As several studies (Wells et al. 1985; Koslowsky et al. 1992; Eisler and Szmukler 1985; King and Bhugra 1989) have shown for the Eating Attitudes Test (Garner and Garfinkel 1979), and Welch et al. (1990), Schoemaker et al. (1994), and Eberenz and Gleaves (1994) have shown for the EDI (Garner and Olmsted 1984), the factor structure can be different for clinical and non-clinical samples, and samples differing in age or location. Thus, derived from a combined and even small sample of anorexics and controls, the ANIS's factorial structure raises some doubts.

This study investigates the factorial integrity of the ANIS in a non-clinical German-speaking at-risk population following two aims: firstly the replication of the original factor structure by application of the methods used by Fichter and Keeser (1980), and secondly the examination of the factor solution (explained variance, easy interpretation) applying different methods of extraction and rotation. This was done stepwise: firstly, an exploratory factor analysis without restriction on the number of factors was performed to test whether the original factor solution could be replicated in an epidemiological sample. Secondly, the factors were forced into a six-factor solution using three different methods [maximum likelihood (ML) extraction followed by Varimax rotation and principal component analysis (PCA) followed by Varimax and oblique rotation]. This was aimed at testing the similarity of the factor structure in a population-based sample fulfilling sample size criteria suggested by Nunnally (1978). The last step of analysis was dedicated to the shortening of the instrument following psychometric considerations.

Subjects and methods

The data used stem from an ongoing longitudinal epidemiological study on the natural history of normal and disordered eating in the female population at risk. The study design has been reported elsewhere (Rathner and Messner 1993). This report is based on the data of the repeated cross-section of this study done in 1993–1994: All schoolgirls of the local German-speaking schools of Brixen/Bressanone in Southern Tyrol, Italy (aged 11–20+ years), were assessed. All schools – three secondary schools (sixth to eighth grade, 11–14 years), three high schools (ninth to thirteenth grade, 15–19 years), and two vocational schools (15–20 years) – were state and mixed-gender schools. An active parental consent procedure was used.

The test battery included the ANIS (Fichter and Keeser 1980), the Eating Behaviour Severity Scale (EBSS; Rathner et al. 1993) measuring the frequency of disturbed eating behaviours (dieting, bingeing, use of diet pills, laxatives, diuretics, vomiting and exercising), and a questionnaire on sociodemographic data and weight history (Rathner and Messner 1993). The BMI and percentage of reference weight (Schlaf and Pudel 1983) were calculated based on measured weight and height (in clothes, without shoes).

Data analysis

Answers to the ANIS items were coded 0–5 according to the test authors, a higher score indicating increased pathology. All computations were based on completely answered ANIS-31 questionnaires (n = 1226). Internal consistency (Cronbach's α, Cronbach 1951) of the scales was determined with and without exclusion of each single item. To assess item' quality, corrected-item total correlation (ITC, referring to ANIS total score) was calculated. As indicators of criterion validity Spearman correlation coefficients were calculated for the ANIS scales and the frequency of dieting, exercising and bingeing according to the EBSS. Probability level was set at $p < 0.05$. For multiple correlations Bonferroni adjustment was made to maintain the experiment-wise type-I error at 0.05. Comparison of group means was done with t-test for independent samples.

Suitability of ANIS-31 for factor analysis was tested with the Measure of Sampling Adequacy (MSA; Kaiser and Rice 1974) indicating high adequacy (0.91). In a first step, exploratory factor analyses were performed (ML followed by Varimax rotation and PCA followed by Varimax and oblique rotation), extracting factors with eigenvalues > 1.00. Secondly, these analyses were repeated limiting the number of extracted factors to six, to permit comparison with the original factor solution by Fichter and Keeser (1980).

The subsequent analysis of the ANIS was aimed at improving its psychometric properties (reliability, validity and economy); thus, we excluded items (a) which showed ITC outside the recommended range 0.3–0.8 (Lienert 1989; p 295), (b) which showed factor loadings < 0.40 in any of the extracted six-factor solutions and (c) items showing multiple factor loadings > 0.40. As MSA for the remaining items still proved high (0.92), a final factor analysis was performed. PCA followed by Varimax rotation was chosen, as it explains a maximum of variance reducing the correlation matrix to a minimum number of orthogonal factors (Lienert 1989, p 546).

Discriminant validity of both the original ANIS and the abbreviated version was tested following a cross-validational approach, i.e. performing discriminant analyses with two random split-half samples (n = 613), the first to derive the discriminant functions, and the second to test them. Random samples were equal in percentage of reference weight and age (t-test), even after exclusion of subjects with missing grouping code or reference weight. Groups going to be discriminated (dieters vs non-dieters, weight

preoccupied vs not weight preoccupied) were built according to subjects' answers to items *not* part of the ANIS: "I'm currently trying to lose weight" (yes/no); "Now I feel too fat or partly too fat/normal or too thin". The discriminant functions comprised the respective scale score and the percentage of reference weight. Age was skipped from the discriminant function because its F-value was insignificant (< 3.84). Chi-square measure was used to test differences in the classification rates derived for the two samples.

Results

Sample characteristics and ANIS (sub)scale scores

The participation rate was 86.9%, including 1402 of 1614 enrolled schoolgirls. This report is based on subjects providing a completely answered ANIS-31 (n = 1226; 87.4%). Most of them attended high schools (n = 744; 60.7%), 315 (25.7%) attended secondary schools, and 167 (13.6%) attended vocational schools. The sample was in a normal weight range with a mean age of 15.9 years; ANIS scale scores are shown in Table 1. A comparative analysis of excluded subjects (n = 176) with those providing a fully completed ANIS-31 (n = 1226) showed no differences in weight, current dieting, and weight preoccupation. There was only a significant age difference, the missing-data subgroup being slightly younger. This suggests that the exclusion of subjects with missing data was unlikely to bias our results.

Table 1 Sample characteristics[a]

	n	Mean	SD	Range
Age (years)[b]	1219	15.9	2.5	11.0–30.9
Height (cm)	1223	163.5	7.6	133.0–182.0
Current weight (kg)	1225	53.8	9.5	26.4– 90.3
In % of reference weight[c]	1222	105.8	14.6	67.7–226.9
BMI	1222	20.0	2.8	13.0– 38.6
Maximum weight ever (kg)	1167	55.4	10.2	26.4– 90.3
In % of reference weight[c]	1164	109.0	15.7	75.8–232.6
BMI	1164	20.7	3.0	13.6– 39.6
Desired weight (kg)	1138	50.6	7.2	18.0– 79.0
In % of reference weight[c]	1135	99.6	9.9	34.6–201.0
BMI	1135	18.9	1.8	6.6– 34.2
Maximum weight last year (kg)	1071	55.0	9.9	26.0– 89.0
In % of reference weight[c]	1068	108.1	15.5	74.2–232.6
BMI	1068	20.5	3.0	13.5– 39.6
ANIS total score	1226	37.8	19.2	4 –139
Figure Consciousness	1226	13.0	9.4	0 – 46
Feelings of Inadequacy	1226	6.7	5.9	0 – 35
Obsessive–Compulsive Traits	1226	10.8	4.2	0 – 25
Adverse Effects of Meals	1226	2.7	3.3	0 – 20
Sexual Anxieties	1226	2.5	2.6	0 – 15
Bulimia	1226	2.1	2.4	0 – 10

[a] Sample size restricted to n = 1226 completely answered ANIS-31
[b] 9 subjects ≥ 21 years
[c] Reference weight according to Schlaf and Pudel (1983)

Analysis of reliability, item-total correlation and validity of ANIS-31

The ANIS total score and the subscales FIG and INAD showed satisfactory internal consistency ($\alpha > 0.80$). Whereas Cronbach's α for the subscale ADV (0.75) was sufficient, the reliabilities of the subscales BUL (0.70), SEX (0.59) and OBS (0.48) showed much less common variance. Significant positive intercorrelations of the ANIS subscales, except for SEX and OBS, were found (Table 2). The latter subscales seem to measure totally different constructs.

Three of the four items the exclusion of which increases the internal consistency of the total score belong to the five-item subscale OBS (items 1, 11, 13), and the fourth item to the three-item subscale SEX (item 18; Table 3). Each of the subscales OBS (item 8), ADV (item 17) and SEX (item 18) contains one item decreasing internal consistency of the subscale. Only items of the subscales OBS and SEX show corrected ITC outside, i.e. below the range 0.30–0.80, and therefore cannot be considered valid parts of the total scale.

All subscales except OBS and SEX show a low, but significant, positive correlation (r = 0.18 to 0.60; $p < 0.003$) with the frequencies of dieting, exercising and bingeing (EBSS). With regard to the minimum requirement for validity coefficients ($r \geq 0.30$) suggested by Lienert (1989, p. 312), the subscales measuring specific psychopathology (FIG, ADV, BUL) and the total score showed criterion validity with disturbed eating behaviour. In addition, significant ($p < 0.001$) albeit low correlations of scale scores with current weight as percent of reference weight and BMI were found for specific psychopathology subscales (FIG: r = 0.29/0.31; ADV: r = 0.14/0.15; BUL: r = 0.19/0.20), and for INAD (r = 0.14/0.15) and ANIS total score (r = 0.22/0.25).

Table 2 Intercorrelations (Pearsonian type) of ANIS-31 scales

Cronbach's α coefficients are printed in the diagonal; $p < 0.00238$ for individual correlation, i.e. experiment-wise type I error rate for all 21 comparisons < 0.05 (except for the correlation OBS-SEX); two-tailed

		1	2	3	4	5	6	7
Figure Consciousness	1	0.85	0.48	0.30	0.53	0.18	0.53	0.88
Feelings of Inadequacy	2		0.83	0.16	0.48	0.26	0.45	0.74
Obsessive-compulsive Traits	3			0.48	0.19	0.04	0.11	0.47
Adverse Effects of Meals	4				0.75	0.11	0.52	0.69
Sexual Anxieties	5					0.59	0.16	0.35
Bulimia	6						0.70	0.65
ANIS-31 total score	7							0.88

Table 3 Corrected-item total correlation *(ITC)* of ANIS-31 items

Subscales and items[a]	ITC[b]
Figure Consciousness	
3. I am afraid of becoming too fat	0.67
6. I tend to terminate a meal not when I am satisfied but rather when I have reached the limit I regard appropriate for my figure	0.45
9. I often feel hungry but try to overcome and control this feeling	0.59
12. Having a good figure is very important to me and I often check myself in a mirror	0.41
15. I try to keep up a diet and eat as little fat and carbohydrates as possible (potatoes, sweets, etc.)	0.59
19. I am not totally honest about my actual eating habits	0.52
21. Every time I succeed in fasting for a certain length of time I am proud of it	0.49
23. Occasionally I negotiate or bargain about the things I eat (e.g. I'm going to eat this, if I do not have to eat that)	0.41
27. I often hesitate and procrastinate before I start eating	0.40
29. After eating I worry about gaining too much weight	0.71
Feelings of Inadequacy	
2. Many demands are put on me which I can hardly cope with	0.40
4. Deep inside I feel inferior and helpless	0.56
14. I feel pressured by the expectations others have of me	0.48
16. I feel bloated and empty	0.51
20. I feel there is no sense in striving for achievement in life, since all may efforts will not change anything	0.36
25. Because of the many demands and expectations that others have on me, I feel that I am not the master of my life	0.49
31. I am tense and restless	0.50
Obsessive-Compulsive Traits	
1. I cannot stand boredom at all	0.17[c]
8. I have rituals, obsessions or obsessive acts concerning eating	0.54[d]
11. Compared to others I am quite conscientious and exact in whatever I do	0.03[c]
13. It is hard for me just to sit around and do nothing	0.10[c]
30. Whenever I start to do something I feel compelled to do it exactly and perfectly	0.23
Adverse Effects of Meals	
7. When I have eaten I feel sick	0.43
17. After eating I feel stuffed	0.41[d]
22. I feel less well after meals than before	0.60
28. After the meal I feel so sick that I would like to throw up	0.53
Sexual Anxieties	
5. Thinking of sexual contacts makes me feel very anxious	0.29
18. It embarrasses me to see other people sexually aroused	0.17[c, d]
26. Kissing makes me anxious	0.16
Bulimia	
10. When I start eating it can happen that I experience an irresistible impulse to eat till I burst	0.55
24. There is a point in eating at which I can hardly stop	0.50

[a] Translation of items by Fichter (1990, p. 352); numbers for items that are part of ANIS-20 are bold face
[b] ITC referring to ANIS-31 total score
[c] Exclusion of item increases internal consistency of ANIS-31 total score
[d] Exclusion of item increases internal consistency of this subscale

Exploratory factor analyses of ANIS-31 performing ML and PCA

Without restriction of the number of extracted factors, both ML (Varimax) and PCA (Varimax, oblique) revealed eight factors with eigenvalues > 1.00. Necessarily the amount of variance explained was higher for PCA (59.8%) than for ML (46.1%). The comparison of the resulting factor solutions showed almost identical factor contents with the exception of two items (items 8, 27), the main factor throughout being constituted by FIG items, the second factor always indicating an item composition identical to INAD. (Detailed results can be obtained from the corresponding author).

Factor analyses of ANIS-31 limited to six factors

Limiting the number of factors extracted necessarily reduced the amount of variance explained. Additionally, ML extraction revealed only three factors showing eigenvalues > 1.00 (FIG, INAD, ADV). The item structure of ML vs PCA components only showed differences with regard to item 8, which performing PCA built one factor

Table 4 Comparison of six-factor solutions for ANIS-31 in non-clinical samples. (*PCA* principal component analysis; *ML* maximum likelihood extraction; *%* percent variance explained)

Fichter and Keeser (1980) Item no. (factor loading)	This study Item no. [original scale (factor loading)]		
ML similarity (n = 117 controls)	ML Varimax (41.9%; n = 1226)	PCA oblique (52.9%; n = 1226)	PCA Varimax (52.9%; n = 1226)
FIGure Consciousness	Factor I (24.7%)	Factor I (26.4%)	Factor I (26.4%)
15 [0.73]	15 (FIG) [0.73]	15 (FIG) [0.76]	15 (FIG) [0.76]
29 [0.69]	29 (FIG) [0.70]	21 (FIG) [0.75]	3 (FIG) [0.72]
3 [0.68]	3 (FIG) [0.70]	3 (FIG) [0.73]	29 (FIG) [0.70]
6 [0.67]	9 (FIG) [0.60]	6 (FIG) [0.71]	21 (FIG) [0.70]
9 [0.61]	21 (FIG) [0.60]	29 (FIG) [0.67]	6 (FIG) [0.69]
21 [0.57]	6 (FIG) [0.59]	9 (FIG) [0.63]	9 (FIG) [0.69]
19 [0.53]	8 (OBS) [0.45]	12 (FIG) [0.52]	12 (FIG) [0.52]
23 [0.44]	12 (FIG) [0.43]	19 (FIG) [0.38]	19 (FIG) [0.43]
27 [0.41]	19 (FIG) [0.39]	23 (FIG) [0.28]	23 (FIG) [0.33]
12 [0.38]	23 (FIG) [0.28]		
Feelings of INADequacy	Factor II (5.4%)	Factor II (7.2%)	Factor II (7.2%)
14 [0.75]	4 (INAD) [0.70]	25 (INAD) [–0.76]	25 (INAD) [0.72]
25 [0.70]	25 (INAD) [0.65]	2 (INAD) [–0.74]	4 (INAD) [0.72]
16 [0.60]	16 (INAD) [0.63]	4 (INAD) [–0.72]	2 (INAD) [0.68]
2 [0.59]	31 (INAD) [0.58]	16 (INAD) [–0.67]	16 (INAD) [0.67]
4 [0.58]	2 (INAD) [0.57]	31 (INAD) [–0.66]	31 (INAD) [0.64]
20 [0.56]	14 (INAD) [0.53]	14 (INAD) [–0.64]	14 (INAD) [0.63]
31 [0.46]	20 (INAD) [0.48]	20 (INAD) [–0.59]	20 (INAD) [0.57]
ADVerse Effects of Meals	Factor III (3.7%)	Factor III (5.7%)	Factor III (5.7%)
22 [–0.56]	28 (ADV) [0.76]	11 (OBS) [0.63]	28 (ADV) [0.77]
7 [–0.53]	7 (ADV) [0.65]	13 (OBS) [0.62]	7 (ADV) [0.73]
17 [–0.53]	22 (ADV) [0.61]	30 (OBS) [0.62]	22 (ADV) [0.66]
28 [–0.45]	27 (FIG) [0.36]	1 (OBS) [0.61]	27 (FIG) [0.53]
			8 (OBS) [0.52]
BULimia	Factor IV (3.0%)[a]	Factor IV (5.3%)	Factor IV (5.3%)
24 [0.71]	10 (BUL) [0.60]	26 (SEX) [–0.80]	10 (BUL) [0.63]
10 [0.63]	24 (BUL) [0.55]	5 (SEX) [–0.77]	24 (BUL) [0.61]
	17 (ADV) [0.45]	18 (SEX) [–0.68]	17 (ADV) [0.60]
SEXual Anxieties	Factor V (2.7%)[a]	Factor V (4.4%)	Factor V (4.4%)
5 [0.83]	5 (SEX) [0.71]	28 (ADV) [0.82]	26 (SEX) [0.77]
26 [0.61]	26 (SEX) [0.60]	7 (ADV) [0.80]	5 (SEX) [0.76]
18 [0.47]	18 (SEX) [0.46]	22 (ADV) [0.67]	18 (SEX) [0.67]
		27 (FIG) [0.52]	
		8 (OBS) [0.48]	
OBSessive-Compulsive Traits	Factor VI (2.3%)[a]	Factor VI (3.9%)	Factor VI (3.9%)
30 [0.58]	30 (OBS) [0.53]	10 (BUL) [–0.55]	11 (OBS) [0.63]
13 [0.56]	11 (OBS) [0.52]	24 (BUL) [–0.54]	13 (OBS) [0.62]
1 [0.51]	13 (OBS) [0.37]	17 (ADV) [–0.54]	1 (OBS) [0.62]
11 [0.44]	1 (OBS) [0.37]		30 (OBS) [0.61]
8 [< 0.30]			

Factors sorted by descending percent of variance explained, items sorted by descending factor loading
[a] Eigenvalue < 1.00

dominated by ADV items, but with ML mostly corresponded with FIG items (Table 4). Item 8 also was the only item presenting relevant factor loadings (≥ 0.40) on more than one factor: performing ML, it loaded highest on the factor FIG and additionally loaded on the ADV-dominated factor; with PCA Varimax the reverse relation was found. Although the item structure was very similar, differences occurred in the variance explained by the third and subsequent factors: whereas PCA and ML followed by Varimax rotation produced identical factor rankings, PCA oblique revealed the variance explained being higher for the factors related to OBS and SEX, and lower for the factors identified as ADV and BUL.

Comparing the six factors resulting from ML in this study with the similarity-rotated factors, which Fichter and Keeser (1980) found for controls, the *congruence of factors is impressive*. Differences in factor compositions only occur in three items: originally belonging to the subscales OBS (item 8), ADV (item 17) and FIG (item 27), these items switched to factors dominated by original items

Table 5 ANIS-20: factor structure, Cronbach's α, corrected ITC and descriptives in a non-clinical sample (n = 1226) [*ITC* item-total correlation referring to ANIS-20 total scale; *FIG-20* Figure Consciousness (ANIS-20); *INAD* Inadequacy (ANIS-31/–20); *ADV-20* Adverse Effects of Meals (ANIS-20); *BUL-20* Bulimia (ANIS-20)]

Scale (factor, variance explained)	α	Item no.	Item loading	Corrected ITC	α subscale if item deleted	α total scale if item deleted	Mean ± SD
FIG-20 (factor I, 34.9%)	0.85	15	0.77	0.68	0.82	0.89	10.5 ± 7.7
		3	0.71	0.72	0.81	0.89	
		21	0.69	0.60	0.84	0.89	
		6	0.69	0.53	0.84	0.89	
		29	0.69	0.73	0.81	0.88	
		9	0.66	0.60	0.83	0.89	
		12	0.57	0.46	0.85	0.90	
INAD (factor II, 10.2%)	0.83	4	0.74	0.67	0.78	0.89	6.7 ± 5.8
		25	0.72	0.62	0.79	0.89	
		16	0.69	0.62	0.80	0.89	
		2	0.67	0.53	0.81	0.89	
		14	0.63	0.57	0.80	0.89	
		31	0.63	0.54	0.81	0.89	
		20	0.59	0.45	0.82	0.89	
ADV-20 (factor III, 7.3%)	0.80	7	0.81	0.63	0.74	0.89	1.3 ± 2.5
		28	0.80	0.69	0.69	0.89	
		22	0.70	0.65	0.75	0.89	
BUL-20 (factor IV, 5.2%)	0.70	24	0.73	0.52	0.59	0.89	3.5 ± 3.2
		10	0.71	0.59	0.51	0.89	
		17	0.63	0.43	0.70	0.89	
ANIS-20 total (57.7%)	0.90						22.1 ± 15.2

Principal component analysis with Varimax rotation revealed identical solutions without and with limitation on four factors; factors sorted by descending percent of variance explained; items sorted by descending factor loadings

of FIG (item 8), BUL (item 17) and ADV (item 27). As the test authors already reported loadings of item 27 both on FIG (0.41) and ADV (–0.35), differences seem to exist only with respect to items 8 and 17. Based on the size of factor loadings found in Fichter's joined sample of AN and controls, item 8 originally was attributed to the subscale OBS. However, as found in our ML solution in controls, item 8 primarily is related to FIG; in the face of its multiple loadings item 8 seems not very specific and decreases the fit to simple structure (Nunnally 1978). Then, item 17 ("After eating I feel stuffed") remains the last controversial item: originally belonging to the subscale ADV with an additional loading on factor OBS, each of our six-factor solutions put this item in the BUL subscale.

Construction and examination of the ANIS 20-item version

The above results on internal consistency and factor structure of the ANIS-31 indicate that the psychometric quality of the instrument might be improved by exclusion of several items and subscales, respectively. Therefore, we decided to skip those items meeting one or more of the following criteria (original item numbering in parentheses): (a) corrected ITC outside the range 0.30–0.80 (OBS: 1, 11, 13, 30; SEX: 5, 18, 26); (b) factor loading < 0.40 in any of the three six-factor solutions (FIG: 19, 23, 27); (c) factor loadings ≥ 0.40 on more than one factor (OBS: 8). Thus, the number of items was reduced to 20 (64.5% of original test length). INAD was the only subscale remaining unchanged; in contrast, the subscales OBS and SEX were totally removed.

As hypothesized, PCA (both unlimited and limited to four factors) followed by Varimax rotation revealed four factors explaining 57.7% of total variance. The minimum factor loading of items was 0.57; none of the items were found having more than one factor loading ≥ 0.40. The first three factors exclusively contained items of the original subscales FIG (factor I), INAD (factor II) and ADV (factor III). Factor IV included the original subscale BUL and also item 17. Thus, the subscales of the shortened version were labelled ANIS-20, FIG-20, ADV-20, and BUL-20. Internal consistencies with and without deletion of items and corrected ITC are depicted in Table 5. Correlations between subscales as well as correlations of subscales and total score were all significantly positive and ranged from 0.44 (FIG-20 with INAD) to 0.86 (FIG-20 with ANIS-20 total score).

All ANIS-20 scale scores increased significantly (p < 0.001) albeit moderately with current weight (percentage of reference weight or BMI), with Pearsonian coefficients approximately 0.30 for FIG-20 (0.31/0.33) and ANIS-20 total (0.27/0.29) and < 0.30 for ADV-20 (0.14/0.16) and BUL-20 (0.17/0.19). Spearman coefficients reflecting the relations between ANIS-20 and EBSS were positive: all ANIS-20 (sub)scale scores increased significantly (p < 0.001) with the frequency of dieting, exercising and bingeing, which was very similar to the ANIS-31.

Table 6 Cross-validational discriminant analysis of ANIS-31 and ANIS-20: classification of dieting and weight preoccupation

Groups N (N) Scale	Dieter 160 (132) mean (mean)	Non-dieter 421 (447) mean (mean)	Total 581 (579) % classified correctly	p (χ^2) (sample 1 vs 2)	Weight preoccuppied 314 (306) mean (mean)	Not weight preoccupied 256 (264) mean (mean)	Total 570 (570) % classified correctly	p (χ^2) (sample 1 vs 2)
FIG	22.9 (21.9)	10.1 (9.7)	80.9 (79.6)	0.58	18.7 (17.0)	8.2 (8.2)	77.9 (76.8)	0.67
FIG-20	19.1 (18.2)	8.0 (7.8)	80.0 (81.9)	0.43	15.4 (14.1)	6.4 (6.4)	76.5 (78.4)	0.44
INAD	9.7 (8.5)	6.3 (5.7)	71.9 (70.5)	0.59	8.7 (7.9)	5.3 (4.4)	70.9 (70.7)	0.95
ADV	4.9 (3.9)	2.1 (2.2)	74.4 (73.9)	0.87	3.9 (3.3)	1.7 (1.8)	70.9 (70.5)	0.90
ADV-20	3.1 (2.2)	0.9 (1.0)	76.4 (73.9)	0.32	2.3 (1.7)	0.6 (0.7)	72.6 (69.5)	0.24
BUL	3.3 (3.2)	1.7 (1.8)	71.6 (71.7)	0.98	2.8 (2.8)	1.4 (1.3)	70.4 (71.9)	0.56
BUL-20	5.1 (4.9)	2.9 (3.0)	71.1 (71.5)	0.87	4.4 (4.5)	2.5 (2.3)	70.9 (71.9)	0.69
ANIS-31	55.2 (52.2)	33.3 (32.0)	79.0 (76.2)	0.25	48.1 (44.9)	29.5 (28.0)	76.3 (76.0)	0.89
ANIS-20	37.0 (33.8)	18.0 (17.5)	81.4 (81.7)	0.90	30.8 (28.2)	14.8 (13.9)	77.9 (76.3)	0.53

Analyses refer to cases providing complete data on percentage of reference weight and respective grouping variable; for group classification see Methods; values for the confirmatory sample, i.e. for sample 2, are given in parentheses; *t*-test indicated significant group differences ($p < 0.001$) in all (sub-)scales

Discriminant analysis relying on ANIS-31 vs ANIS-20

To assess the impact of abbreviation on the ANIS' discriminant validity, we performed discriminant analyses on random split half samples. ANIS-31 and ANIS-20 proved equally accurate in the classification of group membership (weight preoccupation, current dieting). There was no difference between original and abbreviated scales in the percentage of total cases classified correctly as dieters vs non-dieters and weight-preoccupied vs not weight-preoccupied subjects (Table 6). This was found for the first and afterwards confirmed relying on the second random split-half sample, when applying the discriminant function derived from the first on the second split-half sample. Misclassification rates were found to be lowest for the subscale FIG and the total scores (18–24%), and were somewhat higher for the remaining subscales (24–30%).

Discussion

This study primarily was aimed at investigating factorial integrity of the ANIS in a population-based sample of German-speaking female adolescents using different methods of extraction and rotation. The analyses were conducted at three levels: at a *structural level* (i.e. number of significant components, proportion of variance accounted for), at a *component level* (i.e. the nature and relative weightings of the components) and at an *item level* (i.e. with regard to differences between the item structure of similar components). Another aim was the attempt to improve the psychomatric properties of the ANIS by deletion of items and subscales, which were shown to decrease reliability and validity of the total scale. To our knowledge, the factor structure of the ANIS has never been examined in a population-based sample fulfilling sample-size criteria suggested by Nunnally (1978). In addition to the large sample size, a further advantage is the use of four different factor analytic methods.

Exploratory factor analyses (ML, PCA) without limitation of the number of factors extracted always yielded eight factors, with six of them clearly being identified as one of the original ANIS subscales. Changes were found for OBS splitting into two factors ("Perfectionism", "Fear of Boredom"), and some FIG items on Bargaining about Eating, which formed one additional factor. To decrease the likelihood of fragmenting factors by basing extraction rules on eigenvalues, in a next step the expected number of factors (six) was extracted and rotated. Both ML Varimax and PCA (Varimax and oblique rotation) yielded impressively similar factor solutions, and only 3 of 31 items did not load principally with their assigned scales in all three analyses. In addition, only few items (five for ML, one and two for PCA) indicated low (< 0.40) or multiple factor loadings (> 0.40; only item 8). However, by using the same ML extraction as the test authors, only three factors (FIG, INAD, ADV) reached eigenvalues > 1.00 and total variance explained was only 41.9%, compared with 60%, which the authors reported for controls. Principal component analysis supported the structure of the original six scales, the amount of explained variance being 52.9%. Thus, given the overall sample size and the strength of the component saturation in the current study, the factor structure appears stable.

In our study the internal consistency of the ANIS-31 and four subscales was sufficient (0.70–0.88), albeit lower than reported by the test authors. However, the OBS and SEX subscales only show moderate alpha values (0.48/0.59), which is in concordance with previous less consistent results in female controls (Fichter and Keeser 1980), and female Austrian medical students (Rathner and Rumpold 1994). Significant correlations between the ANIS and several weight indices (Fichter and Keeser 1980; Rathner and Rumpold 1994; Rathner and Messner 1993) and between the ANIS and the EBSS (Rathner and Rumpold 1994) have been replicated in the present study indicating criterion validity of the instrument. However, despite their clinical relevance, the internal consistency of OBS and

SEX appeared unsatisfactory, and several items seemed to be potential candidates for deletion, as this might improve the instrument's reliability, validity, and obviously economy.

Thus, an attempt was made to derive a shortened version of the ANIS. Item analysis yielded 11 items belonging to FIG, OBS and SEX, being the candidates for deletion. When the original version was shortened by those items, four factors resulted from PCA, the factor structure of the subscale INAD alone remaining essentially unchanged. The other factors could be identified as shortened versions of FIG (7 items; FIG-20) and ADV (3 items; ADV-20), and a scale consisting of the original two-item subscale BUL with an additional item on feeling stuffed after eating originally belonging to ADV (BUL-20). The shortened version named ANIS-20 exclusively contained items contributory to total scale's and subscales' reliability, all items showing factor loadings > 0.50 and item-total correlations between 0.30 and 0.80. Internal consistency of the ANIS-20 total scale (0.90) was as remarkable as it was for the subscales (0.70–0.85). Furthermore, the abbreviation did not affect the discriminatory power both on subscale and total scale level, as shown by a cross-validational approach in two random split-half samples.

In conclusion, the ANIS is a robust instrument, suitable for application both in clinical and non-clinical samples. Some psychometric weaknesses were found for two subscales on the general psychopathology of ED, i.e. OBS and SEX. Thus, we have presented an abbreviated version, the ANIS-20, containing three subscales on the specific psychopathology of ED and one subscale assessing the core construct of AN, feelings of inadequacy. Comprehensive analysis revealed no loss of reliability and discriminant validity by this abbreviation. However, the screening capacity of the abbreviated ANIS-20 has to be tested, as screening tests in rare disorders show a notoriously low positive predictive value (Rathner and Messner 1993). In addition, the ANIS-20 has to be cross-validated in other samples. If one is specifically interested in the albeit psychometrically weaker subscales OBS and SEX, one may still use the original version. If a short and still robust instrument is needed for screening purposes, we propose the subscale FIG-20, or the multidimensional ANIS-20 as the preferable instruments.

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