



## Research article

## The Night Eating Questionnaire through the lens of the Rasch model

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## ABSTRACT

Previous research focused on the conventional approaches to test psychometric characteristics of the Night Eating Questionnaire (NEQ). The purpose of this research was to examine the psychometric properties of the Night Eating Questionnaire using the Rasch model in a sample of university students. The study was carried out from November 2018 to March 2019 on 300 students in health sciences at the University of Pristina temporarily seated in Kosovska Mitrovica, who completed the NEQ. A confirmatory factor analysis (CFA) suggested that the Serbian version mirrored the original NEQ structure: Goodness of fit index = 0.978, Comparative fit index = 0.996, Tucker-Lewis index = 0.995, Root Mean Square Error of Approximation = 0.011 and Standardized Root Mean Square Residual = 0.057. The Cronbach's alpha coefficient for the total scale was 0.627. The Rasch analysis showed that the item separation index classified the items into six groups based on their level of difficulty. The person reliability index separated well night eaters from day eaters. Few items did not fit the adequate range for the infit/outfit statistics. Overall, there were several groups of NEQ items that have a distinctive difficulty level, but the difference was not a remarkable one. This means that most students did not have night eating syndrome (NES), despite various levels of item difficulty. The NEQ performs well in the efforts to distinguish people who eat and do not eat at night. Most students reported conventional eating

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patterns and only a few had NES. The properties of the NEQ warrant its use in further night eating research.

## 1. Introduction

In efforts to identify the night eating syndrome (NES), a disorder of food intake characterized by meal skipping in the morning and increased food intake in the evening/night [1], a Night Eating Questionnaire (NEQ) has been developed [2]. Thus far, the NEQ has been used in a variety of settings [3–10] and their psychometric testing has shown good reliability and reproducibility. Nevertheless, previous research focused on the conventional methods (i.e. classical test theory) to examine psychometric characteristics of the NEQ. These include calculations of the Cronbach's alpha coefficient, as well as the exploratory and confirmatory factor analyses [3–7]. While these estimates are relevant, there are alternative methods to assess psychometric properties of questionnaires, such as the Rasch analysis [11].

The Rasch analysis (or Rasch model) is the most commonly used method of the item response theory. The Rasch model allows the observer to test the level of difficulty of items in a questionnaire as well as provide information about the questionnaire targeting and precision. Additionally, item-level difficulty can be observed relative to the responder's ability. For this reason, the Rasch analysis has been used to develop different patient-reported outcome measures [12,13]. Over the recent years the Rasch model has been applied in food addiction research [14], food literacy [15] and eating attitudes [16] and behaviors [17]. The original NEQ in English language was developed using the classical test theory [8]. Thus far, the Rasch model has only been used to test the NEQ in the Korean population [8]. However, the original study presented those results in Korean language only, rendering the interpretation of study findings difficult for the international readership. This study is, therefore, the first to offer the Rasch analysis of the NEQ in the English language.

University students comprise an overall healthy young adult population. While the prevalence of NES in the general population is approximately 1.5 % [18], estimates suggest that the prevalence of NES among university students ranges from 4.2 % to 10 % [19,20], although night eating *per se* may be more common. Occasionally, the NES resulting from psychological distress can interfere with school achievements as well as with the overall health and well-being [21]. For this reason, night eating merits further exploration provided that the measuring instruments are reliable and valid.

Due to the multifactorial construct of the NEQ, we hypothesized that:

- H1. The NEQ in this population sample in Serbian language has the same structure as the original questionnaire in the English-speaking population;
- H2. The NEQ has good internal consistency;
- H3. The NEQ has convergent validity with the depression, anxiety and stress scores.

Bearing in mind all mentioned above, the purpose of this research was to examine the psychometric properties of the Night Eating Questionnaire using the Rasch model in a sample of university students.

## 2. Materials & methods

### 2.1. Ethical approval

The Ethics Committee of the Faculty of Health Sciences, University of Pristina temporarily seated in Kosovska Mitrovica approved this study, (approval number 09-2673-1). All participants provided a signed informed consent before enrollment in the study.

### 2.2. Setting and participants

The study was carried out from November 1, 2018 to March 1, 2019 in a sample of students from the Faculty of Health Sciences, University of Pristina temporarily seated in Kosovska Mitrovica, Kosovo, Serbia. The faculty has 1100 students in three branches: medicine (general medicine), which lasts for 6 years; dentistry, which lasts for 5 years; and nursing, which lasts for 4 years. Participants were recruited during compulsory classes. To obtain an adequate sample size, we opted for a more robust Slovin's approach as opposed to other strategies, to have a larger sample size and achieve sufficient statistical power. The Slovin's formula was used to calculate the sample size:  $1100/1 + 1100 \times 0.05^2$ . The minimum sample size was 293 students. A total of 363 students were invited, however, 43 (12 %) students did not come to classes, and 20 (6.2 %) students refused to participate. The final sample consisted of 300 students. The response rate was 93.8 %.

### 2.3. Data collection

The following anonymous questionnaires were used to collect data: the Socio-demographic questionnaire, the Perceived Stress Scale (PSS), the Beck Anxiety Inventory (BAI) and the Night Eating Questionnaire. Two researchers from the team (VA, MM) distributed the questionnaires to students and explained the purpose of this study. Study participants filled in the questionnaires on

their own; however, the researchers measured the height and waist circumference of all participants using a measuring tape (in meters). The weight was also measured using a standard portable weighing scale in kilograms. Because students were measured with their clothes and shoes on, 3 kg were subtracted from the measured weight. The height and weight of students were used to calculate the body mass index (BMI) (as weight in kilos divided by squared height in meters). Few missing answers were recorded, and they were mainly related to their grade point average score, which was not the focus of this analysis.

The Perceived Stress Scale was developed in 1983 and examines the subjective perception of stress [22]. The PSS scale consists of 10 items exploring feelings and coping with the events over the past month. The answers are graded on a 5-point scale ranging from 0-never to 4-very often. A score of 20 and above is considered as a high level of perceived stress. The PSS was translated and validated in Serbian language [23]. The internal consistency of the PSS in Serbian as measured by the Cronbach's alpha coefficient was 0.78 [23].

The Beck Depression Inventory examines the presence of depression symptoms, its severity and interfering with every day functioning. It is composed of 21 items and their answers are graded on a 4-point scale from 0 (no symptoms) to 3 (severe symptoms). The total BDI score is obtained by a sum of individual item grades. A higher score indicates more intense depressive symptoms. The psychometric properties of the BDI in Serbian language were deemed adequate (Cronbach's alpha coefficient 0.87; test-retest reliability 0.63) [24].

The Beck Anxiety Inventory comprises 21 items examining symptoms of anxiety. The answers are graded on a 4-point scale from 0 (no symptom) to 3 (severe symptom). The total BAI score is calculated as the sum of item-level grades. A higher BAI score indicates more severe symptoms of anxiety [25].

The Night Eating Questionnaire is composed of 14 items [2]. Answers are graded on a 5-point scale from 0 (never, not at all or early) to 4 (frequently, a lot or late). Reverse scoring is applied to items #1, #4 and #14. The items are grouped according to the following domains: morning anorexia (items #1 and #2), evening hyperphagia (items #3, #4 and #5), mood disturbance-sleep disorders (items #6, #7 and #8) and nighttime food ingestion (items #9, #10, #11, #12 and #14). The total NEQ score is calculated as the sum of items #1-#12 and #14. The item #13 is not included in the total score because it is used to differentiate the NES from sleep related eating disorders [2].

All participants were required to answer NEQ items 1–9. If the participants rated their answer as 0 for item #9, they were not required to continue answering the questionnaire. A similar criterion applied to item #12. Therefore, items #10, #11 and #12 are answered by participants who rate their answers above 0 on item #9. Items #13 and #14 were answered by participants who scored above 0 on item #12. The NEQ also has items #15, #16 and #17 which are not included in the psychometric testing. Item #15 refers to the duration of night eating. Items #16 and #17 refer to the impact of night eating on individual's life and functioning.

The total NEQ score ranged from 0 to 52 points. A score of 25 or above suggests probable NES. A score of 30 or above is considered as a marker of NES [26].

#### 2.4. Translation procedure

Approval to use the NEQ in Serbian language was obtained from Prof. Kelly C. Allison et al. [2]. The NEQ was first translated from English to Serbian by two independent health care researchers. After consensus, the two versions were merged to one final version of the NEQ. After having obtained the final translation in Serbian, a third scientist performed back translation from Serbian to English. A pilot testing of the Serbian version of the NEQ was performed on a sample of 10 students to check understanding and clarity of items. The item #9 ("Other than only to use the bathroom, how often do you get up at least once in the middle of the night?") was not entirely clear. This item was fine-tuned on a meeting of all 3 translators who later adopted the final version of the NEQ in Serbian.

#### 2.5. Data analysis

The JASP, version 0.14.0.0 (<http://jasp-stat.org>) was used to perform the confirmatory factor analysis (CFA) and examine the McDonald's omega coefficient. We used SPSS 20.0 statistical software package (SPSS Inc., Chicago, IL, USA) for all other analyses.

To examine the construct validity of the NEQ in Serbian language, we performed the exploratory factor analysis (EFA) with Varimax rotation. We analyzed the inverted correlation matrix and observed the factor loadings. Based on the eigenvalue above 1.0, we defined the number of factors. Next, we clustered the factor loadings according to their similar values starting from the highest observed value to the lowest observed value in all factors. In this way, we obtained the composition of items within the NEQ domains. We also observed the communality indices which show the variance of the questionnaire items accounted for all the factors. Higher communalities are more desirable, while removal of items is suggested if the index is below 0.4.

We performed the CFA to examine the fit of the model using the 'diagonally weighted least squares' (DWLS) estimator. This estimator is recommended for responses on the ordinal scale [27], such as the one in the NEQ. These indices were used to examine the model fit: Goodness of fit index (GFI), comparative fit index (CFI), Tucker-Lewis index (TLI), Root Mean Square Error of Approximation (RMSEA) and Standardized Root Mean Square Residual (SRMR). The values of GFI, CFI, and TLI  $\geq 0.95$  and RMSEA and SRMR  $\leq 0.05$  were deemed good. The values of GFI, CFI and TLI  $\geq 0.90$  and RMSEA and SRMR  $\leq 0.08$  were deemed acceptable [28].

The internal consistency of the Serbian NEQ was examined by the Cronbach's alpha coefficient and McDonald's omega coefficient [29]. If the coefficients are above 0.70 then the internal consistency is considered as good [29].

The criterion validity was tested by the Kendall's tau coefficient (for correlation between the NEQ score and gender) and the Spearman's correlation coefficient (for the correlation between the NEQ score and age, BMI, waist circumference, BDI, BAI and PSS scores). Additionally, the Spearman's correlation coefficient was used to test the item-domain correlations.

### 2.5.1. Rasch analysis

The Rasch analysis was performed in the Winsteps software (version 4.0.1). It is a mathematical model based on probability. It compares item difficulty relative to respondents' ability. The results are presented visually on an interval scale using log-odds units (logits). The upper part of scale refers to those items showing a greater difficulty level as well as the respondents with a higher ability. The lower part of the scale refers to less difficult items and lower ability [11,13].

Outcomes of the Rasch analysis include the person and item separation indices. Person separation refers to the questionnaire precision and shows the levels of person ability which the questionnaire is able to identify. Item separation refers to reproducibility of the item clusters which have the same level of difficulty. Adequate levels of these indices are  $\geq 0.8$ . Nevertheless, because the NEQ measures behaviors specific to individual experiences, these indices may be difficult to compare between people.

The focus of the Rasch analysis is the unidimensionality of the NEQ. This can be tested using the fit statistics (infit and outfit), and therefore, conceptualize which items fit within a single underlying construct. The acceptable ranges of mean square standardized residuals (MNSQ) are subject to debates, as some authors suggest a narrower range (up to 1.3) [11], and others [12] allow for a wider range (0.5–1.5). When evaluating NEQ, we considered a wider range as suggested by Bond and Fox [12].

## 3. Results

The total study sample consisted of 300 health sciences students of which 124 were male (41.3 %) and 176 were female (58.7 %). Characteristics of the study sample are presented in Table 1. The average age of participants was  $21.7 \pm 2.9$  years. The mean BMI was  $24.1 \pm 4.4$ . The average waist circumference was  $83.0 \pm 12.8$  cm. Overall, the mean BDI in the study sample was 5.6 out of 63 and the BAI of 8.5 out of 63. The average PSS was 18.6 out of 40. The scores of the NEQ in Serbian language are presented in Table 2. The median NEQ score was 12 out of 52. Overall, the lowest score was observed for the domain "Nocturnal ingestions" (Table 2).

### 3.1. Construct validity

Based on the EFA results, we observed 4 factors which corresponded to the original domains of the NEQ (Table 3). These 4 domains explained 60.45 % of variance. All communalities were above 0.40. The CFA indices were GFI = 0.978, CFI = 0.996, TLI = 0.995, RMSEA = 0.011 and SRMR = 0.057 suggesting a good fit.

### 3.2. Internal consistency

The Cronbach's alpha coefficient for the total NEQ was 0.627 (95 % confidence interval [CI] 0.559–0.686). The McDonald's omega coefficient for the total NEQ was 0.583 (95%CI 0.519–0.648). The internal consistency variations if item deleted are presented in Table 4. The highest coefficients were observed if item #7 was deleted. The lowest coefficients were observed if items #12 and #14 were deleted (Table 4).

Table 5 displays the correlation coefficients between each individual NEQ item and domains scores. Each item correlated with the corresponding domain. Also, each item correlated with the total NEQ score (Table 5).

### 3.3. Criterion validity

Correlations between the domains of NEQ and the selected parameters are shown in Table 6. Stronger levels of morning anorexia correlated with less perceived stress. Stronger levels of evening hyperphagia correlated with more intense anxiety symptoms. Poorer scores on mood/sleep domain correlated with female gender and more intense symptoms of depression and anxiety. Stronger levels of nocturnal ingestions correlated with male gender, younger age, higher BMI and more intense depressive and anxiety symptoms. Students who scored higher on the total NEQ also had higher scores of the BDI and BAI (Table 6).

### 3.4. Rasch analysis

The NEQ reliability index was quite high suggesting good item reproducibility. Moreover, the observed item separation index

**Table 1**  
Characteristics of the study sample (N = 300).

Variables	Value	min-max
Gender		
male	124 (41.3 %)	n/a
female	176 (58.7 %)	n/a
Age	$24.7 \pm 2.9$	18–30
Body mass index	$24.1 \pm 4.4$	17.4–35.0
Waist circumference	$83.0 \pm 12.8$	56.0–129.0
Beck Depression Inventory	$5.6 \pm 7.0$	0–43
Beck Anxiety Inventory	$8.5 \pm 8.9$	0–43
Perceived Stress Scale	$18.6 \pm 8.0$	0–37

Legend: All variables except gender are presented as mean  $\pm$  standard deviation; n/a – not applicable.

**Table 2**  
Mean and median scores of the Night Eating Questionnaire (NEQ) in Serbian language.

NEQ items	Mean (SD)	Median (IR)
1 How hungry are you in the morning	1.9 (1.3)	2.0 (2.0)
2 When do you usually eat for the first time	1.3 (0.7)	1.0 (1.0)
Morning anorexia domain	3.2 (1.6)	3.0 (2.0)
3 Do you have cravings or urges to eat snacks after supper, but before bedtime	1.6 (1.1)	2.0 (1.0)
4 How much control do you have over your eating between supper and bedtime	1.7 (1.1)	2.0 (1.0)
5 How much of your daily food intake do you consume after suppertime	1.1 (0.7)	1.0 (0.0)
Evening hyperphagia domain	4.4 (2.2)	4.5 (3.0)
6 Are you currently feeling blue or down in the dump	1.9 (1.7)	2.0 (4.0)
7 When you are feeling blue, is your mood lower in the ...	1.0 (0.9)	1.0 (0.0)
8 How often do you have trouble getting to sleep	0.7 (1.0)	0.0 (1.0)
Mood/sleep domain	3.7 (2.5)	4.0 (3.25)
9 Other than only to use the bathroom, how often do you get up at least once in the middle of the night	0.7 (1.0)	0.0 (1.0)
10 Do you have cravings or urges to eat snacks when you wake up at night	0.2 (0.6)	0.0 (0.0)
11 Do you need to eat in order to get back to sleep when you awake at night	0.2 (0.5)	0.0 (0.0)
12 When you get up in the middle of the night, how often do you snack	0.2 (0.5)	0.0 (0.0)
14 How much control do you have over your eating while you are up at night	0.4 (1.0)	0.0 (0.0)
Nocturnal ingestions domain	1.7 (2.9)	0.0 (2.0)
Total NEQ score	13.0 (5.5)	12.0 (7.0)

**Table 3**  
Results of the exploratory factor analysis of the Night Eating Questionnaire (NEQ) in Serbian language.

NEQ items	Factor loadings				Communality
	Factor 1	Factor 2	Factor 3	Factor 4	
	Morning anorexia	Evening hyperphagia	Mood/sleep	Nocturnal ingestions	
Item 1	0.793	-0.085	-0.076	0.062	0.646
Item 2	0.726	0.217	0.112	-0.005	0.586
Item 3	-0.080	0.812	0.134	0.042	0.686
Item 4	0.186	0.683	-0.050	0.027	0.504
Item 5	0.034	0.740	0.151	0.308	0.666
Item 6	0.056	0.124	0.694	0.084	0.507
Item 7	-0.255	-0.037	0.675	-0.011	0.523
Item 8	0.293	0.108	0.566	0.111	0.430
Item 9	-0.009	-0.055	0.214	0.656	0.479
Item 10	0.045	0.133	-0.070	0.818	0.694
Item 11	0.113	0.128	-0.075	0.770	0.628
Item 12	0.067	0.155	0.138	0.886	0.833
Item 14	-0.076	0.072	0.085	0.811	0.677
Variance explained	8.89	12.99	10.44	28.13	

**Table 4**  
Internal consistency of the Night Eating Questionnaire (NEQ) in Serbian language.

NEQ items	If item deleted		Item-rest correlation
	Cronbach's $\alpha$	McDonald's $\omega$	
Item 1	0.656	0.607	0.049
Item 2	0.616	0.585	0.216
Item 3	0.599	0.581	0.312
Item 4	0.614	0.588	0.234
Item 5	0.580	0.550	0.499
Item 6	0.609	0.581	0.256
Item 7	0.678	0.644	0.074
Item 8	0.608	0.579	0.263
Item 9	0.591	0.523	0.355
Item 10	0.593	0.523	0.453
Item 11	0.596	0.535	0.432
Item 12	0.583	0.495	0.645
Item 14	0.577	0.499	0.431

shows that the NEQ in the Serbian population had a total of six groups of items based on their difficulty level (Table 7). This means that the NEQ can be used to assess different eating patterns. Contrary, the person reliability index as well as the separation index were rather low. In other words, the NEQ can separate only two types of people (night eaters from day eaters). However, because the NEQ is

**Table 5**  
Item-domain correlations of the Night Eating Questionnaire (NEQ).

NEQ	Morning anorexia	Evening hyperphagia	Mood/sleep	Nocturnal ingestions	Total NEQ score
Item 1	0.924**	0.014	-0.096	0.057	0.240**
Item 2	0.633**	0.198**	0.023	0.025	0.331**
Item 3	0.015	0.820**	0.151**	0.091	0.506**
Item 4	0.119*	0.728**	0.075	0.042	0.454**
Item 5	0.093	0.696**	0.131*	0.263**	0.556**
Item 6	0.016	0.147*	0.562**	0.124*	0.401**
Item 7	-0.105	0.063	0.838**	0.061	0.397**
Item 8	0.064	0.120*	0.466**	0.170**	0.348**
Item 9	0.036	0.090	0.132*	0.958**	0.490**
Item 10	0.078	0.223**	0.022	0.611**	0.456**
Item 11	0.126*	0.196**	0.079	0.556**	0.459**
Item 12	0.071	0.274**	0.124*	0.742**	0.591**
Item 14	0.062	0.259**	0.106	0.731**	0.585**

Legend: The values in tables represent the Spearman’s correlation coefficient.

\* p < 0.05.  
\*\* p < 0.01.

**Table 6**  
Correlations between items of the Night Eating Questionnaire with the selected parameters.

NEQ	Gender	Age	BMI	Waist circumference	BDI	BAI	PSS
Morning anorexia	-0.021	0.042	0.024	0.063	-0.013	0.019	-0.084*
Evening hyperphagia	-0.053	-0.065	0.032	0.028	0.042	0.108*	0.043
Mood/sleep	0.188**	0.001	-0.055	-0.041	0.292**	0.185**	0.079
Nocturnal ingestions	-0.123*	-0.092*	0.088*	0.070	0.128**	0.180**	-0.006
NEQ total score	0.023	-0.060	0.016	0.029	0.199**	0.228**	0.022

Legend: NEQ - Night Eating Questionnaire; BMI - Body Mass Index; BDI - Beck Depression Inventory; BAI - Beck Anxiety Inventory; PSS - Perceived Stress Scale.

\* p < 0.05.  
\*\* p < 0.01.

an instrument that measures individual eating behavior, which is at the same time a rare disorder, this result is acceptable.

A very low standard error of measurement (Model SE) for almost all items confirms that the NEQ is a reliable instrument. Only two items have an infit and only one has an outfit mean squares above the commonly accepted range (0.5–1.5), while two more items have outfit below the cut-off. This means that a student who has an average ability is not challenged to respond to all NEQ items. Moreover, another proof that the NEQ has acceptable psychometric properties is the fact that most frequently observed correlation coefficients are similar to the expected ones (Table 8).

From Fig. 1, we observed that the majority of students in this sample scored below mean (M) and were grouped around the level -1. This means that most students in this study had normal (usual, average) eating behavior and only few of them had NES. Moreover, Fig. 1 shows that, although there were 6 levels of item difficulty (from 2 to -4), the difference between the levels was not a remarkable one. The number of items above and under the mean difficulty level was similar (5 vs. 7 items). Because the NES is rare disorder, it is recommended to administer more questionnaires at the same time to assess eating disorders in a comprehensive manner. Finally, the NEQ can separate well those students who do and do not eat at night.

**Table 7**  
Rasch analysis NEQ fit statistics.

Person = 300	Total	Count	Measured		INFIT		OUTFIT	
			Measure	Realse	MNSQ	ZSTD	MNSQ	ZSTD
Mean	13.0	13.0	-2.16	0.37	1.06	0.1	0.99	0.1
P.SD	5.5	0.1	0.57	0.09	0.59	1.3	0.82	1.3
Real RMSE	0.38	True SD	0.43	Separation	1.41	Person reliability		0.65
Item = 13	Total	Count	Measured		INFIT		OUTFIT	
			Measure	Realse	IMNSQ	ZSTD	OMNSQ	ZSTD
Mean	300.7	299.8	0.10	0.09	1.31	0.2	0.99	-0.5
P.SD	187.4	0.4	0.96	0.04	0.50	5.3	0.43	4.7
Real RMSE	0.10	True SD	0.90	Separation	6.21	Item reliability		0.98

Legend: P.SD - population standard deviation; REALSE - standard errors of measure estimates; Z - z standardized scores; STD - standard deviation; MNSQ - mean square standardized residuals.

**Table 8**  
Rasch analysis NEQ item statistics.

Entry number	Total score	Measure	Model SE	INFIT		OUTFIT		PT MEASURE	
				MNSQ	ZSTD	MNSQ	ZSTD	Corr obs	Corr expect
1	573	-1.13	0.05	1.31	4.1	1.34	4.2	0.29	0.50
2	388	-0.57	0.06	0.51	-7.7	0.57	-6.2	0.34	0.47
3	481	-0.87	0.05	0.85	-2.1	0.84	-2.2	0.05	0.49
4	531	-1.01	0.05	0.84	-2.4	0.86	-2.0	0.46	0.50
5	318	-0.33	0.06	0.38	-9.9	0.39	-9.0	0.58	0.46
6	228	0.06	0.07	1.23	2.4	1.17	1.6	0.41	0.42
7	561	-1.10	0.05	2.05	9.9	2.03	9.9	0.38	0.50
8	316	-0.32	0.06	0.78	-2.8	0.75	-3.1	0.40	0.45
9	216	0.12	0.07	1.26	2.6	1.24	2.2	0.48	0.41
10	160	1.44	0.13	1.32	1.9	0.83	-0.9	0.47	0.25
11	152	1.58	0.14	1.50	2.7	0.91	-0.4	0.45	0.24
12	162	1.41	0.13	0.69	-2.2	0.47	-3.8	0.61	0.26
13	123	0.72	0.09	1.97	6.5	1.45	3.1	0.51	0.34
Mean	300.7	0.01	0.08	1.13	0.2	0.99	-0.5	/	/
P.SD	187.4	0.40	0.03	0.50	5.3	0.43	4.7	/	/

Legend: P.SD - population standard deviation; SE - standard error; MNSQ - mean square standardized residuals; Z - z standardized scores; STD - standard deviation; Corr obs - correlation observed; Corr expect - correlation expected.

#### 4. Discussion

This study showed that the NEQ in Serbian language had a slightly lower internal consistency than the recommended cut-off (0.7). However, the construct validity corresponded to the original 4-dimensional structure as evidenced by the EFA and CFA, which confirmed our first hypothesis. The domains of the NEQ showed good criterion validity, particularly convergent validity with the BDI and the BAI, thereby confirming our last hypothesis. These findings suggest that this questionnaire is sensitive to other variables relevant for the NES research. The Rasch analysis showed good reproducibility and reliability of the NEQ and a slightly higher item separation index than what was expected (6 vs. 4 domains). Overall, the Rasch infit and outfit statistics were acceptable, which means that students who were in good health had no specific challenges when answering the NEQ. It was clear from the visual representation of the NEQ that most students do not have NES despite various levels of item difficulty.

The internal consistency as measured by the Cronbach's alpha for the entire NEQ was 0.627, which is somewhat lower than the values that are commonly considered as adequate. This value can be deemed acceptable because the items logically relate to one another and have also showed variability in students' responses. The internal consistency was adequate in Spanish (0.79) [3], Hebrew (0.78) [4], Brazilian Portuguese (0.78) [6], Korean (0.78) [8] and Chinese language (0.70) [9]. However, the internal consistency was lower in the Italian population (0.68) [5], as well as among university students in Egypt (0.54) [10], which is similar to what this study observed. Potential explanation for lower coefficients may be because of the length of the questionnaire, as fewer items may decrease the overall values of the alpha coefficient. Another reason could be that many students responded to items regarding night eating negatively (quantified as 0), because night eating is not as common. This may have decreased the variability in responses.

The EFA and CFA suggested that the Serbian version of the NEQ has 4 domains. This construct is in line with the 4-dimensional structure of the original NEQ in English. In this way, the construct validity of the NEQ in Serbian has been confirmed. Previous studies in other populations worldwide confirmed that in those study samples the 4-factorial construct was evident [8–10]. This means that the NEQ has 4 distinctive parts which are clearly demarcated. The specific structure of questionnaires can be used to study the night eating phenomenon in more detail. The analysis of domains and research focusing on the predictive values of the NEQ domains could highlight specific aspects that are challenging for people who eat at night.

In the present study, a correlation between morning anorexia and low levels of perceived stress were established, while in the study of Allison et al. [2] there was no correlation between morning anorexia and perceived stress. To date, this relationship has not been examined in other studies, so further studies are needed to better understand this finding. Given the low prevalence of NES in the student population, further studies are warranted to assess clinical significance of NEQ domains and connection with other mental health disturbances identified in people with NES [15].

The evening hyperphagia correlated with anxiety symptoms, while in the study of Allison et al. evening hyperphagia correlated with the BDI and the PSS [2]. However, it should be acknowledged that anxiety has not been described as a symptom of NES, even though it is common in people who eat in the evening [30]. Lower mood/sleep scores were correlated with female gender in this study as well as with more intense symptoms of depression and anxiety. This relationship can also be attributed to the fact that women more often develop mood disorders compared to men [31]. In the study by Allison, nocturnal ingestion was negatively correlated with morning hunger and frequency of nocturnal ingestions. In this study, nocturnal ingestions correlated with several variables, such as male gender, younger age, higher BMI. This could be explained by higher nutritional demands after finishing classes. However, this finding indeed requires a more detailed approach to identify whether these caloric requirements are related to the objective nutritional needs or they may be a symptom of NES.

Students' higher scores on the NEQ correlated with higher scores on the BDI and BAI which has previously been reported [32]. This may be due to the fact that higher scores of NEQ are indicative of NES, and NES *per se* is classified as a mental health disorder.



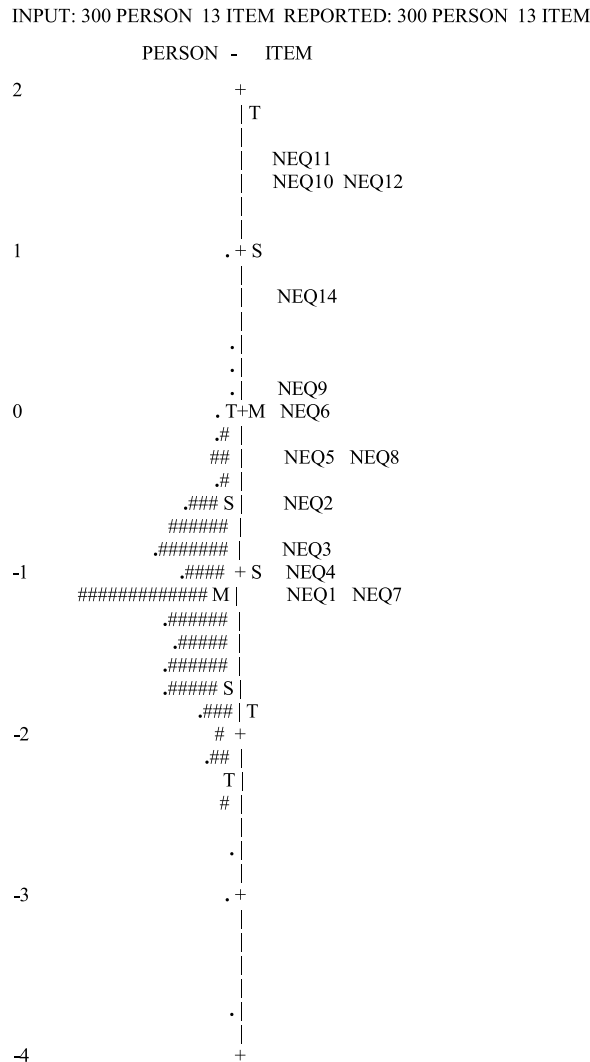


Chart 1. Person item chart for Rasch analysis

Fig. 1. Person item chart for Rasch analysis.

Therefore, it is not surprising that NES occurs along with other mental disturbances, such as depressive and anxiety symptoms [33], and could be consistently identified in other studies across populations.

This study is unique in that, thus far, the Rasch model has not applied to the NEQ in the English language literature. The Rasch analysis suggested that the NEQ in Serbian student population had good reproducibility and reliability. Item separation index was somewhat higher than what we observed on the CFA, but person separation index clearly showed that night and day eaters were two separate groups of people. The Rasch analysis also supported the notion that NES is rare in student population and that in our sample of students only few of them who might indeed have NES. Moreover, the NEQ items were not difficult for an average student, despite items having different levels of difficulty. Most importantly, students were able to respond to all items to the best of their ability.

Night eating is a phenomenon which accounts for the consumption of calories after dinner. Time allocated for evening meals varies according to climates and populations [34], where in predominantly warmer climate, such as the one in Spain, evening meals usually take place from 9 p.m. to 11 p.m. However, in predominantly colder climates, such as the one in Norway, evening meals may be anywhere between 4 p.m. and 7 p.m. With regard to day versus night eaters, time of the evening meal could depend on the local culture [34], but also on the chronotype - a biological propensity to be active and/or sleep at a certain time of day or night [35]. For this reason, people who are labeled as an “evening chronotype”, contrary to a “morning type”, more often eat later at night regardless of what is commonly accepted as an evening meal time in that culture. These individuals tend to skip daytime meals and eat at night.



Eating later in the evening has been associated with opting for fast foods as well [36]. However, high caloric intake in the evening, when physical activity is reduced, can favor unintentional weight gain, binge eating and food addictions [37,38]. Therefore, research on night eaters is complex and has a broad implications for population health and merits further exploration.

The strengths of this study are grounded in the fact that students from all three health science branches (general medicine, dentistry, and nursing) as well from all study years were included. This means that the study sample represented individuals of different ages and socioeconomic strata. Hence, the results might be generalized to the entire population of health sciences students in Kosovska Mitrovica. This study used the McDonald's omega coefficient, in addition to the Cronbach's alpha coefficient, which has been increasingly used to describe the reliability of questionnaires. Another advantage of this study was the opportunity to examine validity relative to the instruments assessing mental health as well as to replicate findings of the original study when the NEQ was developed.

A limitation of this study is a lack of re-testing of the study sample. For this reason, we were unable to examine the stability over time. Potential limitation is the circumstance that we included only health sciences students, rather than students from the entire University in Kosovska Mitrovica. Also, night eating might represent a sensitive topic for some individuals, when one might feel embarrassed and ashamed. As a result, assessment of night eating is open to information bias.

## 5. Conclusion

In conclusion, based on the results of the classical theory testing, the psychometric properties of NEQ are similar to those observed in previous studies. The Rasch model showed a high level of reliability. Further, this model identified that the NEQ had a total of 6 different levels of items classified according to their difficulty. Yet, most students reported average eating patterns and only few of them potentially had NES. The separation index strongly suggests that the NEQ can distinguish well the night eaters from day eaters. Finally, for most students the NEQ items were not difficult to respond to. Overall, the properties of the NEQ warrant its use in night eating research.

Future research of night eating in this specific population should focus on the association of night eating and BMI, because there is inconsistent evidence that night eating affects body weight. Also, it would be helpful to explore in more depth the patterns of night eating in terms of specific hours during the evening and night when young people feel the urge to eat after dinner. Research regarding stress and its association with night eating could pinpoint whether there are acute or chronic stressors that night eaters are exposed to and how they influence appetite. Finally, specific personality traits may be associated with different eating patterns, so the NEQ could be helpful in understanding these complex relationships.

## Ethics statement

The Ethics Committee of the Faculty of Health Sciences, University of Pristina temporarily seated in Kosovska Mitrovica approved this study, (approval number 09-2673-1). All participants provided a signed informed consent before enrollment in the study.

## Data availability statement

Data underlying this study are available on a reasonable request to corresponding author.

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## Patient consent statement

Not applicable.

## CRedit authorship contribution statement

**Vojkan Aleksic:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Marija Milic:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Jelena Dotlic:** Writing – review & editing, Visualization, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Biljana Jeremic:** Writing – review & editing, Validation, Investigation, Formal analysis, Data curation, Conceptualization. **Branislav Djerkovic:** Writing – review & editing, Validation, Supervision, Investigation, Formal analysis, Conceptualization. **Ivan Radic:** Writing – review & editing, Investigation, Formal analysis, Conceptualization. **Ana Odalovic:** Writing – review & editing, Investigation, Formal analysis, Conceptualization. **Ljiljana Kulic:** Writing – review & editing, Investigation, Formal analysis, Conceptualization. **Milivoje Galjak:** Writing – review & editing, Investigation, Formal analysis, Conceptualization. **Tatjana Gazibara:** Writing – original draft, Visualization, Supervision, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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