Application of Exploratory and Confirmatory Factor Analysis to Model Loneliness Dimensions Among Pre-University Students

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Abstract

As students transition from secondary to higher education, they often face emotional and social challenges that influence their sense of connection and psychological well-being. This study applies factor analysis techniques to examine the multidimensional nature of loneliness among pre-university students. Data were collected from 219 Foundation Program students using the University of California, Los Angeles (UCLA) Loneliness Scale. The Kaiser–Meyer–Olkin (KMO) test and Bartlett's test of sphericity were conducted to assess the data's suitability for factor analysis. The KMO value exceeded 0.6 and Bartlett's test was significant, indicating the data was appropriate for further analysis. Exploratory Factor Analysis (EFA) was conducted to identify the fundamental structure of the scale, while Confirmatory Factor Analysis (CFA) validated the results. Cronbach's alpha was calculated to assess reliability. The findings of EFA and CFA align with previous empirical studies, confirming three distinct dimensions of loneliness: isolation, relational connectedness, and collective connectedness. The derived factors showed satisfactory reliability, with scores exceeding 0.8. This study demonstrates the applicability of factor analysis in modeling multidimensional psychological constructs. The results support the structure of the UCLA Loneliness Scale and offer insights into future research and data-informed interventions to enhance student well-being.

Keywords: loneliness; pre-university students; UCLA Loneliness Scale; exploratory factor analysis (EFA); confirmatory factor analysis (CFA).

1   Introduction

In the era of digital connectivity and rapid societal changes, loneliness remains a pressing concern, especially among pre-university students who undergo significant transitions in their social and academic environments. The correlation between loneliness and various negative physical and mental health consequences has been extensively researched in this population, including among students in Malaysia [45], Turkey [28], the Netherlands [37], the United States [42], Germany [59], and China [60]. Loneliness is an emotional condition arising when a person perceives a gap between their actual and desired interpersonal relationships [51]. Loneliness is a prevalent experience across various age groups, yet it manifests with greater frequency among university students, as highlighted by Fan et al. [17], Kılınç et al. [28], and Nottage et al. [37], all of whom draw on existing literature to emphasize its heightened occurrence in these populations. As these students navigate their newfound roles characterized by heightened individualization and independence, they increasingly find themselves making independent decisions. While this situation presents numerous opportunities, it also poses risks. Kılınç et al. [28] emphasize that unfamiliar environments, increased academic and social demands, and a lack of developed coping skills can contribute to social withdrawal, psychological distress, and loneliness.

Extant literature has underscored the variability in the prevalence of loneliness among university students across different geographical and institutional contexts. For instance, Dagnew [11] reported empirical evidence from Ethiopia showing a loneliness prevalence rate of 45.5% among university students, with a significant correlation between loneliness and academic year. Weber et al. [59] found that loneliness among university students is consistently linked to poorer mental health, including symptoms of anxiety and depression. Vilca et al. [57] similarly emphasized, based on prior literature, that loneliness is a major factor contributing to university dropout, often occurring alongside social isolation and limited opportunities for meaningful social integration.

Nevertheless, prior research indicates that loneliness may not possess a singular structure and cannot be succinctly defined by a single explanation [44]. These prior studies argue that individuals encounter loneliness in varied degrees and types. This approach is crucial, as loneliness presents itself as a multifaceted issue resulting from various losses and life changes [10, 61]. Hence, numerous studies suggest determining the number of dimensions of loneliness by conducting more investigations into the underlying factor structure of the University of California, Los Angeles (UCLA) across various populations, including Korean older adults [30, 31], university students in Western college [1], New York [6], Columbus [21], Southwestern university [35], Australia [7], Turkey [15], South Africa [41], and Malaysia [53].

It is crucial to address loneliness to enhance the well-being and health of adolescents and to comprehensively quantify this emotion. While loneliness has traditionally been perceived as a unidimensional construct, recent research suggests a more nuanced understanding, emphasizing the existence of multiple dimensions. Therefore, this study aims to explore the multidimensional nature of loneliness among pre-university students by drawing on empirical evidence and statistical analyses, using the UCLA Loneliness Scale as the primary measure, and employing both exploratory factor analysis (EFA) and confirmatory factor analysis (CFA). The 20–item scale is considered one of the most reliable and commonly used tools for assessing loneliness [3]. By exploring the multidimensional nature of loneliness, the study challenges the traditional, simplistic view of loneliness as a single experience, making this research highly relevant. Its findings can inform interventions, policies, and future research, ultimately contributing to the well-being of this vulnerable population.

2   Methodology

2.1   Sample and setting

This study involved Foundation Program students at Universiti Malaysia Sabah. A total sample of 219 students was recruited using simple random sampling, a probability sampling technique. The population size (N) was approximately 500 students, and the sample size (n=219) was determined using Cochran's formula for sample size calculation for a finite population [33]. Assuming a 95% confidence level, a 5% margin of error, and an estimated population proportion (p) of 0.5, the sample size was calculated to ensure adequate representation. Inclusion criteria required participants to be currently enrolled in the foundation program and aged 18 and above, while students who had withdrawn from the program or had incomplete data were excluded from the study. No participants dropped out of the study, and demographic information such as age, gender, and country of origin were also collected. Participants were asked to complete the UCLA Loneliness Scale to measure their level of loneliness. The scale comprises a total of 20 items. These items assess individuals' satisfaction and dissatisfaction with various dimensions of their social relationships. Participants were asked to rate each item on a scale ranging from 1 (never) to 4 (often). Ten questions with positive wording were reversed to ensure consistency in orientation. After reversing the scores of the items, the sum of all the items was calculated to determine the loneliness scores for each participant. The potential scores range from 20 to 80. Higher scores indicate a higher level of loneliness.

2.2   Ethical considerations

The ethical considerations for this study include obtaining informed consent, ensuring confidentiality and anonymity of participants, allowing the right to withdraw at any time, minimizing potential psychological harm from discussing sensitive topics like loneliness, reporting data truthfully, and being culturally sensitive to the diverse backgrounds of participants.

2.3   Statistical analysis

The demographics of the participants and each item in the scale were summarized using frequency and percentage. The main analyses were performed in four stages. First, the sample was randomly split into subsamples for exploratory and confirmatory analyses using SPSS version 29 and AMOS version 24. This method has been used in previous studies to examine the factor structure of various instruments. For example, Martins et al. [34] applied this approach to validate the Digital Health Literacy Instrument (DHLI), and Tian et al. [54] used it to assess the Achievement Emotions for Physical Education Questionnaire (AEQ-PE). Similarly, Wang et al. [58] and Yang et al. [62] adopted this method for the Emotion and Motivation Self-Regulation Questionnaire (EMSR-Q) and Self-feedback Behaviour Scale (SfBS), respectively.

The second stage involved applying chi-square tests to assess differences between the subsamples for categorical variables, such as Gender (female, male), Origin (East Malaysia, West Malaysia), and Loneliness Levels (no/low, moderate, high). Independent t-tests were used to compare the continuous variable, Loneliness Score (mean, standard deviation), between the subsamples. These analyses ensured that the random split did not introduce significant differences between the subsamples, which could bias the exploratory and confirmatory factor analyses.

In the third stage, this study conducted an Exploratory Factor Analysis (EFA) to examine the initial factor structure of the Revised UCLA Loneliness Scale using the first subsample. Before performing EFA, examining the suitability of the data is necessary. The Kaiser Meyer-Olkin measure of sampling adequacy (KMO) was utilized to examine the factorability of the entire set of variables, and the Bartlett test can be used to determine the overall significance of the correlation matrix. The KMO value is more than 0.6 with a significant Bartlett's test, indicating that factorability is assumed and suitable to continue the factor analysis. This approach has been used in prior studies. For instance, Alzamil et al. [4] applied it to validate the Self-Compassion Scale, and Chen et al. [9] used it to validate the Existential Fulfillment Scale. Similarly, Okwuduba et al. [38] and Serpa-Barrientos et al. [48] employed these tests to ensure the factorability of their instruments. Meanwhile, Mohamed et al. [36] and Tzafilkou et al. [55] used the same method to validate the Personalized Mathematics Learning (PML) and Remote Learning Attitude Scale (RLAS), respectively.

This present study carried out principal component analysis (PCA)-based extraction and Direct Oblimin-based oblique rotation. There are two techniques of factor rotation: oblique and orthogonal. The oblique approach assumes that the factors are correlated, whereas the orthogonal method assumes that they are uncorrelated [19]. To determine the most suitable rotation method, a recommended approach is to specify oblique rotation and observe the relationships or correlations between the factors [8]. Oblique rotation is preferred when factor correlations exceed 0.32, as this indicates a 10% or greater overlap in variance among the factors. Thus, this study used oblique rotation since the highest correlation exceeded the threshold of 0.32.

This research used numerous measures to determine the number of factors that could be kept for interpretation, such as latent root criterion (eigenvalue greater than 1), scree test (the point at which the curve begins to flatten out is the maximum number of factors to extract) and the proportion of total variance explained (50% cut-off threshold) [36, 12]. Furthermore, the criterion for assigning an item to a factor is factor loading > 0.5 since factor loadings with a value of 0.5 or above are generally viewed as having practical significance [19].

At the last stage, a confirmatory factor analysis (CFA) was performed using the second subsample to validate the EFA results. CFA was undertaken to confirm the factorial validity of each factor found by EFA [50]. CFA can offer further evidence on the fit of the proposed model regarding the structure of the identified factors in EFA, and the maximum-likelihood method was employed to estimate the parameters in the model [14]. The model's fitness was evaluated before proceeding to the construct reliability and validity assessment.

Next, the instrument's reliability was assessed using Cronbach's alpha (α) and composite reliability (CR), where the values greater and equal to 0.6 signify satisfactory internal consistency [19]. Furthermore, the construct validity was evaluated using average variance extracted (AVE) and Heterotrait-Monotrait Ratio (HTMT). An AVE value greater than or equal to 0.5 demonstrates that convergent validity is established [20, 32], suggesting that the construct can explain over 50% of the variation in its indicators [20, 25]. According to Fornell and Larcker [18], a construct's convergent validity below 0.50 may still be considered adequate if its composite reliability exceeds 0.60 [47]. HTMT was used to examine the construct's discriminant validity, where an HTMT value below 0.90 suggests discriminant validity is established, signifying that a construct is unique and encompasses characteristics that are not accounted for by the other constructs in the model [20, 24].

3 Results

3.1 Demographics characteristics and response distribution of the scale

In this study, 65.8% of the sample consist of women, with men comprising of 34.2%. Based on the total sample of 219 participants, 71.23% of the participants originated from East Malaysia (including Sabah, Sarawak, and Labuan), while 28.77% were from West Malaysia (Semenanjung Malaysia). In terms of loneliness levels, 9.59% of the participants reported experiencing no or low loneliness, 48.86% experienced moderate loneliness, and 41.55% reported high levels of loneliness. These categories were determined based on total scores from the UCLA Loneliness Scale, with scores of 20–34 indicating low loneliness, 35–49 indicating moderate loneliness, and 50–80 indicating high loneliness, following established guidelines. These findings indicate that the majority of the sample came from East Malaysia, with a significant portion of participants reporting moderate level of loneliness. Also, the mean of the total combined score for the 20–item scale was 40.71 (SD=9.89), suggesting that the majority of participants reported moderate levels of loneliness. Furthermore, no differences were observed between the two subsamples with regard to gender, origin, loneliness categories, and the total combined score on the scale (Table 1).

Table 1: Demographic characteristics for random split-half sample.

Variable	Sample 1 ($n_1 = 109$)	Sample 2 ($n_2 = 110$)	t or χ^2	p-value
Gender (n,%)				
Female	73 (67.0)	71 (64.5)	0.143	0.705
Male	36 (33.0)	39 (35.5)		
Origin (n,%)				
East Malaysia (Sabah, Sarawak, Labuan)	75 (68.8)	81 (73.6)	0.623	0.430
West Malaysia (Semenanjung Malaysia)	34 (31.2)	29 (26.4)		
Loneliness				
No/Low Loneliness	10 (9.2)	11 (10.0)		
Moderate Loneliness	55 (50.5)	52 (47.3)	0.226	0.893
High Loneliness	44 (40.4)	47 (42.7)		
Score* (mean, SD)	40.679 (9.875)	40.746 (9.956)	-0.050	0.960

*Based on skewness, kurtosis, and Kolmogorov-Smirnov, graphical methods, variable score is normally distributed.

The split-half method was used to ensure the reliability and consistency of the data by randomly dividing the total sample of 219 participants into two equal subsamples. This approach tested whether findings, such as loneliness levels and demographics, were consistent across both groups. The absence of significant differences between the subsamples confirms that the results are reliable and generalizable across the entire sample. Chi-square tests were used to compare categorical variables (e.g., gender, origin, and loneliness categories) between the two subsamples, while independent samples t-tests were applied to compare continuous variables such as the total combined score on the scale. Prior to conducting these comparisons, normality of the continuous variable (total loneliness score) was assessed using the Shapiro-Wilk test and inspection of

skewness and kurtosis values. The results indicated that the data were approximately normally distributed, supporting the use of parametric tests such as the independent samples t-test.

In addition, no statistically significant differences were identified between the two subsamples for specific responses to any of the 20–items on the scale (Table 2). Since no statistically significant differences were found between the two subsamples, it can be concluded that the response patterns are consistent across the two groups. This suggests that the scale functions similarly for both subsamples, supporting the scale's reliability across different groups.

Table 2: Response distribution of the scale among split-half samples.

	Variable	Sample 1 $(n_1 = 109)$	Sample 2 $(n_2 = 110)$	χ^2	*p*-value
1.	**I feel in tune with the people around me**				
	Never	5 (4.6)	3 (2.7)	1.139	0.768
	Rarely	18 (16.5)	18 (16.4)		
	Sometimes	57 (52.3)	54 (49.1)		
	Often	29 (26.6)	35 (31.8)		
2.	**I lack companionship**				
	Never	31 (28.4)	23 (20.9)	4.134	0.247
	Rarely	34 (31.2)	42 (38.2)		
	Sometimes	42 (38.5)	39 (35.5)		
	Often	2 (1.8)	6 (5.5)		
3.	**There is no one I can turn to**				
	Never	48 (44.0)	35 (31.8)	6.256	0.100
	Rarely	30 (27.5)	40 (36.4)		
	Sometimes	29 (26.6)	28 (25.5)		
	Often	2 (1.8)	7 (6.4)		
4.	**I do not feel alone**				
	Never	12 (11.0)	9 (8.2)	2.559	0.465
	Rarely	23 (21.1)	26 (23.6)		
	Sometimes	42 (38.5)	34 (30.9)		
	Often	32 (29.4)	41 (37.3)		
5.	**I feel part of a group of friends**				
	Never	7 (6.4)	5 (4.5)	2.601	0.457
	Rarely	16 (14.7)	12 (10.9)		
	Sometimes	39 (35.8)	34 (30.9)		
	Often	47 (43.1)	59 (53.6)		
6.	**I have a lot in common with the people around me**				
	Never	5 (4.6)	5 (4.5)	1.579	0.664
	Rarely	29 (26.6)	22 (20.0)		
	Sometimes	47 (43.1)	49 (44.5)		
	Often	28 (25.7)	34 (30.9)		
7.	**I am no longer close to anyone**				
	Never	60 (55.0)	47 (42.7)	4.090	0.252
	Rarely	24 (22.0)	36 (32.7)		
	Sometimes	20 (18.3)	21 (19.1)		
	Often	5 (4.6)	6 (5.5)		
8.	**My interests and ideas are not shared by those around me**				
	Never	35 (32.1)	26 (23.6)	3.565	0.312

Table 2 Continued:

	Variable	Sample 1 ($n_1 = 109$)	Sample 2 ($n_2 = 110$)	χ^2	*p*-value
	Rarely	40 (36.7)	39 (35.5)		
	Sometimes	29 (26.6)	35 (31.8)		
	Often	5 (4.6)	10 (9.1)		
9.	**I am an outgoing person**				
	Never	13 (11.9)	15 (13.6)	0.565	0.904
	Rarely	21 (19.3)	23 (20.9)		
	Sometimes	52 (47.7)	47 (42.7)		
	Often	23 (21.1)	25 (22.7)		
10.	**There are people I feel close to**				
	Never	2 (1.8)	5 (4.5)	3.152	0.369
	Rarely	10 (9.2)	13 (11.8)		
	Sometimes	45 (41.3)	35 (31.8)		
	Often	52 (47.7)	47 (51.8)		
11.	**I feel left out**				
	Never	44 (40.4)	44 (40.0)	0.089	0.993
	Rarely	29 (26.6)	30 (27.3)		
	Sometimes	27 (24.8)	28 (25.5)		
	Often	9 (8.3)	8 (7.3)		
12.	**My social relationships are superficia**l				
	Never	15 (13.8)	13 (11.8)	0.911	0.823
	Rarely	27 (24.8)	28 (25.5)		
	Sometimes	43 (39.4)	49 (44.5)		
	Often	24 (22.0)	20 (18.2)		
13.	**No one really knows me well**				
	Never	24 (22.0)	21 (19.1)	0.455	0.929
	Rarely	31 (28.4)	32 (29.1)		
	Sometimes	35 (32.1)	39 (35.5)		
	Often	19 (17.4)	18 (16.4)		
14.	**I feel isolated from others**				
	Never	43 (39.4)	41 (37.3)	0.213	0.975
	Rarely	34 (31.2)	34 (30.9)		
	Sometimes	25 (22.9)	28 (25.5)		
	Often	7 (6.4)	7 (6.4)		
15.	**I can find companionship when I want it**				
	Never	5 (4.6)	3 (2.7)	1.320	0.724
	Rarely	22 (20.2)	21 (19.1)		
	Sometimes	51 (46.8)	48 (43.6)		
	Often	31 (28.4)	38 (34.5)		
16.	**There are people who really understand me**				
	Never	8 (7.3)	11 (10.0)	1.592	0.661
	Rarely	22 (20.2)	21 (19.1)		
	Sometimes	40 (36.7)	33 (30.0)		
	Often	39 (35.8)	45 (40.9)		
17.	**I am unhappy being so withdrawn**				
	Never	37 (33.9)	31 (28.2)	3.390	0.335
	Rarely	37 (33.9)	34 (30.9)		

Table 2 Continued:

	Variable	Sample 1 $(n_1 = 109)$	Sample 2 $(n_2 = 110)$	χ^2	*p*-value
	Sometimes	22 (20.2)	34 (30.9)		
	Often	13 (11.9)	11 (10.0)		
18.	**People are around me but not with me**				
	Never	30 (27.5)	26 (23.6)	2.070	0.558
	Rarely	30 (27.5)	39 (35.5)		
	Sometimes	34 (31.2)	34 (30.9)		
	Often	15 (13.8)	11 (10.0)		
19.	**There are people I can talk to**				
	Never	2 (1.8)	5 (4.5)	4.156	0.245
	Rarely	11 (10.1)	9 (8.2)		
	Sometimes	42 (38.5)	31 (28.2)		
	Often	54 (49.5)	65 (59.1)		
20.	**There are people I can turn to**				
	Never	5 (4.6)	6 (5.5)	5.185	0.159
	Rarely	16 (14.7)	10 (9.1)		
	Sometimes	40 (36.7)	30 (27.3)		
	Often	48 (44.0)	64 (58.2)		

3.2 Factorial construct validity

The Kaiser–Meyer–Olkin (KMO) and Bartlett's test values for every construct are presented in Tables 4 and 6. The KMO value was more than 0.600, which is regarded as satisfactory. Bartlett's Test of Sphericity yielded significant results ($p < 0.001$) for all the constructs, indicating rejection of the null hypothesis that the correlation matrix was an identity matrix, and the correlations exist among the variables, which makes it acceptable for factor analysis. The KMO value exceeds 0.6 with a significant Bartlett's test, indicating that factorability is assumed and suitable to continue with the factor analysis. As noted in Section 2.3, Direct Oblimin oblique rotation was applied to account for potential correlations among the factors. In addition, item communalities were reviewed to assess the amount of variance each item shared with the retained factors. Most items demonstrated acceptable communalities above 0.40, and factor loadings generally exceeded the 0.50 threshold, indicating good representation of the latent constructs [19, 47].

Table 3: Total variance explained before deletion of items (Sample 1, $n_1 = 109$).

Factor	Initial Eigenvalues		ESSL[1]		Item
	E[2]	CV[3] (%)	E[2]	CV[3] (%)	
1	6.732	33.660	6.319	31.593	L11, L14, L17, L18
2	3.172	49.521	2.699	45.088	L12, RL1, RL4, RL5, RL6, RL9, RL15
3	1.272	55.883	0.834	49.258	RL10, RL16, RL19, RL20
4	1.058	61.171	0.600	52.256	L2, L3, L7, L8, L13

[1]Extraction sum of squared loadings; [2]Eigenvalues; [3]Cumulative variance.

Based on the initial eigenvalues before extraction, the latent root criteria recommend retaining four factors with an eigenvalue cut-off of 1.0 (Table 3). This aligns with the scree analysis, which

also indicates the retention of four factors, as illustrated in Figure 1. Additionally, the eigenvalues for the extracted factors continue to validate the presence of four factors since the percentage of total variance explained remains above 50% (Table 3). However, the main difference is seen in the extracted eigenvalue of Factor 4, which drops below the cut-off value of 1.0.
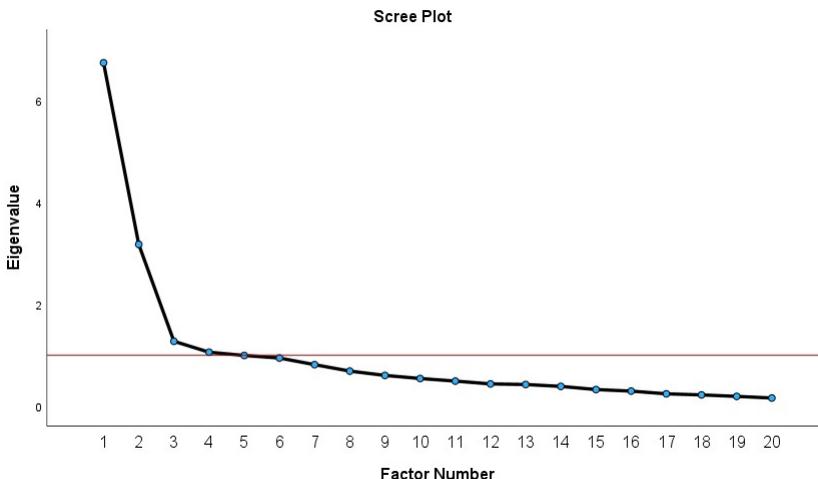

Figure 1: Scree plot before deletion of the items (Sample 1, n_1=109).

The combination of these criteria has resulted in the decision to retain four factors. However, as illustrated in Table 4, item L12 exhibits low communality and does not align with its designated factor. Similarly, item RL4 demonstrates low communality. Therefore, EFA was re-run by excluding items L12 and RL4 one by one. Following the removal of these two problematic items, the factor structure was reassessed by rerunning the EFA. Given the extracted eigenvalue for the fourth factor had dropped below 1.0, a forced three-factor solution was applied. The items were reallocated accordingly based on their loadings, which resulted in a clearer and more interpretable structure. The three retained factors aligned conceptually with the theoretical dimensions of loneliness: isolation, relational connectedness, and collective connectedness.

Table 5 presents the total variance explained after the exclusion of items L12 and RL4. According to the original eigenvalues, the latent root criterion suggests retaining three factors with an eigenvalue cut-off of 1.0 (Table 5). This corresponds with the scree analysis, which indicates the retention of three factors, as illustrated in Figure 2. In addition, the eigenvalues after the extraction suggest retaining three factors, as the percentage of total variance explained remains greater than 50% (Table 5). However, the primary distinction was observed in the extracted eigenvalue of Factor 3, which falls below the cut-off value of 1.0. Combining these criteria resulted in the decision to retain three factors for subsequent analysis. These three factors explain 51.738% of the variation, which was judged satisfactory in terms of the total variance explained [19].

Table 4: Loadings and communalities before deletion of items (Sample 1, $n_1 = 109$).

Item	Extraction				
	Communalities	Factor			
		1	2	3	4
L2	0.427	0.297	-0.159	-0.028	**0.397**
L3	0.473	0.192	0.109	0.320	**0.400**
L7	0.653	-0.029	-0.044	0.066	**0.800**
L8	0.660	0.095	-0.030	-0.052	**0.761**
L11	0.876	**0.864**	-0.066	0.085	0.035
L12	**0.290**	0.127	**0.543**	0.032	0.079
L13	0.458	0.193	0.163	0.208	**0.461**
L14	0.628	**0.795**	-0.060	-0.021	-0.010
L17	0.371	**0.591**	0.131	0.067	0.006
L18	0.693	**0.714**	-0.114	-0.186	0.221
RL1	0.300	0.178	**-0.454**	0.082	-0.074
RL4	**0.200**	0.038	**-0.381**	0.101	-0.114
RL5	0.435	0.105	**-0.508**	0.191	-0.015
RL6	0.547	-0.024	**-0.707**	-0.029	0.245
RL9	0.456	0.030	**-0.597**	0.067	0.147
RL10	0.537	-0.073	-0.144	**0.656**	0.053
RL15	0.408	0.025	**-0.506**	0.187	0.039
RL16	0.530	0.130	-0.214	**0.533**	0.011
RL19	0.809	-0.023	-0.008	**0.893**	0.037
RL20	0.700	0.001	-0.053	**0.809**	-0.008

KMO Test = 0.861, **Bartlett's Test of Sphericity** = 1053.622 ($p < 0.001$)

Table 5: Total variance explained after deletion of items (Sample 1, $n_1 = 109$).

Factor	Initial Eigenvalues		ESSL[1]		Item
	E[2]	CV[3] (%)	E[2]	CV[3] (%)	
1 (Isolation)	6.650	36.946	6.200	34.446	L2, L3, L7, L8, L11, L13, L14, L17, L18
2 (Relational Connectedness)	2.826	52.646	2.364	47.577	RL10, RL16, RL19, RL20
3 (Collective Connectedness)	1.200	59.310	0.749	51.738	RL1, RL5, RL6, RL9, RL15

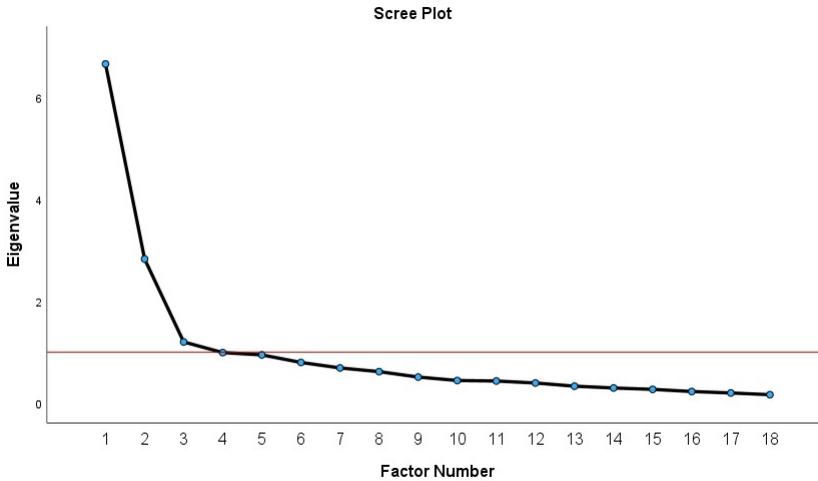[1]Extraction sum of squared loadings;　[2]Eigenvalues;　[3]Cumulative variance.

Figure 2: Scree plot after deletion of the items (Sample 1, n_1=109).

Table 6: Loadings and communalities after deletion of items (Sample 1, $\boldsymbol{n_1 = 109}$).

Item	Communalities	Extraction		
		Factor		
		1	**2**	**3**
L2	0.423	**0.602**	-0.031	0.149
L3	0.465	**0.579**	0.280	-0.100
L7	0.469	**0.660**	0.061	0.005
L8	0.533	**0.751**	-0.028	-0.049
L11	0.764	**0.817**	0.046	0.108
L13	0.430	**0.630**	0.157	-0.139
L14	0.524	**0.693**	-0.075	0.147
L17	0.322	**0.581**	0.027	-0.093
L18	0.686	**0.830**	-0.241	0.169
RL1	0.328	0.002	0.049	**0.545**
RL5	0.461	-0.012	0.147	**0.594**
RL6	0.564	0.053	-0.052	**0.760**
RL9	0.419	0.060	0.093	**0.572**
RL10	0.549	-0.009	**0.661**	0.139
RL15	0.372	-0.013	0.229	**0.462**
RL16	0.535	0.119	**0.520**	0.243
RL19	0.794	0.064	**0.833**	0.062
RL20	0.677	0.023	**0.727**	0.149

KMO Test = 0.871, **Bartlett's Test of Sphericity** = 988.371 ($p < 0.001$)

Table 6 shows the finalized loadings and communalities after the deletion of items L12 and RL4. Based on the table, all variables demonstrate significant loadings, each exceeding the 0.5 threshold. Additionally, all items' communalities surpass 0.3. This study identified three factors,

with Factor 1 encompassing positively worded items, while Factors 2 and 3 consist of negatively worded items. All the retained items were included and further inspected in CFA (Table 5).

3.3 Confirmatory factor analysis (CFA)

Although not shown, all the variables were observed to have skewness and kurtosis values falling within the permissible range of -2 to $+2$. Therefore, all variables in the current study were considered to be normally distributed [27]. Furthermore, the data met the assumption of multivariate normality since Mardia's kurtosis coefficient was lower than the M_c, as suggested by Pérez-Fabello and Campos [39] and Sanchez-Lizarraga et al. [46].

Table 7: Results of CFA (Sample 2, $n_2 = 110$).

Item	Estimate	S.E.	Standardized Estimate	CR	p-value	Reliability and Validity
			Factor 1: Isolation			
L2	1.000		0.501			
L3	1.250	0.280	0.584	4.456	<0.001	
L7	1.400	0.294	0.656	4.755	<0.001	
L8	1.256	0.284	0.578	4.429	<0.001	CR = 0.876,
L11	1.848	0.352	0.807	5.247	<0.001	AVE = 0.447,
L13	1.620	0.329	0.702	4.923	<0.001	$\alpha = 0.875$
L14	1.891	0.352	0.855	5.367	<0.001	
L17	1.186	0.286	0.519	4.142	<0.001	
L18	1.588	0.318	0.722	4.992	<0.001	
			Factor 2: Relational Connectedness			
RL10	1.000		0.620			
RL16	1.320	0.213	0.695	6.201	<0.001	CR = 0.880,
RL19	1.485	0.193	0.949	7.680	<0.001	AVE = 0.655,
RL20	1.511	0.200	0.922	7.572	<0.001	$\alpha = 0.862$
			Factor 3: Collective Connectedness			
RL1	1.000		0.738			
RL5	1.148	0.149	0.764	7.680	<0.001	CR = 0.829,
RL6	1.199	0.147	0.812	8.152	<0.001	AVE = 0.499,
RL9	0.823	0.171	0.483	4.800	<0.001	$\alpha = 0.825$
RL15	0.974	0.141	0.688	6.894	<0.001	
Fit Indices	Chi-square test (χ^2) = 250.934, $d = 132$, Ratio Chi-square (χ^2Ratio) = 1.901, Root Mean Square Error of Approximation (RMSEA) = 0.091, Standardized Root Mean Square Residual (SRMR) = 0.080, the Goodness of Fit Index (GFI) = 0.806, and Comparative Fit Index (CFI) = 0.886.					

Table 7 shows the estimate, reliability, validity, and model fitness of the loneliness scale. All items display factor loadings exceeding 0.5, with the exception of item RL9, which approaches the

0.5 threshold. The fit indices indicate that the chi-square value was significant, and all other fit indices were approaching the threshold values, signifying a reasonable model fit. Moreover, all factors have Cronbach's alpha and composite reliability of more than 0.8, confirming the scale's good internal consistency. The AVE values for some constructs (isolation and collective connectedness) were lower than the threshold of 0.5, approaching the threshold. However, the construct's convergent validity remains satisfactory as long as the composite reliability is above 0.6 [18].

Table 8: Results of CFA (Sample 2, $n_2 = 110$).

	Isolation	Relational Connectedness	Collective Connectedness
Isolation	▉		
Relational Connectedness	0.231	▉	
Collective Connectedness	0.448	0.889	▉

Table 8 shows the HTMT values for the loneliness scale. The analysis found an HTMT ratio below 0.9, suggesting the model's discriminant validity was established.

4   Discussion

The present study explored the factorial structure of the Revised UCLA Loneliness Scale among pre-university students at Universiti Malaysia Sabah. A total of 219 students took part, and the sample was split into two groups for the execution of EFA and CFA. The findings corroborated the notion that the UCLA Loneliness Scale embodies loneliness as a multidimensional construct rather than a unidimensional one. Specifically, this study posits a three-factor structure for the R-UCLA Loneliness Scale, initially discerned through EFA and subsequently validated through CFA. The three identified dimensions are isolation, relational connectedness, and collective connectedness capture distinct yet interrelated aspects of students' loneliness experiences.

Pre-university students represent a transitional demographic often marked by academic stress, evolving social identities, and limited autonomy. These factors may intensify feelings of disconnection or amplify sensitivity to relational dynamics, making it important to assess loneliness through a framework that captures multiple dimensions of the construct. The consistent identification of a three-factor solution, as demonstrated in this study, has been persistently observed across diverse populations. This pattern has been observed among university students in various contexts, including Western college [1], New York [6], Columbus [21], Southwestern university [35], Australia [7], Turkey [15], South Africa [41], as well as among high school students in Poland [29], despite the use of different versions of the UCLA Loneliness Scale.

Within the Malaysian context, there has been limited exploration into the factor structure of the UCLA Loneliness Scale among the student population. To date, only Swami [53] has conducted a study on this matter, utilizing the Malay version of the eight-item ULS (ULS-8). 532 participants from Malaysian community samples participated in the study of Swami [53], and the results sup-

ported a unidimensional structure. Other studies in Malaysia have typically utilized the 20–item UCLA Loneliness Scale as a one-factor scale without examining its factor structure. These studies investigated the relationship between loneliness among undergraduate students and various factors such as face-to-face communication [23], social media and messaging applications [13], social media addiction [45], internet addiction [2, 26], demographic characteristics [52], and mental health [63]. Meanwhile, Roseli and Mahyuddin [43] and Uba et al. [56] used a 20–item UCLA Loneliness Scale as a one-factor scale to explore the risk factors associated with loneliness among university students and the connection between loneliness and depression among high school students, respectively.

Moreover, the three factors that have been found in the previous studies were labelled with different names, sometimes featuring overlapping terminology. Nevertheless, none of the identified factor solutions represent the same set of items. For instance, Adams et al. [1] categorized these factors as "psychological loneliness", "psychosocial loneliness", and "social loneliness". Austin [6] used labels such as "intimate others", "social others", and "belonging and affiliation", and McWhirter et al. [35] labelled them as "intimate others", "social others", and "affiliative environments". The most widely adopted terminology comes from Hawkley et al. [21], who labeled the three factors as "isolation", "relational connectedness", and "collective connectedness". These terms have been applied across various populations, including French Canadian teachers [16], the general and older populations in the United States [40], and university students in Australia [7] and South Africa [41]. This study also adopted these three factors as "isolation", "relational connectedness", and "collective connectedness". This nomenclature was chosen because all the items within these factors align with the definitions provided by Hawkley et al. [21].

These variations in item allocation and factor labeling across studies may, in part, be attributed to differences in language nuances, sociocultural norms, and how loneliness is perceived or expressed in different cultural contexts. In particular, cultural interpretations of social connectedness and group affiliation may influence how individuals respond to certain items, potentially affecting the dimensionality structure observed in each setting. This variability in naming and item allocation may also suggest that while core constructs of loneliness remain relatively stable, the specific structure and interpretation of these constructs can be fluid across populations. Cultural values, language expression, and societal expectations can shape how individuals conceptualize and experience loneliness, which in turn affects how they respond to scale items and how these items cluster into factors.

While the three-factor structure identified in this study is consistent with those reported in previous research, slight variations were observed in terms of item allocation and factor strength. Most items showed strong loadings on the same dimensions as in Hawkley et al. [21], particularly within the isolation and relational connectedness factors. However, a few items related to social belonging and group identity demonstrated moderate cross-loadings or shifted factor alignment, particularly within the collective connectedness dimension. These differences may reflect contextual and cultural nuances specific to the Malaysian pre-university student population, highlighting the importance of validating psychological constructs within local settings.

The first factor, called "isolation", comprises 9 out of the 20 items on the scale and appears to be associated with loneliness at the individual level. As indicated by Hawkley et al. [21] and Shevlin et al. [49], this factor encapsulates emotions of aloneness and withdrawal, assumed to serve as fundamental components underlying the experience of loneliness. Adolescents often experience feelings of withdrawal and aloneness, which some may view as beneficial since it allows them to spend time alone developing their identities [49].

The second and third factors relate to the social dimensions of loneliness and focus on inter-

actions within social networks [21, 49]. The relational connectedness factor includes items that express sentiments of familiarity, intimacy, and support, reflecting the concept of a relational social self. These elements of social support play a crucial role in establishing connections with others and may act as a safeguard, mitigating the adverse effects commonly associated with loneliness [49]. The third factor, "collective connectedness", refers to group cohesion and is shown via phenomena such as a sense of being "in tune with others" or having shared interests. These features address sentiments of cohesiveness and group identification, which correspond to the idea of a collective social self [21, 49].

The UCLA scale as a whole, as well as the three derived factors, displayed good levels of internal consistency. Specifically, Cronbach's alpha was 0.89 for the full scale, 0.86 for isolation, 0.84 for relational connectedness, and 0.82 for collective connectedness, indicating satisfactory reliability for each subscale. The factor loadings in this model exhibited positive values and were found to be statistically significant. Consequently, these factors are suitable for use in survey contexts, particularly within the pre-university student population in Sabah. Although these three variables were significantly associated, with correlations ranging from 0.270 to 0.820, the HTMT ratio is less than 0.9, indicating that the model's discriminant validity was established. This suggests that each of these three factors possesses distinct and unique characteristics from one another. Adopting a multidimensional approach to loneliness not only enhances conceptual understanding but also enables more targeted interventions. For instance, strategies aimed at strengthening peer relationships may be more effective for students scoring high on relational disconnectedness, while community-building efforts may better address deficits in collective connectedness.

Additionally, item 12 ("My social relationships are superficial") displayed low communality and factor loading, failing to load with its designated factor. Communality represents the amount of variance in a measured variable explained by the factor it indicates [19]. A low communality indicates that the item does not share much variance with the other items in the scale and may not be adequately explained by the underlying construct being measured. Factor loading, on the other hand, represents the correlation between the item and the underlying factor [19]. Low factor loading suggests that the item is not a good indicator of the construct being measured.

The low communality and factor loading of item 12 suggest that it did not effectively capture the intended construct (isolation). The word "superficial" in the item may have contributed to this issue. "Superficial" is open to various interpretations, and pre-university students may have different understandings of what constitutes "superficial." The potential confusion caused by the word "superficial," which might not be well understood by college students [15], could lead to inconsistent responses and ultimately result in the item not aligning with the intended factor.

Given its consistently low communality and poor loading, item 12 may not adequately represent the construct of isolation among pre-university students. Future use of the scale in similar populations may consider rewording the item to improve clarity (e.g., replacing the word "superficial" with more contextually relatable language), or omitting the item entirely if psychometric performance remains weak across further studies.

Similarly, item 4 ("I do not feel alone") exhibited low communality and factor loading. Consistent findings regarding item 4 emerged across culturally and sociologically diverse samples of various ages, including older adults [30, 31], high school students [29], parents [5], and adults [22]. Studies consistently reported that item 4 exhibits low factor loading and fails to adequately load on any factor, suggesting it may operate differently than other items in the scale. The direct wording of the item might be the root of this issue, which could cause the findings to be distorted by the ceiling effect [30].

5   Limitations and Suggestions

The present study is subject to certain limitations warranting acknowledgement. Firstly, its development took place within a specific setting and among a particular population, thereby constraining the applicability of the results to broader contexts and diverse populations. Specifically, the study's sample comprises pre-university students at Universiti Malaysia Sabah, introducing limitations in generalizability beyond this specific demographic. Moreover, the reliance on an English-language questionnaire and the relatively modest sample size constitutes additional limitations.

To address these constraints, future research endeavors could benefit from expanding the participant pool to include students from various academic years (such as first, second, third-year, and final-year students) across different faculties and encompassing diverse levels of higher education, including postgraduate students. Such an approach would enhance the generalizability of findings to the broader student body at Universiti Malaysia Sabah. Furthermore, the study recommends adopting a bilingual approach during data collection to augment the reliability and accuracy of the findings.

6   Conclusions

In conclusion, this study aligns with prior empirical evidence, reinforcing the existence of three consistent dimensions of loneliness observed across various populations. This multidimensional model encompasses the dimensions of "isolation", "relational connectedness", and "collective connectedness". It is advised that future research, particularly those focusing on the population of pre-university students, using the UCLA Loneliness Scale as a multidimensional rather than a unidimensional measure. Recognizing and assessing the various dimensions within the scale, such as "isolation", "relational connectedness", and "collective connectedness", would offer a more nuanced and comprehensive evaluation of loneliness in this specific demographic. This shift towards a multidimensional perspective can enhance the precision of research findings and contribute to a deeper understanding of the multifaceted nature of loneliness among pre-university students. Additionally, these insights hold significant implications for the design of intervention programs, particularly in addressing adolescent loneliness. By recognizing and targeting the various dimensions of loneliness, intervention strategies can be more precisely tailored, offering valuable opportunities for developing or organizing beneficial programs that cater to the diverse experiences of loneliness among pre-university students.

Conflicts of Interest The authors declare that there are no conflicts of interest.

Ethical Considerations The study involved a voluntary questionnaire survey among pre-university students at Universiti Malaysia Sabah. Permission to conduct the study was obtained from the relevant academic unit at the Preparatory Centre for Science and Technology (PPST), Universiti Malaysia Sabah. Participation was voluntary and informed consent was obtained from all respondents prior to completing the questionnaire. The survey was conducted anonymously and no

identifiable personal information was collected. As the study involved a non-clinical/humanities survey with minimal risk to participants, formal approval from a medical research ethics committee was not required at our institution.

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