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ADAPTATION AND VALIDATION OF THE METEOROPATHY QUESTIONNAIRE TO THE TURKISH SAMPLE

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Abstract

The present study aimed to adapt and evaluate the psychometric properties of the Meteoropathy Scale (METEO-Q) for the Turkish population. Furthermore, it aims to suppress some limitations of the original study by examining construct validity and test-retest reliability, and associations between certain variables. A total of 603 participants (*M*=34,92, *SD*=13,57) were recruited. METEO-Q, Seasonal Pattern Assessment Questionnaire (SPAQ), and sociodemographic form were utilized to collect data. To test the construct validity, exploratory factor analysis and confirmatory factor analysis were carried out. The exploratory factor analysis result pointed out the presence of a two-factor structure. Two-factor structure exhibited a reasonable model fit in the confirmatory factor analysis. The two factors (meteorosensitivity and meteoropathy), structured checklist and, total score of METEO-Q indicated good reliability (α = .86, .88, .95, .93, respectively). Test-retest reliability scores demonstrated good reliability. The METEO-Q score was positively associated with SPAQ, gender, self-mutilation, and suicidal behaviors. In conclusion, the Turkish version of METEO-Q provides a valid and reliable measurement tool for the general population.

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The ancient Greeks realized a relationship between the weather and people's health. Thus, they created the term meteoropathy from the combination of the Greek words meteora and pathos (Žikić & Rabi-Žikić, 2018). Meteoropathy means weather-related illness, symptom, pain. It impacts every facet of an individual's life (Celic et al., 2019). Temperature, humidity, barometric pressure, and the degree of brightness of the sun are the variables that come to mind when it comes to weather. A sudden or severe change in at least one of these variables causes mental and physical symptoms in susceptible individuals: headache, weakness, sensitivity to muscle and joint pain, depressed mood, irritability, and palpitation. These symptoms often regress within a day or two (Mazza et al., 2012).

Meteorosensitive people are those who have a biological predisposition to experiencing the effects of changes in the climate on their mental and physical state. The quantity of this sensitivity is different among meteoropathic individuals—those who develop a particular illness or worsen existing health conditions due to these changes. Some people experience new symptoms; on the other hand, some face a worsening of pre-existing diseases (Mazza et al., 2012). Meteoropathy is more severe in women, middle-aged or older people, and those with chronic diseases (Licanin et al., 2012). In addition, meteoropathy can be seen in children, too (Janiri et al., 2009). Meteoropathy is believed to be a condition of modern times, where people often spend time indoors. People who do physical activity and spend a few hours a day outside generally do not experience weather-related discomfort (Janiri et al., 2009). To sum up, meteoropathy can expand in this century due to a person's poor adaptation to the weather conditions by spending less time outdoors, i.e., in climate-controlled conditions (Lickiewicz et al., 2020).

It has been shown in the literature that very low-frequency atmospherics cause physical and chemical effects on the human body and cause physical and mental symptoms in sensitive people. For example, as notified in Dorno's case report in 1934, the tinnitus symptom that occurred after the war changed with the impulse rate of the atmosphere. Reiter, on the other hand, determined the relationship between pain sensitivity and very low-frequency atmospherics in damaged tissues in the 1960s (Schienle et al., 1998). Jakobi and colleagues suggested that atmospheric pressure is a biological stressor that increases platelet adhesion (Jacobi et al., 1981). Participants with high psychasthenia scores in the Minnesota Multidimensional Personality Inventory were more affected by low-frequency atmospherics (Jacobi et al., 1981).

When healthy subjects were exposed to low-frequency atmospherics, EEG changes occurred in alpha and beta frequencies. Persons with meteoropathy or meteorosensitivity complaints more frequently reported symptoms during exposure,

but there was no significant difference in their EEG compared to the control group (Schienle et al., 2001).

In a study conducted with healthy individuals, there was a stronger correlation between rheoencephalography findings and fluctuations in weather conditions in men than in women (Vodolazhskaya & Vodolazhskii, 2016). In the same study, cerebral weather sensitivity was most common in the post-ovulatory phase in non-meteoropathic women, and cerebral weather sensitivity was rarely seen in the preovulatory phase (Vodolazhskaya & Vodolazhskii, 2016).

Air temperature regulates brain development by changing gene expression and neuronal structure in animal experiments. Furthermore, ambient temperature affects neurogenesis in the adult human brain and mental health is adversely affected in people who have short-term exposure to harsh weather conditions and are exposed to hurricanes (Ruszkiewicz et al., 2019).

A person suffering from psychiatric problems could be more vulnerable to weather and climatic variations (Janiri et al., 2009; Di Nicola et al., 2020; Oniszczenko, 2020). For instance, meteoropathy is associated with suicide attempts in bipolar disorder patients (Di Nicola et al., 2020). Oniszczenko (2020) claimed meteorosensitivity is associated with mood-related affective temperaments and has mediated the relationship between insomnia and affective temperament. Weather conditions are also associated with seasonal affective disorder (Oniszczenko, 2020). Individuals with a high degree of seasonality exhibited a tendency to respond emotionally to the weather conditions (Reid et al., 2000). The relationship between psychiatric diseases and meteoropathy draws attention. Furthermore, physical conditions have also been affected by weather variations. For example, total knee arthroplasty patients reported that meteoropathy could trigger their pain (Loth et al., 2018).

As given in the related literature, meteoropathy draws attention from researchers due to atmospheric events being an important factor affecting the mental and physical well-being of individuals. The Meteoropathy Scale was developed by Mazza et al. (2012) and subsequently studied across various populations to assess meteoropathy. Unfortunately, there is currently no validated measurement tool to assess meteoropathy in the Turkish population. Furthermore, the original developmental study of the Meteoropathy scale has some limitations on validity and reliability analyses. Specifically, the original study did not perform both exploratory and confirmatory factor analyses to test construct validity and did not examine test-rest reliability. Thus, the present study aims to test the Turkish validity and reliability of the Meteoropathy Questionnaire (METEO-Q) while addressing certain limitations of the original study. Specifically, we aimed to expand the original scale study of METEO-Q by testing the scale's construct validity with exploratory and confirmatory factor analyses. Furthermore, we aimed to expand reliability by performing test-retest reliability and to explore the associations with the Turkish

version of the METEO-Q with the seasonality and symptom severity of seasonal affective disorder scale, gender, and certain psychiatric conditions.

Method

Participants

A convenience sample of 603 participants was enrolled in this study. All participants confirmed the study with informed consent before receiving the related measurement tools. Their ages ranged from 18 and 87 years (*M*=34.92, *SD*=13.57). A total of 339 (56.2%) were female, and 43,8% were male participants. Most of the participants graduated from a university (55.4%). Regarding marital status, 23.4% were in a relationship, 36.3% were single, and 40.3% were married. Most of the participants (54.6%) had full-time jobs. A second sample of 44 participants was recruited for test-retest reliability analysis. The mean age was found to be 21.68 (*SD* = 4.88), ranging between 18 and 50 for this small sample. Most of the participants (81.8%) were female, and 40.9% of the participants were in a relationship, whereas 59.1% of the participants were single. Half of them (50%) completed high school and the rest attended university. None of them had a full-time job.

Instruments

Sociodemographic data form

The researchers use that to investigate the descriptive demographic forms of the participants, such as age, gender, educational level, marital status, occupation, and whether the participants have any disease history.

METEO-Q

We used the METEO-Q developed by Mazza et al. (2012) to adapt and examine the psychometric properties of the Turkish population. The 11-item METEO-Q contains two parts: meteorosensitivity and meteoropathy. Meteorosensitivity refers to the body and mind's biological susceptibility to atmospheric events. Meteoropathy is about suffering from the development of a particular illness or experiencing a worsening of an existing disease due to climatic changes. The first five items of the measurement assess meteorosensitivity both qualitatively and quantitatively. After rating the first five items, participants were instructed to write about any induced modifications for each item, following the given instruction: “specify induced modifications”. The subsequent six items of the METEO-Q measure meteoropathy, focusing on the quantified effects of the symptoms. There is also a 21-item structured symptom checklist for the physical and psychological symptoms associated with climatic changes at the end of the scale.

Participants were asked to rate the extent to which they experienced each item based on a 5-point Likert scale ranging from 0 (absent) to 4 (severe). The descriptive statistics of the questionnaire are presented at Table 1 and Table 2.

Seasonal Pattern Assessment Questionnaire (SPAQ)

SPAQ was developed by Rosental et al. (1987) to investigate seasonal affective disorder. The Turkish adaptation study was conducted by Noyan et al. (2000). The Turkish form of SPAQ has two factors: sleep, mood, social activity, and energy; the other factors are appetite and weight, according to the factor analysis results. The first six items were about the global seasonality, and the internal consistency of the global seasonality was found. 67. The global seasonal scale exhibited good internal consistency (Cronbach alpha score was .87) in our study.

Procedure

First, the researchers requested permission for the Turkish adaptation of METEO-Q from Dr. Mazza, the questionnaire developer. Eskişehir Osmangazi University Faculty of Medicine, the Non-Invasive Clinical Research Ethics Committee, approved the present study on December 30, 2020, with decision number 57. The English version of METEO-Q was translated into Turkish by the two independent researchers who have good comment on English, and two different forms were subsequently compared to decide the best version of the scale. The obtained form was back-translated by a separate researcher proficient in both English and Turkish. The researchers discussed the potential differences between the original and back-translation forms of the scale. Finally, after sending the translated form to Dr. Mazza, who conducted the original scale review, the final form was obtained. Afterward, we carried out an online survey using Google Forms. The data were collected from social media (e.g., Twitter, Instagram). In addition Evrim Ağacı also shared the link of study on its platform. Online informed consent was obtained by all participants. The measurement set was delivered in the following order: sociodemographic form, METEO-Q, and SPAQ. The online survey took an average of 15 minutes to complete. For the test-retest reliability analysis, we created a new online survey in which it is required to use a nickname and an e-mail or telephone number. After four weeks, we remind the participants to attend the second survey.

Statistical Analysis

The data for the study were analyzed with IBM SPSS version 23 and LISREL Package Program 8.80. First, 603 samples were used to analyze the item distributions. Normality assumptions were checked before the analysis of the study. According to Tabachnick et al. (2013), skewness and kurtosis should be between -1 and +1 for the data to be considered normally distributed. There is no missing data. Afterward, we randomly split the data into two subsamples for exploratory factor analysis (EFA) (n= 300) and confirmatory factor analysis (CFA) (n= 303). It should

be: "Afterward, we randomly split the data into two subsamples for exploratory factor analysis (EFA) (*n*= 300) and confirmatory factor analysis (CFA) (*n*= 303). For exploratory factor analysis, we enrolled 300 participants and ran a Principal Component Analysis with Promax rotation with all METEO-Q items consistent with the original scale. After examining the exploratory factor analysis of the scale, we ran confirmatory factor analysis models to verify the validity of METE-Q by using LISREL Package Program version 8.80 with the remaining 303 random participants. The Comparative Fit Index (CFI), the root of the mean square error of approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), and the chi-square/degrees of freedom were chosen as model fit indices. To get an acceptable model, CFI should be equal to .90 or above (Schermelleh-Engel et al., 2003), RMSEA values should be .08 or below, SRMR should be equal to .05 or below, and the normed chi-square or degrees of freedom should be below 3 (Schermelleh-Engel et al., 2003). The Pearson's correlation analysis was conducted to evaluate the association between scores on METEO-Q and SPAQ. Cronbach's alpha, item-total correlation, and test-retest were used to evaluate the internal consistency and reliability. An independent sample *t*-test was performed to examine scores differences in sociodemographic factors.

Results

Exploratory Factor Analysis

We investigated the factor structure of the METEO-Q using exploratory factor analysis by using a subsample. Kaiser-Meyer-Olkin value was .938 and Bartlett's Test of Sphericity was significant ($\chi 2$ (55)=2277.875, p=.000). Based on the Kaiser criterion, two factor structure (meteorosensitivity and meteoropathy) were extracted, accounting for 68.59% of the total variance. While examining the two-factor solution, all 11 items had good factor loading. As can be seen in Table 1, the factor loading of the Turkish form of METEO-Q ranged between .93 and .50. In other words, each item of the scale significantly contributes to the two-factors at good and excellent levels.

Table 1. Descriptive statistics and exploratory factor analysis results of METEO-Q

METEO-Q	Mean	*SD*	Skewness	Curtosis	Item-Total correlation	Factor loading	
						1	2
Factor 1: Meteorosensitivity							
1. Variations of mood in relation to the change of latitude, the geographic zone, the jet leg.	.60	.88	1.40	1.24	.588	.926	

METEO-Q	Mean	*SD*	Skewness	Curtosis	Item-Total correlation	Factor loading 1	Factor loading 2
Factor 1: Meteorosensitivity							
2. Variations of mood in relation to atmospheric changes (e.g.: when it begins or when it stops raining, when it's cloudy, when it's sunny or when the sun suddenly goes down, when humidity increases).	1.24	1.08	.49	-.66	.806	.664	
3. Variations of mood in relation to the brightness of the sky (when days are more or less luminous or when days "grow tall" or "they are shortened" according to the seasons).	1.28	1.20	.35	-1.27	.808	.682	
4. Variations of mood caused by the temperature changes (warmer or colder days).	1.25	1.57	.52	-.83	.793	.844	
5. Mood changes caused by the seasons changing.	1.17	1.13	.58	-.75	.821	.668	
Factor 2: Meteoropathy							
6. Indicate the degree of relation between the set in symptomatology and the climatic or atmospheric change.	1.29	1.10	.53	-.51	.880		.502
7. Tendency of these disturbs to minimize or disappear when the triggering condition stops or when an opposite environmental condition comes up.	1.24	1.15	.41	-1.14	.779		.801
8. Eventual coincidence of these disturbs with other cyclical phenomena (e.g. menstrual cycle).	.82	1.16	1.28	.33	.702		.783
9. Presence of prodromical symptoms few days before the climatic modifications (irritability, weariness…).	.72	.94	1.20	.66	.723		.909
10. Interference with daily activities due to disturbs induced by climatic changes.	1.08	1.06	.72	-.28	.813		.807
11. Uneasiness feelings induced by climatic changes.	1.09	1.05	.70	-.34	.843		.853

Table 2. Descriptive Results of Symptom Checklist

	Mean	*SD*
Lability of mood	1.39	1.18
Reactivity to external events	1.15	1.14
Depression	1.19	1.14
Anxiety	1.48	1.25
Asthenia	1.51	1.19
Anhedonia	1.64	1.20
Irritability	1.23	1.19
Indefinite feeling of uneasiness	1.53	1.26
Pain	.95	1.19
Vertigo	.36	.77
Headache	.95	1.12
Nausea	.27	.67
Alterations of cardiac rhythm	.44	.82
Concentration difficulties	1.18	1.21
Insomnia	1.13	1.22
Excessive sleepiness	1.31	1.23
Lack of appetite	.50	.91
Excessive appetite	.65	1.02
Digestion dysfunctions	.79	1.14
Alteration of sexuality	.80	1.07
Weakness during work activities	1.44	1.18

Confirmatory Factor Analysis

We ran a confirmatory factor analysis to test the emerged model from EFA of the Turkish version of METEO-Q. This analysis performed on the second subsample, which consisted of 303 participants by using LISREL 8.80.

Table 3. Comparison of the fit indices of the tested model

Model	**$\chi 2$**	**df**	**$\chi 2$ /df**	**CFI**	**SRMR**	**RMSEA**
Two-factor model	214.60	43	4.99	.96	.06	.11
Two-factor model with three covariance error	114.86	40	2.87	.98	.04	.08

We tested the model of METEO-Q, which indicating two-factor structure. The initial model exhibited poor model fit, as indicated by the following fit indices: $\chi 2$ = 214.60, p = .00; RMSEA= .11, SRMR= .056, CFI= .96, $\chi 2$/df= 4.99. The examination of modification indices' suggestions revealed some modifications that hold statistical and theoretical significance, aimed at improving the model fit. In accordance with the modification suggestion, we set the error term freely between

the following item pairs; item 6 and item 10; item 6 and item 11, and item 10 and item 11 (see figure 1). Finally, we achieved a better adjustment of this final two-factor model with three covariance error terms ($\chi 2 = 114.86$, $p = .00$; RMSEA= .08, SRMR= .04, CFI= .98, $\chi 2/df = 2.87$). As shown in Table 2, the fit indices of the model that setting covariance indicated a better fit.

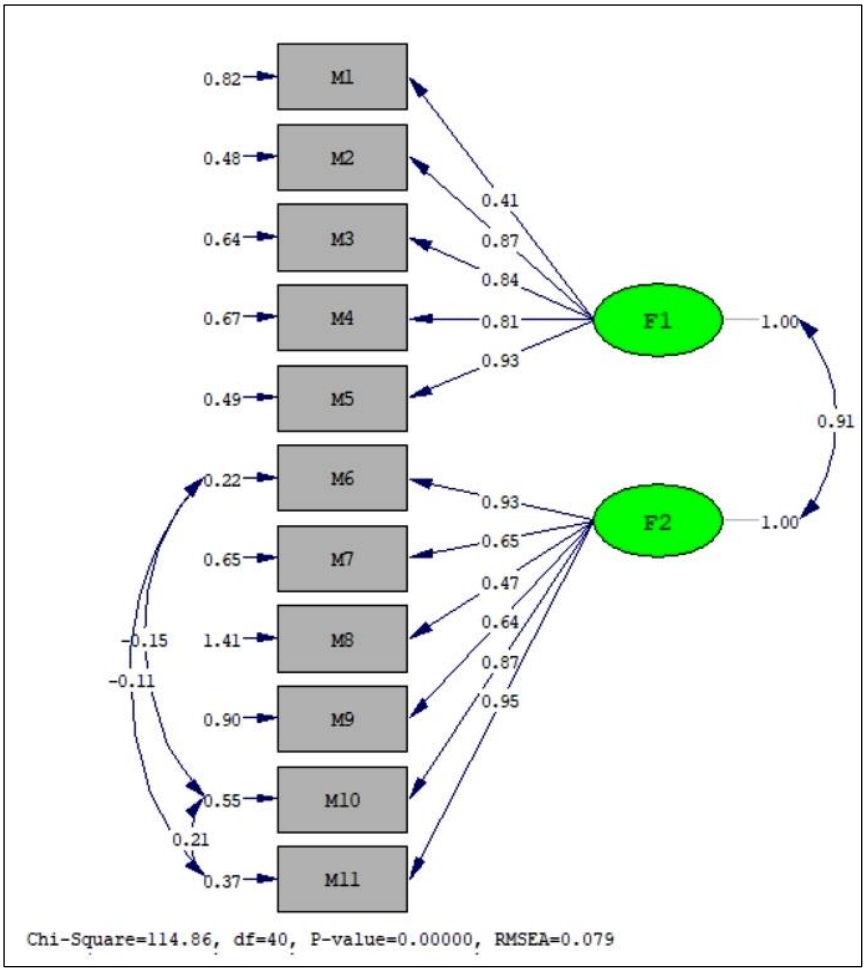

Figure 1.

Reliability

We used internal consistency by computing Cronbach's Alpha scores for the total METEO-Q and subscales to examine the reliability of the total sample. Internal

consistency for the total scale score was .93, and internal consistency of the subscales was determined as .86 for meteorosensitivity and .88 for meteoropathy. We calculated the Cronbach alpha score as .95 for the structured checklist. The item-total correlation is presented in Table 1. Furthermore, we also conducted a test-retest reliability score with a sample size of 44. The test-retest reliability revealed that the total score of METEO-Q (r =.68, p <.001), meteorosensitivity subscale (r =.56, p <.001), meteoropathy subscale (r =.66, p <.001), and the structured checklist (r =.75, p <.001) had positive and significant reliability.

Correlation with SPAQ

As previous research claimed that alterations in weather changes may also trigger psychological disorders, specifically seasonal affective disorder (Cianconi et al., 2020), we calculated the Pearson correlation coefficient between the total score, subscales of METEO-Q, the structured checklist, and SPAQ on the total sample. As expected, we found a positive relationship between the total and subscales of METEO-Q, the structured checklist, and a positive relationship between SPAQ-Global seasonality and severity. The correlation coefficient between the variables is presented in Table 4.

Table 4. Correlation coefficients between METEO-Q and SPAQ

	1	**2**	**3**	**4**	**5**	**6**
1.METEO-Q Total		.939**	.957**	.771**	.730**	.565**
2. Meteorosensitivity			.798**	.679**	.671**	.475**
3. Meteoropathy				.775**	.710**	.561**
4. METEO-Q Checklist					.784**	.627**
5. SPAQ-Seasonality						.535**
6.SPAQ-severity of the symptoms						

**. Correlation is significant at the 0.01 level (2-tailed).

Subgroup Differences Analysis

The independent samples t-test was carried out to measure the mean differences in gender in the total sample. There were significant differences between men and women in total METEO-Q ($t_{(601)}$ = -7.938, p<.001), meteorosensitivity ($t_{(601)}$ = -6.512, p<.001), meteoropathy ($t_{(601)}$ = -8.340, p<.001), and the structured checklist ($t_{(601)}$ = -7.409, p<.001). Women had significantly higher mean score than men. There was also significant mean difference in suicidality in total METEO-Q ($t_{(601)}$ = -4.593, p<.001), meteorosensitivity ($t_{(601)}$ = -3.550, p<.001), meteoropathy ($t_{(601)}$ = -5.034, p<.001), and the structured checklist ($t_{(601)}$ = -6.216, p<.001). In other words, participants who attempted suicide scored higher. Finally, we found a statistically significant differences in self-mutilation in total METEO-Q ($t_{(601)}$ = -6.892, p<.001),

meteorosensitivity ($t_{(601)}$=-6.119, p<.001), meteoropathy ($t_{(601)}$ = -6.846, p<.001), and the structured checklist ($t_{(601)}$=-8.892, p<.001).

Discussion

The current study aimed to adapt and examine the psychometric properties of the METEO-Q Scale in the Turkish population. Besides, this study also aimed to eliminate some of the limitations of the original study by testing factor structure. We demonstrated that the Turkish version of METEO-Q had good psychometric properties when used with the Turkish population. As consistent with the original study of Mazza et al. (2012), the scale had a two-factor structure. As presented in the related literature, gender and some psychiatric conditions, such as suicide attempts and self-mutilation, were found to be associated with both the total and subscale scores on the scale.

Our first goal was tested by conducting exploratory factor analysis to test the construct validity of METEO-Q. The scale had two factors, and all items made statistically significant contributions to measuring meteoropathy. Mazza et al. (2012) did not examine construct validity in the development study. Instead, they tested the scale with classical item analysis, including the index of difficulty and the index of discrimination as the analysis indicators. However, factor analysis is the most common technique for construct validity in psychological measurement (Ellis, 2017). Factor analysis is a superior technique to classical item analysis for some reasons, such as comparing item intercorrelations with other items simultaneously and providing the factor numbers (Benson, 1978). Thus, we first applied exploratory factor analysis to examine construct validity. Our result demonstrated that the scale has two factors, and all items significantly contribute to the scale. The first five items have loaded factor one, meteorosensitivity, and the remaining six items have loaded factor two, which refers to meteoropathy, as in the original study by Mazza et al. (2012).

Our other goal was to verify the validity of the structure obtained from EFA by performing CFA. While the original research did not test the underlying factor structure, we examined the CFA model to find out the underlying factor structure with a different data set. According to CFA results, the two-factor model, which correlated with each other, showed a better fit to the data when setting the free error covariance. According to the results of the present study, meteoropathy and meteorosensitivity are associated with each other. In other words, these two are dependent subdimensions of METEO-Q (Mazza et al., 2012). In sum, METEO-Q has exhibited good construct validity.

We also expected that meteoropathy would be positively associated with seasonal affective disorder, gender, and some psychiatric conditions following the

previous research. As expected, the subdimensions of global seasonality and severity of SPAQ and METEO-Q were positively associated. Thus, we extended the original study's findings in light of this literature. Women had a higher score than men in meteoropathy and meteorosensitivity, as expected in the structured symptom checklist and in line with the study of Mazza et al. (2012). Furthermore, we found that people who attempted suicidal behavior got a higher score on the METEO-Q than those who did not. This finding presented evidence to support the idea that sensitivity to climatic and weather changes was associated with suicidal behaviors (Kim et al., 2004; di Nicola et al., 2020). Besides, some research claimed that weather conditions negatively affected aggressive behavior (Lickiewicz et al., 2020). Following the study of Lickiewicz et al. (2020) on self-mutilation behaviors as indicators of self-directed aggression, we demonstrated that persons who engaged in self-mutilating behaviors showed higher scores in METEO-Q. Our findings have expanded and supported the existing literature, indicating that individuals who suffer from psychiatric problems, including suicidal attempts and self-mutilation, may be more sensitive to weather conditions. Hence, our findings showed that METEO-Q reflected good criteria-related validity by considering the association with SPAQ, gender, and psychiatric conditions.

Regarding reliability analysis, we calculated Cronbach's Alpha scores, inter-item correlation, and test-retest reliability. The total score, two scale factors, and structured symptom checklist showed good internal consistency in line with the original study. In addition, test-retest correlation analysis also refers to adequate reliability scores. Hence, the scale proved to be a reliable measurement tool to assess meteoropathy.

Although the strength of the study was to expand the original study of METEO-Q, this study also addresses some limitations that are important to point out. First of all, the homogeneity of our sample is questionable since we selected our participants via convenience sampling. That means our sample is not representative of Turkish society, so we could not generalize the results. Another limitation is that we used only the general population via an online survey. Future studies should replicate the study with a clinical population such as bipolar disorder, as we know sensitivity to climatic variation is an important issue in some psychiatric conditions.

Despite the limitations, this study contributes to the related literature by extending the psychometric properties of the original study and its necessary implications for clinicians and researchers in psychiatry. Weather and climatic variation impact one's physical and psychological health (Balsamo et al., 1992; Mazza et al., 2012; Celic et al., 2019; Oniszczenko, 2020; Lickiewicz et al., 2020; Rzeszutek et al., 2020). Furthermore, the number of meteoropathic people who are extremely sensitive to weather and climatic variations is increasing (Lickiewicz et al., 2020). Thus, detecting meteoropathy and meteorosensitivity gains importance for clinical practice to consider the effects of weather and climatic variations on individuals' physical and psychological health. Hoxha and Zappacosta (2023) have

highlighted that awareness of meteoropathy plays a crucial role in developing approaches aimed at improving the quality of life for meteoropathic individuals. Examining psychometric properties, we suggest that the Turkish version of METEO-Q is a reliable and valid measurement tool for assessing meteoropathy.

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