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Original Article
http://dx.doi.org/10.4322/2357-9730.59646

Scores of a web-based version of the Seasonal Pattern Assessment Questionnaire in Brazil

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Clin Biomed Res. 2015;35(4):200-210

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ABSTRACT

Introduction: Seasonal affective disorder (SAD) is a proposed mental disorder still controversial. This condition is prevalent in northern latitudes, but few studies have been conducted at locations in the southern hemisphere. It is usually assessed by the Seasonal Pattern Assessment Questionnaire (SPAQ). This study aimed to evaluate, through on-line questionnaire, the hypothesis that, in the Brazilian population, latitude and longitude influence SPAQ scores.

Methods: An advertisement was posted on a sleep medicine website inviting visitors to investigate seasonal patterns of behavior and mood, using a Brazilian Portuguese version of the SPAQ. The geographic coordinates of the place of residence of each respondent were analyzed as a continuous variable or distributed in quartiles of latitude and longitude. The psychometric properties of the SPAQ were assessed by reliability and factor analyses.

Results: Answers from 1001 respondents out of 1045 were considered eligible. High SPAQ scores were observed in 287 respondents, equally distributed among all latitude and longitude quartiles. Data collected in different seasons and during daylight saving time did not differ significantly in any of the scores for SPAQ dimensions. No correlations between SPAQ scores and latitude or longitude were observed. Psychometric properties of the SPAQ were preserved in all geographic locations.

Conclusion: The finding of similar SPAQ scores at a wide latitude range defies the concept of SAD symptoms as latitude or longitude-dependent phenomena.

Keywords: *Seasonality; seasonal affective disorder; SPAQ; depression; psychometrics*

The Seasonal Pattern Assessment Questionnaire (SPAQ)[1] has been widely used in the identification of the proposed seasonal affective disorder (SAD). This condition was first described as being a syndrome[2] consisting of depressive symptoms that begin in the autumn-winter and subside in the following spring-summer. Research on SAD has been published extensively in the literature[3,4]. SAD is commonly referred to as "winter depression" but it paradoxically includes summer depression[5,6]. The idea of SAD is controversial. Hansen et al.[7], from the University of Tromsø, the northernmost university in the world, consider SAD as "nothing more than a 'SPAQ-iasis', a constructed disease." However, the belief in its validity persists being promoted[8].

The SPAQ, developed by Rosenthal et al.[9], investigates seasonality through questions on six dimensions: mood, appetite, weight, sleep length, energy level, and social activity. Although these dimensions reflect basic physiological functions that are expected to change in response to changes in the environment, they have been used to diagnose a putative psychiatric condition.

SAD has been attributed to lack of natural light in the winter at high latitudes, since a correlation between latitude and prevalence of SAD has been reported[10,11]. However, there are data in disagreement with this assumption[12,13].

In few studies, the SPAQ was administered in the southern hemisphere. Data from temperate zones in South Africa[14] and Australia[15] confirmed the existence of scores compatible with SAD. In the tropical zone of Australia[16], temperature and humidity were considered to have a greater influence on seasonality than photoperiod. When comparing different Australian latitudes, Murray and Hay[17] found no correlation between seasonality scores and latitude. Although Brazil is extended over 38 degrees of latitude, from 5° N to 33° S, to our knowledge, no Brazilian study explored the influence of latitude on the results of the SPAQ. In Brazil, only one case-report[18] and one cross-sectional study[19] of SPAQ scores were found.

The psychometric properties of the SPAQ were described in few studies. In the Norwegian population[20] two components were identified in factor analysis: 1) sleep length, social activity, mood, and energy level; 2) weight and appetite. Reliability analysis confirmed a good internal consistency (Cronbach's alpha = 0.82). The psychometric properties were investigated also in a sample of college students in Illinois, USA[21]. A single component was identified in factor analysis and a good internal consistency was reported (Cronbach's alpha = 0.81). Likewise, in a small sample from a central Sweden county, factor analysis resulted in a single factor and internal consistency was good (Cronbach's alpha = 0.88)[22]. The internal consistency was similarly good for Spanish version of the SPAQ (Cronbach's alpha = 0.85)[23] but was only questionable for the Turkish version of the questionnaire (Cronbach's alpha = 0.67)[16]. No study was found testing the psychometric properties of the SPAQ in the southern hemisphere.

We hypothesized that a web-based survey using the SPAQ would be able to identify a latitude-dependent gradient of the questionnaire scores and, possibly, to identify distinct psychometric characteristics as different latitudes, cultures, and climates were investigated. Additionally, we intended to provide data about the presence of SAD in an inclusive Brazilian sample.

METHODS

This was a web-based cross-sectional survey. The English version of the SPAQ was translated into Brazilian Portuguese. A digital version was made available on a sleep medicine website. Sample size was calculated assuming a prevalence of SAD of 4% for the subtropical zone, as observed by Curcio et al.[19] in Porto Alegre, and an estimated prevalence of 1% for the tropical zone. Considering a power of 80% and an alpha of 5%, with continuity correction, the calculated sample size was approximately 1,000 questionnaires.

An advertisement was posted on the website inviting visitors to investigate seasonal patterns of behavior and mood. Respondents had to agree with the anonymous use of their data and to reply questions concerning demographic data and shift work, before being allowed to answer the SPAQ. Only the results of individuals who gave consent were included in this study. As exclusion criteria, we removed records from residents outside of Brazil, from Brazilian latitudes situated at the northern hemisphere, and with missing data. The research protocol was approved by the institutional ethics committee.

The SPAQ has questions that yield a score from 0 (No change) to 4 (Extreme change) for the magnitude of seasonal variations experienced by the subjects in six dimensions: mood (overall feeling of well-being), appetite, weight, sleep length, energy level, and social activity. The sum of the six scores results in the Seasonality Score Index, ranging from 0 to 24 points. One additional diagnostic criterion was obtained by a specific question about the severity of problems caused by seasonal variations. The question was answered as: 0 (no problem), 1 (mild), 2 (moderate), 3 (marked), or 4 (severe).

Individuals who reached 10 points in the Seasonality Score Index and classified the severity of problems caused by seasonal variations as at least moderate (2 points or higher) were considered "SAD-compatible", since no psychiatric/psychological evaluation was performed and the SPAQ is sensitive but not specific for SAD[24]. Individuals with 10 points or more on the Seasonality Score Index and who classified the severity of problems caused by seasonal variations as absent or mild (0 or 1, respectively, on the 0-4 scale) or with 8 to 9 points and severity of problems caused by seasonal variations classified as at least moderate (2 points or higher-) were considered subsyndromal or "S-SAD-compatible". The screening thresholds adopted in this study are lower than the usual ones in the use of SPAQ[25,26]. However, it is has been reported that normal seasonality scores are usually higher in places in which seasonal environmental conditions are more remarkable and easily recognized, such as high latitudes[27]. Thus, as our sample was located in low to middle latitudes, we adapted the screening points to one point lower, in order to provide a more sensible screening.

The geographic coordinates of the place of residence of each respondent were assigned using data from the Brazilian Institute of Geography and Statistics (Instituto Brasileiro de Geografia e Estatística, IBGE)[28].

The latitude and longitude values were converted from degrees to seconds. The sample was distributed in quartiles of latitude and longitude to compose different groups, based on sample size instead of geographic data, in order to compose groups with a similar number of respondents. Additionally, the four cities with the highest number of respondents were analyzed in search for aggregation of seasonal characteristics, e.g., a greater occurrence of weight changes in one city and of mood changes in another, considering the potential influence of geographical features, such as coastal or inland location.

Data are presented as mean ± standard deviation (SD). For the comparisons between geographical zones and cities, a one-way analysis of variance (ANOVA) followed by post-hoc Bonferroni's test was employed. The percentages of SAD-compatible and S-SAD-compatible scores in each latitude and longitude quartile and in the four cities with the greatest number of respondents were compared by the chi-square test. Pearson's correlation test was performed to evaluate the association between the Seasonality Score Index and geographical coordinates. We used linear models to predict SPAQ scores and binary logistic regression to predict SAD-compatible scores using as regressors: sex, geographical coordinates as continuous variables, season of data collection, and daylight saving time (DST). The psychometric properties of the SPAQ were assessed by Cronbach's alpha to estimate reliability and by factor analysis using principal components and varimax rotation with SAD-compatible scores as selection variable. All statistical analyses were performed with SPSS v.17 (SPSS, Chicago, Il, USA). Due to the large number of comparisons performed, the limit for statistical significance was set at $p < 0.01$ for alpha error.

RESULTS

After the questions were published on the website, 1,045 people answered the SPAQ over a period of 14 months, at a rate of about two or three respondents per day. Forty-four records met exclusion criteria (one due to reply from outside Brazil, two due to replies from Brazilian northern latitudes, and 41 due to incomplete data), resulting in a sample of 1,001 respondents. The majority of the respondents were men (n = 535). The age ranges of the sample were: 18 to 40 years (n = 800), 40 to 65 years (n = 182), and older than 65 years (n = 19). The 1,001 respondents were divided into four latitude and four longitude quartiles (Table 1). Answers were obtained from 223 municipalities. The four cities with the greatest number of respondents (major cities) were São Paulo (n = 169), Rio de Janeiro (n = 93), Porto Alegre (n = 85), and Belo Horizonte (n = 38). Bands of geographical coordinates and location of the cities considered in the analyses are presented in Figure 1.

Table 1 shows that mean values of the six dimensions and the Seasonality Score Index for latitudes 1 to 4 were similar ($p = 0.732$). For longitudes 1 to 4, values for the Seasonality Score Index were significantly, despite marginally, different ($p = 0.010$). The westernmost longitude quartile showed higher scores of social activity ($p = 0.005$) and appetite ($p = 0.003$). Additionally, comparing data collected in each season, no significant difference was seen in the average of any scores of the six domains and in the global Seasonality Score Index.

Considering the whole sample, 28.7% had SAD-compatible scores and 25.1%, S-SAD-compatible scores. The distribution of individuals with SAD-compatible or S-SAD-compatible scores in each latitude quartile, in each longitude quartile, and in each of the four major cities did not differ significantly (Table 2). In a binary logistic model, female gender predicted the existence of SAD-compatible and S-SAD-compatible scores with an odds ratio of 1.47 (95% confidence interval 1.14-1.89; $p = 0.003$). Latitude quartile and city, included separately in the model, did not reach significance. Comparison of each sub-score by city showed a significant difference in weight subscore (ANOVA; $p = 0.01$). The weight sub-score obtained in Belo Horizonte (0.55 ± 0.83) was significantly lower than that obtained in Porto Alegre (1.2 ± 1.1; $p = 0.005$) and Rio de Janeiro (1.1 ± 0.9; $p = 0.038$) by the post hoc Bonferroni test. The Pearson's correlation coefficient between SPAQ scores and latitude was negligible ($r = 0.03$). In the multivariate linear regression model using the total score as dependent variable and latitude, longitude, season, DST, and sex as regressors, only sex was a significant but weak predictor (beta = 0.09; $p = 0.003$). In the binary logistic model, sex was also the only regressor with 95% confidence interval not crossing 1, odds ratio of 1.4 (1.07-1.85) (Figure 2). The factor analysis identified three components in the three northernmost latitude quartiles and only two in the fourth latitude quartile (Table 3). Internal consistency indicated by Cronbach's alpha was questionable in the whole sample (0.66), in all latitude quartiles, respectively, 0.66, 0.67, 0.60, and 0.72, and in all longitude quartiles, respectively, 0.67, 0.61, 0.69, and 0.68.

The male-female ratio of the respondents was similar among the latitude quartiles (Figure 3). Females had significantly higher sub-scores for seasonality of mood ($p = 0.003$), weight ($p < 0.001$), appetite ($p = 0.004$), energy level ($p = 0.024$), Seasonality

Table 1: Means and standard deviations of the scores for the six dimensions and the Seasonality Score Index by geographic coordinate quartiles, by season, by daylight saving time of data collection, and by city.

Latitude	**Quartile 1 0°-20°26' S (n = 251)**	**Quartile 2 20°33'-23°27' S (n = 250)**	**Quartile 3 23°29'-25°04' S (n = 250)**	**Quartile 4 25°17'-32º02' S (n = 250)**	**P**
Sleep length	1.5 ± 1.1	1.5 ± 1.1	1.7 ± 1.2	1.5 ± 1.1	0.386
Social activity	1.7 ± 1.1	1.6 ± 1.2	1.5 ± 1.1	1.8 ± 1.1	0.013
Mood	1.8 ± 1.2	1.7 ± 1.3	2.0 ± 1.3	1.8 ± 1.2	0.130
Weight	1.0 ± 1.1	1.1 ± 1.1	1.0 ± 1.0	1.0 ± 1.0	0.607
Appetite	1.3 ± 1.2	1.5 ± 1.2	1.3 ± 1.1	1.5 ± 1.1	0.070
Energy level	2.0 ± 1.2	1.9 ± 1.3	2.0 ± 1.3	2.0 ± 1.2	0.469
Seasonality Score Index	9.3 ± 4.2	9.3 ± 4.3	9.4 ± 4.0	9.6 ± 4.3	0.732

Longitude	**Quartile 1 34º51'-43º56' W (n = 258)**	**Quartile 2 43º56'-46º38' W (n = 259)**	**Quartile 3 46º38-49º16' W (n = 245)**	**Quartile 4 49º16'-67º48' W (n = 239)**	**P**
Sleep length	1.5 ± 1.2	1.6 ± 1.2	1.5 ± 1.1	1.5 ± 1.1	0.813
Social activity	1.6 ± 1.2	1.5 ± 1.1	1.5 ± 1.2	1.8 ± 1.1*	**0.005**
Mood	1.8 ± 1.2	1.9 ± 1.3	1.8 ± 1.3	1.8 ± 1.2	0.486
Weight	0.9 ± 1.0	1.0 ± 1.1	1.0 ± 1.0	1.2 ± 1.0	0.036
Appetite	1.3 ± 1.1	1.3 ± 1.1	1.4 ± 1.2	1.6 ± 1.1*	**0.003**
Energy level	2.0 ± 1.2	2.0 ± 1.2	1.8 ± 1.3	2.1 ± 1.2	0.016
Seasonality Score Index	9.0 ± 4.2	9.5 ± 4.1	8.9 ± 4.3	10.1 ± 4.2	0.010

Season	**Spring (n = 363)**	**Summer (n = 203)**	**Fall (n = 129)**	**Winter (n = 306)**	**P**
Sleep length	1.6 ± 1.2	1.5 ± 1.1	1.6 ± 1.1	1.5 ± 1.1	0.381
Social activity	1.6 ± 1.2	1.7 ± 1.2	1.7 ± 1.1	1.6 ± 1.1	0.562
Mood	1.8 ± 1.3	1.8 ± 1.3	1.9 ± 1.2	1.8 ± 1.3	0.983
Weight	1.0 ± 1.1	1.0 ± 1.1	1.0 ± 1.0	1.0 ± 1.0	0.835
Appetite	1.5 ± 1.2	1.3 ± 1.1	1.5 ± 1.0	1.4 ± 1.1	0.129
Energy level	2.0 ± 1.2	2.0 ± 1.3	2.1 ± 1.2	2.0 ± 1.2	0.929
Seasonality Score Index	9.5 ± 4.4	9.2 ± 4.5	9.7 ± 4.1	9.2 ± 3.8	0.653

City	**São Paulo (n = 169)**	**Rio de Janeiro (n = 93)**	**Porto Alegre (n = 85)**	**Belo Horizonte (n = 38)**	**P**
Sleep length	1.6 ± 1.2	1.4 ± 1.2	1.6 ± 1.2	1.7 ± 1.0	0.588
Social activity	1.5 ± 1.0	1.4 ± 1.1	1.7 ± 1.1	1.8 ± 1.1	0.093
Mood	1.9 ± 1.3	1.6 ± 1.2	1.7 ± 1.2	1.8 ± 1.2	0.192
Weight	1.0 ± 1.1	1.1 ± 0.9	1.2 ± 1.1	0.6 ± 0.8!	**0.010**
Appetite	1.4 ± 1.1	1.3 ± 1.1	1.6 ± 1.1	1.2 ± 1.1	0.273
Energy level	2.1 ± 1.2	2.0 ± 1.2	2.1 ± 1.1	1.9 ± 1.2	0.782
Seasonality Score Index	9.5 ± 4.2	8.8 ± 4.1	9.9 ± 4.3	8.9 ± 3.9	0.332

Daylight saving time	**Yes (n = 437)**	**No (n = 564)**	**P**
Sleep length	1.5 ± 1.2	1.5 ± 1.1	0.935
Social activity	1.6 ± 1.2	1.6 ± 1.1	0.845
Mood	1.8 ± 1.3	1.8 ± 1.3	0.705
Weight	1.0 ± 1.1	1.0 ± 1.0	0.369
Appetite	1.4 ± 1.2	1.4 ± 1.1	0.702
Energy level	2.0 ± 1.3	2.0 ±1.2	0.668
Seasonality Score Index	9.3 ± 4.5	9.4 ± 4.0	0.735

* Significantly different from the other longitude quartiles; ! Significantly different from the other major cities.

Table 2: Number and percentage of respondents with normal SPAQ scores or reaching SAD and S-SAD compatible SPAQ scores.

	Total Number	SAD-compatible SPAQ scores n (%)	S-SAD-compatible SPAQ scores n (%)	Normal SPAQ scores n (%)
Latitude quartiles				
[0º-20º26'S]	251	65 (26)	64 (25.5)	122 (48.5)
[20°33'-23°27'S]	250	76 (30)	55 (22)	119 (48)
[23°29'-25°04'S]	250	80 (32)	54 (22)	116 (46)
[25°17'-32°02'S]	250	66 (26.5)	78 (31)	106 (42.5)
P		0.349	0.048	0.526
Longitude quartiles				
[34°51'-43°56'W]	258	75 (29)	55 (21)	128 (50)
[43°56'-46°38'W]	259	82 (31)	56 (22)	121 (47)
[46°38'-49°16'W]	245	58 (24)	67 (27)	120 (49)
[49°16'-67°48'W]	239	72 (30)	73 (31)	94 (39)
P		0.223	0.045	0.088
Major cities				
Belo Horizonte	38	13 (34.5)	9 (23.5)	16 (42)
Rio de Janeiro	93	26 (28)	18 (19)	49 (53)
São Paulo	170	58 (34)	30 (18)	82 (48)
Porto Alegre	85	25 (29)	27 (32)	33 (39)
P		0.695	0.116	0.350
Total (Brazil)	1,001	287 (28.7)	251 (25.1)	463 (46)

Table 3: Rotated component matrix of the six dimensions of the Seasonality Score Index in four latitude and longitude quartiles.

	Latitude quartile 1			Latitude quartile 2			Latitude quartile 3			Latitude quartile 4	
	Component			Component			Component			Component	
	1	2	3	1	2	3	1	2	3	1	2
Sleep length		0.773			0.704			-0.675		-0.456	
Social activity			-0.600			0.547			0.859		0.643
Mood		0.632			-0.833			0.819			0.613
Weight	0.796			0.812			0.837			0.809	
Appetite	0.862			0.843			0.804			0.810	
Energy level			0.760			-0.826		0.450	0.639		0.704

	Longitude quartile 1			Longitude quartile 2			Longitude quartile 3			Longitude quartile 4		
	Component			Component			Component			Component		
	1	2	3	1	2	3	1	2	3	1	2	3
Sleep length			0.857		–0.468				0.816			–0.572
Social activity		0.754				0.845		0.804			0.763	
Mood			–0.502		0.788			0.677				0.766
Weight	0.799			0.840			0.774			0.829		
Appetite	0.835			0.786			0.830			0.854		
Energy level		–0.736			0.641				–0.627		0.837	

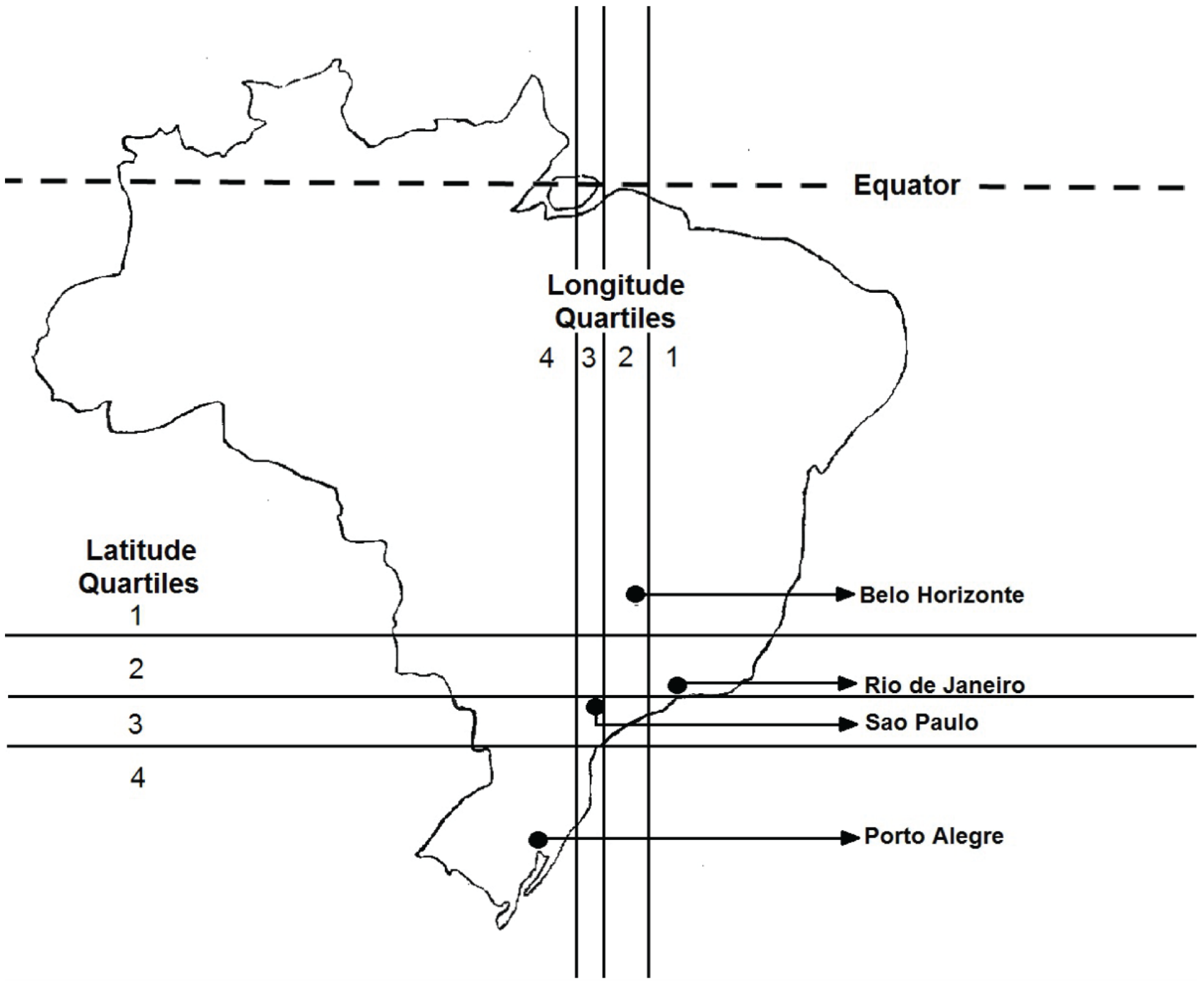

Figure 1: Latitude and longitude bands and cities analyzed. Each latitude band included, approximately, 250 individuals. The discrepancy in the size of each band reflects the higher density of respondents in southern and southeastern Brazil.

Variable	OR	CI 95%
Female	1.4	1.07–1.85
Longitude	0.95	0.82–1.11
Latitude	1.04	0.9–1.21
Season	0.98	0.85–1.12
DST	0.88	0.62–1.26

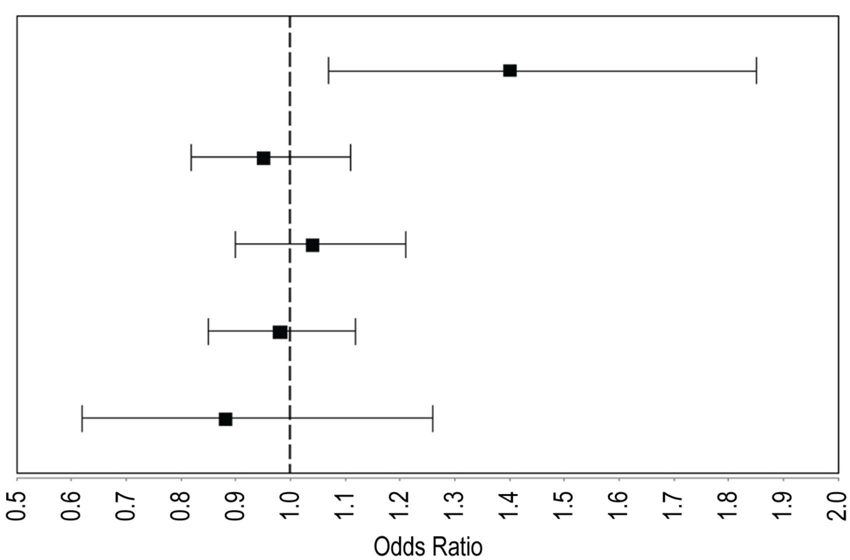

Figure 2: Binary logistic regression model to predict SAD-compatible score using latitude, longitude, season and DST when the SPAQ was answered, and female sex as regressors. DST, daylight saving time; OR, odds ratio; CI, confidence interval.

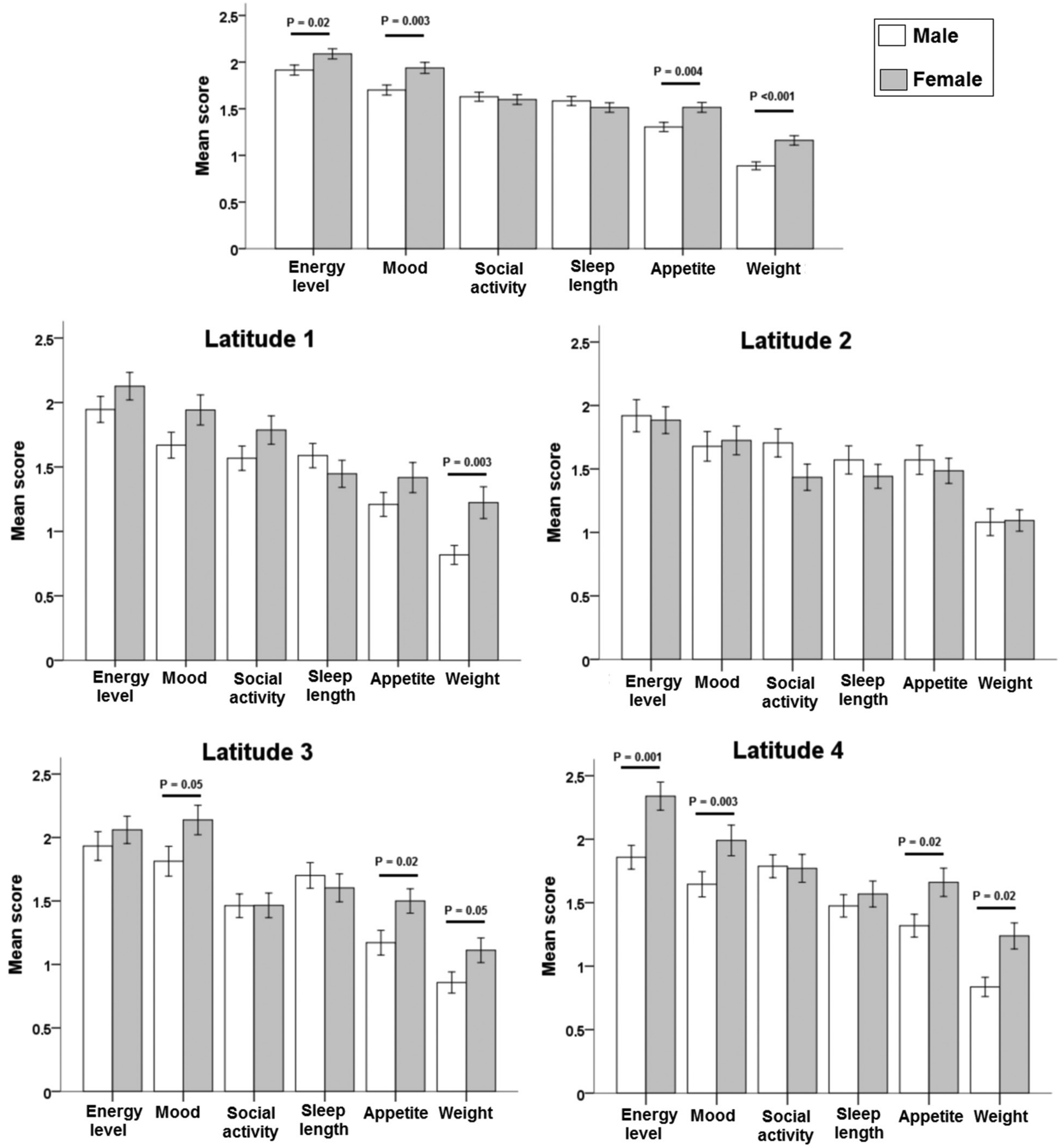

Figure 3: SPAQ sub-scores in male and female subjects by latitude band. Most of the sub-scores are significantly higher in females. The difference among latitude bands is non-significant and no interaction between gender-and latitude band was noted.

Score Index ($p = 0.003$), and the severity of problems caused by seasonal variations ($p = 0.001$). General linear model with the Seasonality Score Index as the dependent variable, controlling for latitude quartile and gender, was significant for gender ($p = 0.002$) and for the interaction between gender and latitude quartile ($p = 0.036$) but not for latitude quartile ($p = 0.65$).

One hundred fifteen respondents reported shiftwork. The average Seasonality Score Index of this group was similar (9.6 ± 4.5) to that of the respondents reporting regular work schedule (9.4 ± 4.1; $p = 0.6$). All subscales, including the severity of problems caused by seasonal variations, were comparable with only negligible differences.

DISCUSSION

This study using a web-based version of the SPAQ in several Brazilian latitudes and longitudes showed a uniform distribution of the scores over a wide range of latitudes. This is the first report on the absence of correlation between SPAQ scores and geographical coordinates in Brazil. Our hypothesis was that the different environmental conditions of Brazil would lead to a wide diversity of SPAQ scores. Nevertheless, latitude, longitude, geographical or seasonal variables were not determinant to the SPAQ scores in this Brazilian sample, in the uni- or multivariate models.

The lack of correlation between SPAQ scores and geographical coordinates as continuous variables and comparisons between cities with extremely different sunlight conditions like Porto Alegre and Manaus in this large sample are evidence of no SPAQ-latitude association. The strategy of grouping the respondents by quartiles of population according to latitude was chosen to generate balanced groups. Several other grouping strategies were attempted, such as by length of photoperiod, state, region, and latitude range, resulting in non-significant differences in the scores. None of these attempts resulted in significant differences and were abandoned.

This is not an epidemiological study. The potential sampling bias introduced by a web-based questionnaire invalidates any information regarding prevalence, a word that is not used in our results. Thus, we stress out that no epidemiological data should be drawn from our report. Our sampling protocol prevents the attainment of proper epidemiological parameters, since we cannot establish the denominator. The sample does not represent epidemiology of SAD in the Brazilian population, but rather indicates that SAD-compatible scores are possible and plausible among Brazilians.

The fact that SAD-compatible scores are observed in all Brazilian regions, regardless of photoperiod, is patent, supporting our conclusion of an intrinsic circannual pattern of mood disorder. Rather than a new disease, unique to the high latitudes, and rather than a 'winter disease', SAD might represent a subtype of mood disorder characterized by circannual fluctuation.

In 20 studies[12], the prevalence of SAD ranged from 0 to 9.7%, while the prevalence of S-SAD ranged from 0 to 22.5%. In depressed patients the prevalence of SAD was higher, ranging between 10 and 20%. The present study showed a percentage of 29% for SAD-compatible scores, which is higher than any other report. Another potential reason for this higher percentage, in addition to sampling bias and the use of a web-based instrument, is that SPAQ is a screening tool with high sensitivity but low specificity. For these reasons, we name our finding as "SAD-compatible scores".

Despite the high percentage of SAD-compatible scores, no correlation was observed between SPAQ scores and latitude or longitude as continuous variables, neither in univariate (r = 0.03) nor in multivariate models, adjusting for confounders.

The condition was equally distributed among quartiles, but this is a secondary finding since they are geographically unbalanced and unequal in terms of latitude range, considering the vast Brazilian territory. The Brazilian population is concentrated more densely in southern and southeastern regions. The same unevenness in number of respondents was observed when the results were compared among cities. The percentages of SAD and SAD-S-compatible scores were, however, virtually identical in all attempted analyses.

We obtained SAD-compatible scores even in regions where only minor season-related changes are observed. Future efforts are necessary to confirm the independence of the SPAQ scores from geographical coordinates, using adequate tools.

Porto Alegre, which is the only major city located in subtropical zone, southern to the tropic of Capricorn, is the only in which factor analysis identified three different components. This may be an indicator that the factors contributing to the equal percentage of SAD-compatible scores may be different among regions. Finally, interesting differences can be noted when comparing genders. Differences in energy level, mood, appetite, and weight were observed in more than one latitude quartile, with women presenting higher mean scores than men in a consistent way. Such differences may be a consequence of the higher prevalence of mood disorders in women, being manifested in these subscales.

Regarding the lack of correlation between SPAQ scores and latitude in the present study, this finding agrees with other data from studies conducted in the southern hemisphere, such as in Australia[19], but is opposite to studies conducted in the northern hemisphere[10-13], which have shown significant correlations. This discrepancy between studies in southern and northern hemispheres gives rise to two possibilities: publication bias and magnitude of latitude range in the hemispheres. Regarding publication bias, one may note that only few articles on SAD have been published in the southern hemisphere, while they are numerous in the northern hemisphere. Thus, the lack of correlation in the southern hemisphere may change as long as more studies conducted in southern countries are published. Concurrently, one may argue about the range of latitude in each hemisphere. Studies in the southern hemisphere are conducted in tropical or subtropical zones, i.e., in localities closer to the equator. For instance, São Paulo is located at 23ºS, Soweto (South Africa) at 26° S[17], Porto Alegre (the southernmost city in the present article) at 30ºS, and Melbourne (Australia) at 37° S[18]. Conversely, studies conducted in the northern hemisphere has been held in higher latitudes, such as Ankara (Turkey) at 39ºN, Manitoba (Canada) at around 50° N[10], Dalarna (Sweden) at around 60° N[25], Reykjavik (Iceland) at 64° N[28], and Nuuk (Greenland) at around 64° N[9]. Thus, the reason for the discrepancies between southern and northern hemispheres could be due to the actual distance of study location from the equator: the farther from the equator, the greater the influence of latitude on SPAQ scores.

Even in Scandinavian countries, the inconsistency of reports on the influence of latitude on the prevalence of SAD persists[15,16]. In a comprehensive literature review, Mersch et al.[29] found a significant correlation between latitude and SAD in North America and in Europe, but this effect was reduced when they included worldwide data from Australia and Asia. In conclusion, the authors state that the correlation between latitude and SAD is mild if faced with the effects of potential confounders, such as climate, genetic vulnerability, and social-cultural factors, which may play an important role on self-perceived seasonal mood alterations.

The tendency towards higher scores of social activity and appetite observed in the westernmost quartile are more likely due to chance. No east-west gradient can be observed and these two subscores do not correlate with longitude. The differences in scores observed in terms of the season of data collection are negligible. The statistically significant results are most likely due to chance, considering the large number of comparisons.

One problem with the SPAQ, as a diagnostic instrument for a mood disorder, is that changes in appetite and weight have the same score value as changes in mood and energy level. The highest seasonality scores that have been reported in the existing SPAQ literature are for sleep length, appetite, and weight[30]. The highest scores in the present study were for energy level, mood, and social activity. This difference in dimensions may be of importance. While sleep length, appetite and weight are easily recognized as behaviors that change during short days and cold weather, the dimensions with higher seasonality scores in Brazil seem to be more closely related to the classic symptoms of depression. Based on this difference in affected dimensions, one can speculate that seasonality of depression in Brazil is more truly a mood disorder.

In countries with more clearly defined seasons, with long nights in the winter, changes in sleep may be a normal behavioral response, not a symptom of depression[7]. Higher latitudes lead to longer nights and therefore to higher scores on sleep dimension. Due to higher caloric needs, a harsh winter may lead to changes in appetite and weight that can be considered also a physiological response not a symptom of a supposed “winter depression”. These normal features of a temperate climate can increase the SPAQ score leading mistakenly to the identification of SAD.

Regarding the sleep dimension, longer or shorter nights may be an important factor determining seasonality scores, as mentioned by Hansen et al.[7]. At the winter solstice, cities like Manaus, capital of the state of Amazonas, have the duration of the night of 12 hours and 5 minutes. For the sake of the argument, mean score for sleep length was 1.5 in this city, 1.7 in Belo Horizonte, where the longest winter night lasts for 13 hours and 4 minutes, and 1.6 n Porto Alegre, where the longest night lasts for 14 hours and 9 minutes. Therefore, the similar scores for sleep length in these cities are not even close to be explained by the duration of winter nights. This may be genuinely due to insomnia or hypersomnia that could reflect some degree of depression. Alternatively, elevated temperature and humidity during the summer could strongly impact sleep. Notwithstanding the difference in summer-winter mean temperature change between Manaus (1.5 °C) and Porto Alegre (10.4 °C), the scores for Sleep length were comparable in both cities.

Some limitations must to be taken into consideration for a proper understanding of the present study. The sampling bias is the most obvious and inevitable of these limitations in a web-based survey. We expected, however, that this bias should be equally distributed along the whole range of latitudes and not interfere with the conclusion that the SPAQ is not affected by latitude in Brazil. It should be considered that there may have been an oversampling of people with seasonality complaints, leading to a subsequent increase in the percentage of SAD-compatible scores, even in latitudes where the condition is rare. Also, the SPAQ was not designed for web-based applications. Nonetheless, the psychometric properties of the questionnaire were relatively conserved. In accepting the null hypothesis that there is no effect of latitude on SPAQ scores, despite the large sample size, one must bear in mind that the study was designed with a 20% probability of beta error. Additionally, the availability of the questionnaire in a sleep medicine website could have increased the fraction of respondents who reached SAD-compatible scores due to co-morbid sleep disorders. If that were the case, it would be expected that the subscores for Sleep length would be the highest. This, however, was not observed (Figure 3). Despite of all aforementioned limitations, the convenience sampling used in the present study was useful to address the plausibility of SAD in Brazil.

The present results emphasize the concept that seasonal oscillation, like the one depicted by the SPAQ dimensions, may emerge independently of changes in sunlight exposure. It can be hypothesized that the apparently extrinsic character of SAD may be generated by an intrinsic circannual periodicity. In support of such hypothesis, Antarctic residents show two peaks of depression, anger, fatigue, and confusion, as well as of thyroid function: one in November, during summer, in the total daylight period, and one in July, during the period of total darkness[31]. Instead of an extrinsic photoperiod-driven mechanism causing SAD symptoms, an endogenous rhythm is more likely to be involved in the development of SAD. Additionally, besides being attributed to photoperiod variations, the condition called SAD has been considered to depend on cultural factors, in the form of spring-summer and fall-winter depression[32].

In summary, the SPAQ scores of the respondents showed no correlation with geographical coordinates. Differences in scores in some longitudes may be due to chance since no east-west pattern could be identified from these preliminary data. The psychometric properties of the questionnaire were conserved over the range of coordinates. Based on the performance of all items of the SPAQ in an extensive range of latitudes of Brazil, respondents display latitude-independent SPAQ scores.

The claim that seasonal affective disorder is caused by the lack of sunlight in winter, being a condition "typical" of high latitudes, is questioned by the present data. On the contrary, these data support the hypothesis that mood seasonality is a worldwide phenomenon. The observational data generate the hypothesis that seasonal oscillations of mood, appetite, body weight, sleep length, energy level, and social activity are, at least for some individuals, independent from climatic or extrinsic influences such as day length.

Acknowledgements

The project was sponsored by the Research Incentive Fund (FIPE) of the Hospital de Clínicas de Porto Alegre. D.M. is recipient of a productivity research grant from the National Research Council (CNPq).

Disclosure

Denis Martinez is the co-owner of a private sleep clinic responsible for the website in which the digital version of the SPAQ was made available. Nothing to declare by the other authors.

REFERENCES

1. Raheja SK, King EA, Thompson C. The seasonal pattern assessment questionnaire for identifying seasonal affective disorders. *J Affect Disord*. 1996;41(3):193-9. http://dx.doi.org/10.1016/S0165-0327(96)00087-0. PMid:8988451.

2. Rosenthal NE, Sack DA, Gillin JC, Lewy AJ, Goodwin FK, Davenport Y, et al. Seasonal affective disorder. A description of the syndrome and preliminary findings with light therapy. *Arch Gen Psychiatry*. 1984;41(1):72-80. http://dx.doi.org/10.1001/archpsyc.1984.01790120076010. PMid:6581756.

3. Magnusson A, Boivin D. Seasonal affective disorder: an overview. *Chronobiol Int*. 2003;20(2):189-207. http://dx.doi.org/10.1081/CBI-120019310. PMid:12723880.

4. Rosenthal NE. Diagnosis and treatment of seasonal affective disorder. *JAMA*. 1993;270(22):2717-20. http://dx.doi.org/10.1001/jama.1993.03510220073037. PMid:8133590.

5. Wehr TA, Giesen HA, Schulz PM, Anderson JL, Joseph-Vanderpool JR, Kelly K, et al. Contrasts between symptoms of summer depression and winter depression. *J Affect Disord*. 1991;23(4):173-83. http://dx.doi.org/10.1016/0165-0327(91)90098-D. PMid:1791262.

6. Wehr TA, Sack DA, Rosenthal NE. Seasonal affective disorder with summer depression and winter hypomania. *Am J Psychiatry*. 1987;144(12):1602-3. http://dx.doi.org/10.1176/ajp.144.12.1602. PMid:3688288.

7. Hansen V, Skre I, Lund E. What is this thing called "SAD"? A critique of the concept of Seasonal Affective Disorder. *Epidemiol Psichiatr Soc*. 2008;17(2):120-7. PMid:18589628.

8. Rosenthal NE. Issues for DSM-V: seasonal affective disorder and seasonality. *Am J Psychiatry*. 2009;166(8):852-3. http://dx.doi.org/10.1176/appi.ajp.2009.09020188. PMid:19651748.

9. Rosenthal NE, Genhart M, Sack DA, Skwerer RG, Wehr TA. Seasonal affective disorder and its relevance for the understanding and treatment of bulimia. In: Hudson JI, Pope HG, editors. *The psychobiology of bulimia*. Washington, DC: American Psychiatric Press; 1987. p. 205-28.

10. Kegel M, Dam H, Ali F, Bjerregaard P. The prevalence of seasonal affective disorder (SAD) in Greenland is related to latitude. *Nord J Psychiatry*. 2009;63(4):331-5. http://dx.doi.org/10.1080/08039480902799040. PMid:19306154.

11. Blazer DG, Kessler RC, Swartz MS. Epidemiology of recurrent major and minor depression with

a seasonal pattern. The National Comorbidity Survey. *Br J Psychiatry*. 1998;172(2):164-7. http://dx.doi.org/10.1192/bjp.172.2.164. PMid:9519070.

12. Brancaleoni G, Nikitenkova E, Grassi L, Hansen V. Seasonal affective disorder and latitude of living. *Epidemiol Psichiatr Soc*. 2009;18(4):336-43. PMid:20170049.

13. Levitt AJ, Boyle MH. The impact of latitude on the prevalence of seasonal depression. *Can J Psychiatry*. 2002;47(4):361-7. PMid:12025435.

14. Szabo CP, Blanche MJ. Seasonal variation in mood disorder presentation: further evidence of this phenomenon in a South African sample. *J Affect Disord*. 1995;33(4):209-14. http://dx.doi.org/10.1016/0165-0327(94)00090-V. PMid:7790674.

15. Murray G. How common is seasonal affective disorder in temperate Australia? A comparison of BDI and SPAQ estimates. *J Affect Disord*. 2004;81(1):23-8. http://dx.doi.org/10.1016/S0165-0327(03)00197-6. PMid:15183596.

16. Morrissey SA, Raggatt PT, James B, Rogers J. Seasonal affective disorder: some epidemiological findings from a tropical climate. *Aust N Z J Psychiatry*. 1996;30(5):579-86. http://dx.doi.org/10.3109/00048679609062653. PMid:8902165.

17. Murray GW, Hay DA. Seasonal affective disorder in Australia: is photoperiod critical? *Aust N Z J Psychiatry*. 1997;31(2):279-84. http://dx.doi.org/10.3109/00048679709073832. PMid:9140637.

18. Teng CT, Akerman D, Cordás TA, Kasper S, Vieira AH. Seasonal affective disorder in a tropical country: a case report. *Psychiatry Res*. 1995;56(1):11-5. http://dx.doi.org/10.1016/0165-1781(94)02540-Y. PMid:7792337.

19. Curcio F, Miola G, Lehmen R, Martinez D. Seasonal affective disorder in Porto Alegre. *J Bras Psiquiatr*. 1996;45:425-8.

20. Magnusson A, Friis S, Opjordsmoen S. Internal consistency of the Seasonal Pattern Assessment Questionnaire (SPAQ). *J Affect Disord*. 1997;42(2-3):113-6. http://dx.doi.org/10.1016/S0165-0327(96)00104-8. PMid:9105952.

21. Young MA, Blodgett C, Reardon A. Measuring seasonality: psychometric properties of the Seasonal Pattern Assessment Questionnaire and the Inventory for Seasonal Variation. *Psychiatry Res*. 2003;117(1):75-83. http://dx.doi.org/10.1016/S0165-1781(02)00299-8. PMid:12581822.

22. Rastad C, Sjödén PO, Ulfberg J. High prevalence of self-reported winter depression in a Swedish county. *Psychiatry Clin Neurosci*. 2005;59(6):666-75. http://dx.doi.org/10.1111/j.1440-1819.2005.01435.x. PMid:16401242.

23. Goikolea JM, Miralles G, Bulbena Cabré A, Vieta E, Bulbena A. Spanish adaptation of the Seasonal Pattern Assessment Questionnaire (SPAQ) in the adult and children-adolescent versions. *Actas Esp Psiquiatr*. 2003;31(4):192-8. PMid:12838442.

24. Magnusson A. Validation of the Seasonal Pattern Assessment Questionnaire (SPAQ). *J Affect Disord*. 1996;40(3):121-9. http://dx.doi.org/10.1016/0165-0327(96)00036-5. PMid:8897111.

25. Kasper S, Rogers SL, Yancey AL, Schulz PM, Skwerer RG, Rosenthal NE. Phototherapy in subsyndromal seasonal affective disorder (S-SAD) and “diagnosed” controls. *Pharmacopsychiatry*. 1988;21(6):428-9. http://dx.doi.org/10.1055/s-2007-1017038. PMid:3244785.

26. Kasper S, Rogers SL, Yancey A, Schulz PM, Skwerer RG, Rosenthal NE. Phototherapy in individuals with and without subsyndromal seasonal affective disorder. *Arch Gen Psychiatry*. 1989;46(9):837-44. PMid:2774849.

27. Perry JA, Silvera DH, Rosenvinge JH, Neilands T, Holte A. Seasonal eating patterns in Norway: a non-clinical population study. *Scand J Psychol*. 2001;42(4):307-12. http://dx.doi.org/10.1111/1467-9450.00241. PMid:11547905.

28. Instituto Brasileiro de Geografia e Estatística (IBGE). *Sistema geodésico brasileiro* [internet]. Rio de Janeiro: IBGE. [cited 2014 Apr 15]. Available from: http://www.ibge.gov.br/home/geociencias/geodesia/bdgpesq_googlemaps.php.

29. Mersch PP, Middendorp HM, Bouhuys AL, Beersma DG, van den Hoofdakker RH. Seasonal affective disorder and latitude: a review of the literature. *J Affect Disord*. 1999;53(1):35-48. http://dx.doi.org/10.1016/S0165-0327(98)00097-4. PMid:10363665.

30. Merikanto I, Lahti T, Castaneda AE, Tuulio-Henriksson A, Aalto-Setälä T, Suvisaari J, et al. Influence of seasonal variation in mood and behavior on cognitive test performance among young adults. *Nord J Psychiatry*. 2012;66(5):303-10. http://dx.doi.org/10.3109/08039488.2011.633618. PMid:22126305.

31. Palinkas LA, Reed HL, Reedy KR, Do NV, Case HS, Finney NS. Circannual pattern of hypothalamic-pituitary-thyroid (HPT) function and mood during extended antarctic residence. *Psychoneuroendocrinology*. 2001;26(4):421-31. http://dx.doi.org/10.1016/S0306-4530(00)00064-0. PMid:11259861.

32. Kasof J. Cultural variation in seasonal depression: cross-national differences in winter versus summer patterns of seasonal affective disorder. *J Affect Disord*. 2009;115(1-2):79-86. http://dx.doi.org/10.1016/j.jad.2008.09.004. PMid:18849078.

Received: Oct 29, 2015
Accepted: Nov 26, 2015