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Is there a connection between circadian type and seasonal affective disorder in Iceland?

Katla Sigurðardóttir
Giedré Grigaraviciuté

Hug- og félagsvísindasvið

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Leiðbeinandi
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600 Akureyri

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Úrdráttur

Árstíðarbundin truflun (e. *Seasonal affective disorder)* er blanda líffræðilegra- og skap truflana með árstíðabundnu mynstri, sem vanalega er að finna á haustin og veturna með minnkandi einkennum að vori og sumri (Kurlansik *et al.* 2012). Á Íslandi er að meðaltali meiri myrkur en sólarljós, með einungis allt að 1268.4 klukkustundir af sólarljósi í gegnum árið (Veðurstofa Íslands. 2007). Dægursveifla (e. *circadian rhythm)* er líffræðilegur hrynjandi sem finna má hjá mönnum og dýrum sem á sér ítrekað stað og byggist á góðri samhæfingu líffræðilegra kerfa og aðlögun að lífskjörum. Turpin (1992) vildi meina að til væru tvær týpur að dægursveiflum í mannkyninu, annarsvegar morgun týpa og hins vegar kvöld týpa. Hér skoðuðum við möguleg tengsl milli dægursveiflu týpna og árstíðarbundinnar truflunar á Íslandi og áhrif niðurstaðna á aldur og kyn í þýðinu. Notast var við sex sálfræðilega spurningalista. Þrír þeirra höfðu nú þegar Íslenska þýðingu og voru það; Depression Anxiety Stress Scales (DASS), Patient Health Questionnaire-9 (PHQ-9) og the Seasonal Pattern Assessment Questionnaire (SPAQ). Höfundar ásamt teymisfélögum sínum stóðu fyrir Íslenskri þýðingu á hinum þremur spurningalistunum: the Bergen Insomnia Scale (BIS), The Movement Imagery Questionnaire (MIQ) and Morningness - Eveningness Questionnaire (MEQ). Í þessari rannsókn voru alls 241 þátttakendur eftir útilokun ónothæfra gagna, Þátttakendur voru fengnir á opinberum stöðum á borð við: bókasöfn, golf klúbba og vinnustöðva, einnig í gegnum internetið. Gagnasöfnun fór fram í febrúar. Þátttakendum var skipt niður í hópa eftir aldri: ungir (18-29), miðaldra (30-59) og eldri (60+). Pearsons kí-kvaðrat próf sýndi samband á milli dægur týpna og árstíðabundinnar truflunar (SAD) ($x^2(2) = 9.235$, $p = 0.009878$) og samkvæmt tvíkosta aðhvarfsgreiningu voru sterkustu áhrifin á árstíðabundinna truflun (SAD) komin frá kvöld- á móti morgun dægursveiflu týpu ($z= 2.097$, $p= 0.036$) ekki voru tölfræðilega marktæk áhrif í öðrum breytum, hvorki kyni né aldri. Kvöld dægursveiflu týpur eru viðkvæmari fyrir árstíðabundnum truflunum heldur en aðrar dægursveiflu týpur, niðurstöður okkar gætu því verið gagnlegar til geðheilbrigðisverndar

fyrir þá sem flokkast sem kvöld dægursveiflu týpur. Þörf er á frekari rannsóknum til að bera mat á marktækni niðurstaðna vegna ónægilegrar úrtaksstærðar.
Lykilorð; árstíðarbundin truflun • dægursveifla • dægursveiflu týpur • aldur • kyn.

Abstract

Seasonal affective disorder (SAD) is a combination of natural and mood disturbances with a seasonal pattern, typically occurring in the autumn and winter with a decrease of symptoms in the spring or summer (Kurlansik *et al.* 2012). In Iceland there is on average more darkness than sunlight, counting up to 1268.4 hours of sunlight, throughout the year (Veðurstofa Íslands. 2007). A circadian rhythm is a biological rhythm found in humans and animals that occur repeatedly and are in excellent coordination of biological systems and adjustment to the living environment. Turpin (1992) indicated that there are two circadian types of humans, either morning or evening types. Here we investigated the possible connection between circadian types and seasonal affective disorder in Iceland and the interaction of those results with age and gender in the population. Six psychological questionnaires used, where three of them already had an Icelandic translation those were the Depression Anxiety Stress Scales (DASS), Patient Health Questionnaire-9 (PHQ-9) and the Seasonal Pattern Assessment Questionnaire (SPAQ). The authors along with their team members did the Icelandic translation for the remaining three questionnaires: the Bergen Insomnia Scale (BIS), The Movement Imagery Questionnaire (MIQ) and Morningness-Eveningness Questionnaire (MEQ). In this study, there were 241 participants after the exclusion of missing data, recruited in February in public places such as libraries, golf clubs, and workplaces, as well as over the internet. They were grouped by age in young (18-29), middle (30-59), and old (60+). A Pearson's Chi-squared test showed a relationship between circadian type and SAD ($x^2(2) = 9.235$, p-value = 0.009878) and according to the binomial logistic regression the evening vs. morning chronotype had the most substantial influence on SAD ($z= 2.097$, $p= 0.036$) while none of the other variables, age or gender, were significant. Evening chronotype is more vulnerable to seasonal changes than other chronotypes, concluding that our research might be useful for mental health protection for those identified as more evening chronotype.

Further research is needed to validate the significance of our results due to the insufficiency of sample size in our research.

Keywords; seasonal affective disorder • circadian rhythm • circadian types • age • gender

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Introduction

Seasonal Affective Disorder

Autumn and winter are the time of the year that people might be more vulnerable to stress and apparent symptoms of depression, especially people who live in northern latitudes (Sourander, Koskelainen, & Helenius, 1999). Seasonal affective disorder (SAD) is a combination of biologic and mood disturbances with a seasonal pattern, typically occurring in the autumn and winter with a decrease of symptoms in the spring or summer (Kurlansik *et al.,* 2012). On average in Iceland, there is more darkness throughout the months than there is sunlight. December is the darkest month with relatively 12.1 hours of sun on average and May being the sunniest with approximately 192 hours of sun on average; Over the year there are on average 1268.4 hours of sunlight (Veðurstofa Íslands. 2007). On the background of these pieces of information, the Icelandic nation should be more vulnerable for seasonal affective disorders (SAD).

What are the causes of SAD? Could it be lower physical activity due to restricted daylight and fewer opportunities for outdoor activities? Interestingly, a study by Fumiharu, Eiji, Hyuntae, Roy, and Yukitishi (2005) indicated that there is a low relationship between day length and physical activity in humans. Kurlansik and Ibay (2013) stated that one of the common biologic reasons for SAD is a shift in the circadian phase, which might have an impact on human health. The circadian relation to SAD comes from the Phase shift hypothesis (PSH) which states that most patients who suffer from SAD become depressed during winter time, somewhat because of a phase delay in circadian rhythms relative to the sleep/wake cycle (Lewy, Rough, Songer, Mishra, Yuhas & Emens, 2007). There are various characteristics of SAD, as we have mentioned, sleep disturbance and therefore, mood and changed eating habits (Partonen & Magnusson, 2001).

Circadian type

Zhang and Seghal (2019) indicated that the human body has a fantastic capacity to adjust to environmental factors that interestingly are related to the earth´s rotation and is in contact with the light-dark cycle. Organisms in the human body can measure time with the circadian clock so that human species can anticipate in daily routines.

Turpin (1992) suggested that there are two circadian types of humans, either morning or evening types. Biological rhythms are events in humans and animals that occur repeatedly and are in excellent coordination of biological systems and adjustment to the human living environment (Lamont & Amir, 2017), as well as necessary for the proper functioning of human health (Hatcher & Mahoney, 2018). Various hormones released in the human body confers about the information of daytime for further biological processes (Neumann, Schmidt, Brockmann & Oster, 2019). Hatcher and Mahoney (2018) illustrated that clock genes, and proteins are related and regulate daily rhythms in humans. They are located in the hypothalamus and therefore have a diverse impact on human behavior, tissues, and hormones. One twin study showed that genes are potent and influence circadian type from early childhood up until adolescent years even more than environmental factors. The same study also indicated that the CLOCK gene not only is linked to the "morningness-eveningness" pattern but also sleep patterns (Hur, 2007).

Researches showed differences in body temperature depending on the circadian type. Natale and Cicogna (2002) argued that the human level of body temperature is in most cases lower early in the morning and reached a maximum value at midday for morning type human but nearly midnight for evening type of human. Lamont and Amir (2017) pointed out that circadian rhythms regulate homeostasis, e.g., daily activities, sleep, feeding time, energy sources, endocrine, and immune functions as well as regulating pro-inflammatory processes with a high peak late at night. Circadian rhythms have a 24h period, in case of disturbance,

various health issues can occur owing to a cause of a drop in the immune system and increase of inflammation (Cutolo, 2019), during imbalance between environmental and internal factors metabolic and neurological disorders can appear (Zhang & Sehgal, 2019).

Various human differences can appear in terms of circadian types. Evidence showed that there was no difference between morning and evening types in sleep structure, but some inequality in sleep stages and spectral power. Morning types indicate more need for sleep during the night and men are typically more affected by their biological clock then women (Mongrain, Carrier & Dumont, 2005).

Personality may vary depending on the chronotype. Morning type of person is likely to have high social values, for instance, more open for a change and self-enhancement, while evening type seems to prefer more individual value and are likely to be more conservative (Vollmer & Randler, 2012). The relationship between circadian rhythms and substance use illustrated by Barko, Shelton, Seggio, and Logan (2019), differed whether you were a morning or evening type person and the relapse rates since circadian genes refer to mood changes and reward-related brain regions. In the end, gender differences were likely to appear depending on the morning-evening type (Vollmer & Randler, 2012).

The possible relation between SAD and circadian type

It is essential to look at the connection between circadian types and SAD to be able to identify those who are more likely to develop SAD (Hidalgo *et al.,* 2009) and to examine the age and gender-related distribution (Magnusson & Stefansson, 1993). A recent study conducted in Iceland showed that both variables were related to activity levels during the winter (Arnadottir *et al.* 2017). However, Fumiharu *et al.* (2005) indicated an even higher relation with physical activity and climate changes rather than the days' length. Those are fundamental aspects to look at for further examination of the connection between human

circadian type, winter SAD, gender, and age in the Icelandic population.

Research question

Primary research question:

Is there a relationship between human circadian type and SAD in Iceland?

Secondary research question:

Does this relationship interact with gender and age?

Null hypothesis:

There is no relation between the human circadian type and SAD in Iceland.

Age and gender do not interact with the relationship between human circadian type and SAD in Iceland.

Alternative hypothesis:

There is a relation between human circadian type and SAD in Iceland.

Age and gender do interact with the relation between human circadian type and SAD in Iceland.

Methods

Participants

In order to answer our research questions, we recruited a total of *n*=261 participants in the study. We provided them with six psychological questionnaires, recruited through workplaces, golf clubs, the internet, and other public places. The participants were all Icelandic inhabitants and split up to age groups young (18-29), middle (30-59) and old (60+) with data collected in February 2019.

Materials

For data collection and analysis, six questionnaires used with three of them already having an Icelandic translation, e.g., Depression Anxiety Stress Scales (DASS) (Tyrfingsson, n.d.), Patient Health Questionnaire-9 (PHQ-9) (Snæbjörnsdóttir, 1991), and Seasonal Pattern

Assessment Questionnaire (SPAQ) (Magnusson, 1996). The three remaining questionnaires used for data collection did not have an Icelandic version and required translation e.g., Bergen Insomnia Scale (BIS) (Pallesen, *et al.* 2008), The Movement Imagery Questionnaire (MIQ) (Hall & Pongrac, 1983) and Morningness-Eveningness Questionnaire (MEQ) (Horne & Östberg, 1976).

The translators work for each test was divided into two groups with four translators: translating from English to Icelandic and back- translating to English. Those that were responsible for the English to Icelandic translation for the BIS questionnaire, as well as the second half of the English to Icelandic translation of the MEQ questionnaire, were: Giedré Grigaraviciuté and Katla Sigurðardóttir. The other six translators (Jóhanna, Dagrún, Bryndís, Halldóra, Stefanía & Inga) were responsible for the other translations of the questionnaires. Each translator independently translated their questionnaires and compared the results afterward. Any discrepancy was discussed to form one coherent Icelandic version. Finally, after we gave the Icelandic version to the fellow translators for the completion of back-translation to English, we made a comparison of both versions. In case of any inconsistencies, we discussed within the group members and solved cooperatively with the translators and the supervisor. After that, when translators were sure that the Icelandic version of the questionnaire matched the original meaning of the English version; we presented the final Icelandic translated questionnaires to the supervisor. Also, we also presented a pilot test for the translated versions, where the other translators looked at the final Icelandic version to assess the appropriate meaning of the questions and answers.

The questionnaires used in this research were the MEQ (Horne & Östberg, 1976), DASS (Tyrfingsson, n.d.) PHQ-9 (Snæbjörnsdóttir, 1991), and the SPAQ (Magnusson, 1996) questionnaires.

MEQ.

Morningness-Eveningness Questionnaire (MEQ) by J.A Horne and O. Östberg (1976) is a self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms (Horne & Östberg, 1976). It contains 19 multiple-choice questions. Most of the questions have four or five response options. The time-questions asked about the preferred timing to do or perform a specific task, (question 3-9, 11-16 and 19). Answers graded from 1 to 6, the highest number indicating definite morningness and the lowest number indicating definite eveningness. Questions 1, 2, 10 and 18 have a cross along each scale referring to the appropriate score value. For question 17 the most extreme cross on the right-hand side is taken as the reference point, and the appropriate score value range below this point taken (Horne & Östberg, 1976). The score added together, and the sum converted into a five-point morningness- eveningness scale: definitely morning type, moderately morning type, neither type, moderately evening type, definitely evening type (Horne & Östberg, 1976).

DASS.

The Depression Anxiety Stress Scale (DASS) is a self-reported scale designed to measure the set of depression, anxiety, and stress (Psychology Foundation of Australia, 2018). It requires no special skills to administer. If an individual has sought professional help and administered the DASS, interpretation should be carried out by an appropriately qualified health professional. The scale is constructed to define, understand and measure the clinical, emotional state, usually described as depression, anxiety and stress (Psychology Foundation of Australia, 2018). The DASS should thus meet the requirements of both researchers and scientist-professional clinicians (Psychology Foundation of Australia, 2018). DASS contains 42 questions divided into three scales, depression, anxiety and stress, containing 14 items each. The DASS has a high internal consistency and can be administered either in groups or individually for research purposes (Psychology Foundation of Australia, 2018).

PHQ-9.

The Patient Health Questionnaire (PHQ) is a self-administered version of the PRIME-MD diagnostic instrument for common mental disorders (Kroenke, Spitzer, & Williams., 2001). Dr. Spitzer developed the PHQ-9, along with Dr. Williams, Dr. Kroenke, and colleagues, with an educational grant from Pfizer US Pharmaceuticals, New York (Kroenke, Spitzer & Williams., 2001). The PHQ-9 is a multipurpose questionnaire used for screening, diagnosing, monitoring and measuring the severity of depression (Kroenke, Spitzer, & Williams., 2001). The questionnaire is brief and useful in clinical practice (Kroenke, Spitzer, & Williams., 2001). The PHQ-9 contains nine questions with four response options. The questions ask how often over the past two weeks the patient has been bothered by the given statement in the question.

SPAQ.

The Seasonal Pattern Assessment Questionnaire (SPAQ) was developed by Rosenthal et al. in 1987 (Magnusson, 1996). This questionnaire is a widely used instrument to screen for Seasonal affective disorders (SAD) (Magnusson, 1996). The SPAQ is a brief, self-administered screening tool and has eight multiple-choice questions used to determine the potential presence of SAD (Penwell-Waines & Stepleman, 2013) The primary strengths of the SPAQ are its brevity, widespread use in adult clinical and community samples, and established test-retest reliability and internal consistency (Penwell-Waines & Stepleman, 2013)

Procedure

Each research group got 60 copies of the final questionnaires, 30 for each researcher. Advertisement for participants was put out at the researchers' workplaces, on the internet, golf clubs and other public places until reached the minimum number of participants. Questionnaires were handed out in an unmarked enveloped, and the participants were asked to close the envelope when they had finished answering. When we gathered all the data, we switched the envelopes within the researcher group to keep the identity of the participants hidden and untraceable. The data was entered into an Excel-template and coded according to instructions handed out by the supervisor. The final dataset was marched from all the turned-in templates and entered into R-studio for statistical analyses.

Ethics

The National Bioethics Committee approved this study.

Variables

The dependent variable was winter SAD and measured on a nominal scale. Independent variables were circadian type: morning type (definitely morning type and moderately morning type), neutral type, and evening type (moderately evening type and definitely evening type) measured in nominal scale, while age measured in interval scale and gender on a nominal scale.

We calculated a total score of question nr. 1 from the SPAQ questionnaire (Icelandic version) to define the Global Seasonality Score (GSS), thereby created three different GSS groups ("Low," "Medium" and "High"). Scores (<9) points were qualified as the "low" group, scores between (9<11) points qualified as the "medium" group and scores (>11) points qualified as the "high" group. To detect if people were feeling worse during any specific season we subdivided SPAQ question no. 2 (Icelandic version) "feeling worst" into a seasonal intersection, winter, spring, summer, and fall. After that, we defined those who had

SAD. Participants that were categorized as GSS group "high," answered SPAQ question nr. 7 „If you experience changes with the seasons, do you feel these are a problem for you? " (Icelandic version) With "yes" and SPAQ question nr. 8 „If yes, is the problem...“ (Icelandic version) With (>1) and were feeling worst during winter time, were defined as having SAD. Finally, we defined a subgroup called S-SAD, a group for those with a milder form of SAD. Everyone in the middle GSS group who answered SPAQ question nr. 8 (Icelandic version) higher than 0 (>0) and were not feeling worst during the winter (SPAQ question nr.2) (Icelandic version) as well as everyone in the high GSS group who answered the SPAQ question nr. 8 (Icelandic version) with (<2) and were not feeling worst during the winter (SPAQ question nr.2) (Icelandic version) categorized into previously mentioned S-SAD group.

Subsequently, we calculated the total MEQ score by computing the total scores from the MEQ questionnaire and formulated three MEQ groups. Score (<42) points categorized as "evening," score (>42) and (<58) were categorized as "neutral" and over (>59) were categorized as "morning."

Statistics

The performance of the analyses was in R-Studio. To address our primary research question “Is there a relation between human circadian type and SAD in Iceland?” we conducted a chi-square test for the 2 formed SAD groups (no-SAD / SAD, and S-SAD) and chronotype (morning, neutral, evening) because both variables were on a nominal scale. To address our second research question "Does this relationship interact with gender and age?" it was optimal to use logistic regression

Results

1.1 Sample

Out of the *n*=261 sample size, *n*=249 participants met the inclusion criteria. The exclusion was due to missing data, participants living outside of Iceland or not having Icelandic as their mother-language. We enrolled *n*=146 females, age (*M*=44.48, *SD*=20.16) and *n*=103 males (*M*=45.73, *SD*=18.83) (see table 1).

Table 1.

An age distribution depending on gender.

	Female			Male	
n	*M*	*SD*	*N*	*M*	*SD*
146	44.88	20.16	103	45.73	18.83

1.2. Is there a relationship between human circadian type and SAD in Iceland?

According to Pearson's Chi-squared test there was a significant relationship between circadian type and SAD (x^2(2) = 9.235, p-value = 0.009878) (see table 2).

Table 2.

Shows the distribution of chronotypes depending on Seasonal affective disorder (SAD).

	Chronotypes		
Variable	Morning	neutral	Evening
no SAD	66	118	27
S-SAD	5	22	11

1.3. Does this relationship interact with gender and age?

Total of *n*=34 people were in an evening group, of them were *n*=15 male (*M*=5.73, *SD*=5.76) and *n*=19 female (*M*=8.58, SD=5.76). *n*=71 participants were in the morning group, of them were n=33 male (*M*=3.79, *SD*=3.37) and n=38 female (*M*=4.47, *SD*=3.99), *n=144* in neutral group, of them were *n*=55 male (*M*=5.8, *SD*=4.21) and *n*=89 female (*M*=6.79, *SD*=4.99) (see table 3). *n*=38 people in total were suffering from S-SAD compared with, *n*=211 people that did not suffer from SAD.

Table 3.

Descriptive statistics of chronotype and gender.

	Female						Male					
Chronotype	*n*	*M*	*SD*	Med	min	max	N	*M*	*SD*	Med	min	max
Evening	19	8.58	5.76	8	0	20	15	5.73	5.16	4	0	17
Morning	38	4.47	3.99	3.5	0	14	33	3.79	3.37	3	0	13
Neutral	89	6.79	4.99	6	0	20	55	5.8	4.21	5	0	19

According to the binomial logistic regression (see table 4), the evening vs. morning chronotype had the most substantial influence on SAD ($p<.05$). None of the other variables were significant, but the second highest influence was due to gender, and the third highest influence was due to neutral vs. morning chronotype, and the lowest influence obtained by age

Table 4.

The coefficients table shows the influence of chronotype, age, and gender on SAD.

	Seasonal affective disorder (SAD)			
Variable	Estimate Std.	Error	z value	Pr(>|z|)
(Intercept)	-1.64085	0.78201	-2.098	0.0359 *
MEQgroups: neutral vs. morning	0.66962	0.54863	1.221	0.2223
MEQgroups evening vs. morning	1.372	0.65433	2.097	0.0360 *
Age	-0.01204	0.01119	-1.076	0.2819
Gender male vs. female	-0.64654	0.39311	-1.645	0.1

*P <0.05
Null deviance: 212.75 on 248 degrees of freedom
Residual deviance: 199.57 on 244 degrees of freedom
AIC: 209.57

To sum up, if a person had an evening circadian type personality they were likelier to experience SAD than if they had morning circadian type personality.

Discussion

The present study showed a significant relationship between circadian type and SAD (p<.05) in the Icelandic population during winter time. Comparing chronotype, participants who were more evening chronotype, were intelligibly likelier to experience SAD than those who were morning or neutral chronotype. However, results showed no significant interaction with gender or age with SAD, whereby, descriptive statistics showed only a minor effect in which females were likelier to suffer from SAD than men. Besides, age affected seasonality (S-

SAD), which indicated that with increased age there was a lower risk of suffering from seasonality. On the other hand, there was a significant relationship between circadian type and SAD, whereas those who were more evening circadian type, were more likely to suffer from a milder form of SAD, seasonality (S-SAD) rather than those who were more morning type. Also, depending on this conclusion the younger the participant was, the likelier he/she was to be more evening type rather than morning type, consequently feasible to suffer from S-SAD/SAD.

2.1 Relation to previous research

Some previous results from a longitudinal study on SAD and depression showed a high peak of seasonal changes especially during the winter time with no other changes related to health or anxiety; whereas, length of daylight was a significant environmental cause of mood variation on seasonality (Suhail & Cochrane, 1997).

Schwartz *et al.* (1997) indicated some changes in core body temperature of patients with SAD in various seasons, with an increased core temperature during wintertime compared to summer, which might have an impact on human physiology during seasonal variation. On the other hand, Koorengevel, Beersma, den Boer and Hoofdakker (2002) stated, that there was no variation in a circadian pacemaker with the seasons, establishing that the circadian component is a necessary, but not a sufficient cause of substantial component of SAD, as well as a biological marker.

Lewy, Lefler, Emens, and Bauer (2006) researched the circadian phase-shift hypothesis for patients suffering from SAD in winter, with the use of melatonin to influence phase-shift. Correlation between SAD ratings and phase-shift showed a significant relation between melatonin dosage and optimal alignment of circadian rhythms. These results might consider when developing new intervention strategies for treatment in SAD patients.

When comparing our research results, with a total sum of n=249 participants, to larger

sample size, supports for our results can be found in a study from Chotai, Smedh, Johansson, Nilsson and Adolfsson (2004) — with n=2542 participants, indicating a highly significant seasonal, e.g. mood (P <0.001), weight (P <0.020) and energy level (P <0.001) during the winter period. Also found a significant effect of gender, where they concluded that females were significantly (P <0.001) likelier than men to experience physiological seasonality changes with remission of problems with increasing age, whereas 6.7% women were likelier to suffer from S-SAD compared to 4.5% of men. The study also indicated that results could vary widely across ethnic groups and can be considered in future studies.

Similar results are in both studies when comparing gender variables, whereas results show a significant but not massive difference between males and females on other variables; however, females were in most cases likelier to be negatively influenced by environmental cues. Our results did not indicate a significant relationship between gender and SAD and even less relation between age and SAD when controlling for circadian type.

Interestingly, there is another study that supports our hypothesis considering gender to winter SAD, in which the authors, Sourander *et al.* (1999) pointed out, that girls in their puberty are significantly more vulnerable to stress during the seasonal variation, especially during February and March.

In a systematic review of various studies of SAD, Magnusson (2000) pointed out a lack of researches examining the relation of higher latitude to SAD, where he indicated that children were more prone to suffer from SAD in higher, rather than lower latitude with daylight having a higher influence on SAD. Moreover, Magnusson specifies November, December, January and February as ‘‘winter months", whereas it may vary between latitudes (Chotai *et al.* 2004).

Finally, research done by Winkler et al. (2002) showed both cultural and mood differences depending on SAD with the highest effects during November, December, January, and February.

In conclusion, various studies support our research results and might be taking for consideration for future studies on the relation of chronotype and SAD including other previously mentioned variables with a larger sample size.

2.2 Limitations

Considering a population of 350.000 people in Iceland our research limited of sample size *n*=261, with enrolled data of *n*=249 participants who participated by taking various psychological tests that were translated and validated by our research group.

In this context, due to inconsistency in sample size to age and gender variables we cannot confirm our hypothesis considering the connection of both variables to SAD as we aimed for, for so we accomplished to identify another conclusion of influence of chronotype on SAD that was equally exciting.

Results for both age and gender *n*=261 were rather weak but showed a stronger relation to seasonality (S-SAD) than to seasonal affective disorder (SAD).

Comparing our research to a review of a study in Alaska *n*=361, the prevalence of winter SAD for males was 5.8% whereas, for females 12.9 %. The results comparing to winter S-SAD prevalence were higher for both gender groups or 18.8%. Furthermore, similar to this study, another review in Norway with *n*=6313, showed similar gender difference considering prevalence on winter SAD, that was for males 6.5%, females 12.8%, also with only 0.7% difference in prevalence to winter S-SAD (Magnússon, 2000).

In this case, due to data inconsistency, we cannot answer in full extent our primary research question, in which case we cannot reject our null hypothesis. Consequently, owing to the small sample size this research should be reconducted with larger sample size and compared to others.

Furthermore, some limitations might consider when responding questionnaires due to possible distractions during the data collection process, whereas environmental cues varied between participants which in some way might have had an impact on their answers. Although, other cues limiting participants performance and participation might be, e.g. envelopes and paperwork whereas some might have found the use of a digital device more manageable, which might consider during further studies.

The timing was crucial for the study whereas we had to finish recruiting and had only one month (February) in the winter time. That limits our results comparing to winter SAD whereas not all winter months concluded. In other words, this is not sufficient data in more extended terms for it is only one month of the year and it should be done during other months also in order to determine a variable connection to SAD in Iceland.

In summary, there is a need of a larger sample size for more excellent research results and data collection, that can be managed, for example, by merely rewarding participants for participation, as well as the use of other instruments. There might be some literature gap due to the age of data; however, we still managed to use an excellent combination of both recent and older references during the research which satisfied our conclusions

2.3 Future directions

The work performed in this research provides the basis for future research. To refine and further elaborate our finding more research will be necessary.

First, while we have analyzed data with n=249 participants focusing on gender and age, very little can be said about the social status of those participants. Our study could thus be extended in additional information's about the participant such as education, work, and family status to an in-depth understanding of the population to see if those variables could interfere with SAD and Circadian types.

Second, our study offers the opportunity for further examination of young people's mental health in Iceland. Our results showed that younger persons were likelier to suffer from seasonality than the older ones. Hence our research might be extended to a young person's mental health in Iceland, such as anxiety and depression. With additional mental health questionnaires and elaboration.

Thirdly, our data gathering was conducted in February and only once. It would be recommended to extend the research and gather data in all seasons from the participants to monitor the seasonality changes and mood changes closer. Thereby, this would give a clearer picture of the seasonality effect in the population.

Finally, since the BIS, MEQ and MIQ questionnaires needed translation for this study, we do recommend that for further research in Iceland, the researcher gets the translations validated to minimalize any misunderstanding or confusion when answering the questionnaires. Our results showed that evening circadian types are more vulnerable to seasonal changes than other circadian types. The results could use for better mental health protection for this group of people in the Icelandic population. Thus, it might further investigation on mental health between circadian types be useful for the health department to develop proper mental health protection for each circadian type.

Conclusion

In conclusion, chronotype was related to seasonality (S-SAD) with a minor effect of age and gender in the Icelandic population, supporting the hypothesis of a link between circadian type and seasonal affective disorder (SAD). Our results do suggest that evening type personalities are likelier to suffer from S-SAD comparing to morning type, which suggests that the more evening type a person is the likelier they are to suffer from seasonality. We also found that age and gender influence chronotype. Consequently, age has a minor influence that is showing that participants with a younger age did have a higher likelihood to suffer from seasonality rather than the older participants. Lastly, there was higher interaction

with gender, considering woman more likely to suffer from seasonality rather than men.

Further studies need to be conducted to confirm these findings, including larger samples of the population, considering longitudinal or cross-sectional studies and by comparison to other studies results.

Roles of the authors

In order for both authors to be satisfied with their work, there was a need to divide the workload. This thesis is teamwork including Katla Sigurðardóttir and Giedré Grigaraviciuté, where they were more or less equally responsible for the content, e.g., data gathering, thesis chapters, and translation work with a revision and help from a supervisor. During the thesis writing, they exchanged the document and gave each other permission for necessary changes.

Giedré Grigaraviciuté (GG) managed the text order and context. She found most of the needed references and studies. She conducted the statistical analysis with help from the supervisor and was responsible for typos, errors, and proofreading.

Katla Sigurðardóttir (KS) managed the in-text citing and the references. She was responsible for most of the feedbacks revising and took care of the abstract. She was also responsible for the final format of the thesis.

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