Sun Exposure, Depression and Anxiety among College Students

King In Wong, 194068972

National College of Ireland

Bachelor of Arts (Hons) Degree in Psychology

Dr Rocio Galant Megías

March, 2022

Submission of Thesis and Dissertation

National College of Ireland
Research Students Declaration Form
(Thesis/Author Declaration Form)

Name: King In Wong

Student Number: 19406972

Degree for which thesis is submitted: BA (Hons) in Psychology

Title of Thesis: Sun Exposure, Depression and Anxiety among College Students

Date: 06/02/2022

Material submitted for award

A. I declare that this work submitted has been composed by myself.

B. I declare that all verbatim extracts contained in the thesis have been distinguished by quotation marks and the sources of information specifically acknowledged.

C. I agree to my thesis being deposited in the NCI Library online open access repository NORMA.

D. ***Either*** *I declare that no material contained in the thesis has been used in any other submission for an academic award.
    Or *I declare that the following material contained in the thesis formed part of a submission for the award of
    BA (Hons) in Psychology_____
    (State the award and the awarding body and list the material below)

Acknowledgements

Firstly, I would like to thank all the participants who spent their precious time involved in this study. And I want to thank my friends for giving me valuable advice and sharing my survey on social media. My final year project's lecturer Dr Micelle Kelly also gave me great help on the data analysis part. Last but not least, thanks to my supervisor Dr Rocio Galant Megías, for assisting my thesis and always answering all my questions.

Everyone has contributed a lot of effort to their thesis, and I feel honoured to have a chance to create one as one of my life achievements. Again, I appreciate my participants for taking their time to participate in this study and my lecturer and supervisor assisting me throughout the whole process. They have supported my journey on the psychological pathway and shaped my future that I cannot appreciate simply by words.

Abstract

Previous research found that nearly half of the college students suffered mental disorders (Blanco et al., 2008), and 41.6% of college students suffered from anxiety and 36.4% from depression (Mistler et al., 2012). Moreover, the prior studies related to vitamin D, depression and anxiety among college students were insufficient. Therefore, this research aims to investigate the relationship between sun exposure, anxiety and depression among college students to fill the literature gap and provide greater understanding.

In the current quantitative study, 80 college students with no cognitive disability voluntarily participated in this study by completing a survey through social media promotion. The survey involved a demographic questionnaire, sun exposure questionnaire and Hospital Anxiety and Depression Scale. The results from the correlational analysis revealed that sun exposure was not significantly correlated to depression and anxiety. However, it showed a significant correlation between depression and anxiety.

These findings have filled the literature gap and challenged the theory of sun exposure being the vitamin D's primary source. Further research of possible factors and interventions of college students' mental illness despite sun exposure, and more studies focusing on college students' mental illness are required to improve college students' mental health.

Table of Contents

Sun Exposure, Depression and Anxiety among College Students

Mental health is as important as physical health, as poor mental health could lead to mental health disorders such as depression and anxiety disorders (Prince et al., 2007). Mistler et al. (2012) had found that mental health disorders were common and concerning among young adulthood, with about 36.4% of college students suffering from depression and 41.6% of college students suffering from anxiety. In addition, young adults of age 18-25 are the typical age group of college students who had the highest percentage of suffering from severe mental disorders among all age groups (Blanco et al., 2008). Moreover, Furr et al. (2001) had revealed that within 53% of the college students who had experienced depression, 9% of them had suicidal thoughts. All these studies mentioned had concluded that severe mental health crises among college students could potentially lead to suicidal thoughts. One of the stress factors that was linked with mental health disorders among college students was the lack of vitamin D, as it could impact the emotions and behaviours according to its sufficiency level (Cheng et al., 2020; Groves et al., 2013; Kalueff et al., 2004; Wang et al., 2020).

Vitamin D and Mental Health Disorders

Bicikova et al. (2015) had studied the correlation between calcidiol level and patients with depression and anxiety disorders, as calcidiol was linked to vitamin D. The result revealed that lower levels of calcidiol were found in patients with anxiety and depression disorders, compared with the control group with no mental health disorders. It indicated that a lower vitamin D level could be significantly related to depression and anxiety disorders.

Furthermore, Armstrong et al. (2007) had studied the correlation between vitamin D, anxiety and depression among patients with fibromyalgia. Seventy-five participants were involved and filled in the Hospital Anxiety and Depression Score (Zigmond & Snaith, 1983; HADS). The results suggested that vitamin D deficiency commonly occurs in fibromyalgia patients, especially those with a higher level of anxiety and depression.

Vitamin D and Depression

Regarding depression, a systematic review in 2014 found 390 articles that studied the relationship between vitamin D and depression and 15 left after inclusion criteria of randomised controlled trials applied (Spedding, 2014). The general conclusion indicated that vitamin D had a significant and robust relationship with depression.

In the same year, Huang et al. (2014) recruited early pregnancy women to study the correlation of the vitamin D, depressive and anxiety symptoms using the Depression, Anxiety and Stress Scales and Patient Health Questionnaire Depression Module (Kroenke et al., 2001; PHQ-9). Results revealed that a lower vitamin D level was associated with significantly higher depressive symptoms but not anxiety. In addition, Huang et al. (2014) found that physical activity could improve depressive and anxiety symptoms.

Additionally, El-Salem et al. (2021) and Knippenberg et al. (2010) had carried out studies of the correlation between vitamin D status and the depression scores of patients with multiple sclerosis. They both indicated that low vitamin D status was correlated to higher depression scores based on the Hospital Anxiety and Depression Score (HADS).

A recent study had used HADS to investigate if vitamin D would be an effective treatment for patients with depression in a psychiatric department (Abdul-Razzak et al., 2018). It showed that it was significantly effective in improving their depressive symptoms. Furthermore, to treat depression related to vitamin D, a study found that vitamin D supplements could effectively improve depressive symptoms, proving the correlation between vitamin D deficiency and depression symptoms (Parker et al., 2017). However, a recent study by Zhu et al. (2020) suggested that vitamin D supplementation was not associated with improved symptoms of depression but only anxiety instead.

Vitamin D and Anxiety

There has been no systematic review of the association between vitamin D and anxiety yet, but some studies focused on participants with special conditions.

Kalueff et al. (2004) had studied the correlation between vitamin D and emotional behaviour change among mice. The mice who had deficient in the vitamin D receptor demonstrated significantly more anxiety-related behaviours than mice who had normal receptor of vitamin D. It indicated that lack of vitamin D could be correlated to increased anxiety.

In addition, recent research (Martino et al., 2018) that recruited postmenopausal women had shown a significant association between vitamin D deficiency and higher anxiety levels. These studies indicated that vitamin D deficiency could be correlated to behaviour change, especially in the increased level of anxiety.

A study by AlGhamdi et al. (2019) studied the effects of vitamin D supplements intake and severity of anxiety among patients diagnosed with general anxiety disorder. The result suggested that taking vitamin D supplements had improved the severity of their anxiety symptoms, which means that increased vitamin D is associated with a lower level of anxiety.

To examine vitamin D levels, many researchers would require a specific blood test (Constantini et al., 2010; Gordon et al., 2004; Hamilton et al., 2010; Moyad, 2009; Newbury et al., 2003). In addition, the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) is a standard measurement used for examining the level of anxiety and depression. Many research studies applied it to study the correlation of vitamin D, anxiety and depression (Abdul-Razzak et al., 2018; Alkhatatbeh et al., 2019; Armstrong et al., 2007; Kjærgaard et al., 2012; Knippenberg et al., 2010; Rolf et al., 2017; Wepner et al., 2014).

Vitamin D and Sun exposure

Many studies had stated that the leading cause of low vitamin D was due to the lack of sun exposure (Alagöl et al., 2000; Al-Othman et al., 2012; Anderson et al., 2013; Binkley

et al., 2007; Brouwer-Brolsma et al., 2016; Harinarayan et al., 2013; Holick, 2008, Holick & Chen, 2008; Lips, 2006; Nimitphong & Holick, 2013; Tsiaras & Weinstock, 2011). Furthermore, lack of sun exposure could be why some college students tend to have more depressive symptoms in winter (Low & Feissner, 1998), as full-time college students tend to attend lectures in the morning and end in the late afternoon. Since there is less daytime sun exposure in winter, it could lead to vitamin D deficiency which causes seasonal depression (Low & Feissner, 1998). Regarding seasonal depression, bright light therapy has been proven to significantly treat both seasonal and non-seasonal depression (Terman & Terman, 2005).

It is vital to study both depression and anxiety with sun exposure, targeting college students, as nearly half of college students suffered from mental disorders (Blanco et al., 2008). Therefore, it is crucial to find out if sun exposure is significantly related to college students' mental illnesses such as depression and anxiety so that there may be more interventions related to sun exposure in the future to improve college students' mental health.

Since sun exposure is one of the primary natural sources of vitamin D, it could indicate that lack of sun exposure could negatively impact mental health (Nair & Masche, 2012; Nimitphong & Holick, 2013). However, it is uncertain yet as there is a lack of studies that showed that sun exposure was correlated with depression and anxiety. Therefore, the current researcher will explore the correlation between sun exposure, depression, and anxiety in this study.

This research focused on the relationship between sun exposure, anxiety and depression since sun exposure has never been proven to be linked with mental disorders before by any research. Moreover, the current study only recruits college students as college students have a higher risk of having mental disorders (Blanco et al., 2008), in which depression and anxiety are chosen as the variables of this study as they are common among college students (Mistler et al., 2012).

Research Aims

This research investigates the relationship between sun exposure, depression and anxiety. It is vital to discover if more factors could impact depression and anxiety. If more factors are proven to be related, more possible reasons and interventions may be found in the future to treat mental health issues among college students. For example, suppose higher sun exposure is proven to be related to lower depression and anxiety. In that case, college students can use sun exposure-related intervention to improve their mental health.

Hypothesis

1) Lower sun exposure is correlated to higher depression.

2) Lower sun exposure is correlated to higher anxiety.

3) Higher depression is correlated to higher anxiety.

Methodology

Participants

In this study, the researcher recruited 80 college students in Ireland who have no cognitive disability and are in the age range of 18-85 by promoting this study on social media, including Facebook and Instagram.

The inclusion criteria are college students in the age range of 18-85 with no cognitive disability. The exclusion criteria are non-college students outside the range of age 18-85 and have a cognitive disability because this study focuses on college students, and the people over 85 years old or with cognitive disability may have difficulty remembering the past events or understanding the questions, which could potentially affect the accuracy of this study's result.

G*Power 3.1 has been run and suggests 46 participants as the recommended sample size. 2 tails were run with a 95% chance of getting the power of .95. Moreover, 05 Cohen effect was applied as it is the large Cohen's effect size for Pearson's r.

Materials

The current study included three sections, in which the first section was demographic questions; the second section was Sun Exposure; the third section was Hospital Anxiety and Depression Scale.

Demographic Questionnaire

In the first section, a demographic questionnaire (see Appendix 1) was performed to ask about the age and if the participants have any cognitive disability. The aim of asking these two questions was to ensure only the participants in the age range of 18 to 85 with no cognitive disability were not recruited into the result data of this study, as this study was not designed for vulnerable groups due to ethical reasons. And I, as a researcher, is not clinically trained to provide mental and physical health support if the vulnerable groups feel distressed during and after the study.

Sun Exposure Questionnaire

In the second section, a pilot study called Sun Exposure Questionnaire (see Appendix 2) was used to categorise the level of sun exposure, based on the theory that sun exposure was the major source of vitamin D (Nair & Masche, 2012; Nimitphong & Holick, 2013). This questionnaire had been reviewed and understood by five people beforehand to ensure the content is clear, related to this study and straightforward enough for participants to understand. There were two same questions that both asked about the average sun exposure time per day but in different settings: one was in working days including college and job, and another one was in non-working days, because the hours of sun exposure may differ due to working circumstances. The multiple-choice questions included answers of: (1) < 10 minutes; (2) 10 minutes -1 hour; (3) 2-5 hours; (4) > 5 hours. The scoring system worked by adding them both together and then dividing the sum by 2 to get the daily average sun exposure hours, in which < 10 minutes = 0; 10 minutes -1 hour = 1; 2-3 hours = 2; 4 - 5 hours = 3; > 5 hours= 4. For example: (2 + 0)/ 2 = 1.

Hospital Anxiety and Depression Scale

In the third section, a scale called Hospital Anxiety and Depression Scale (see Appendix 3) was used to identify the level of anxiety and depression. This scale is a self-assessment scale that hospitals commonly use for practising and investigating patients' emotional issues (Zigmond & Snaith, 1983), especially for mood disorders like anxiety and depression (Snaith, 2003). Moreover, this scale had been previously used for finding out if vitamin D would be an effective treatment for patients with depression in a psychiatric department (Abdul-Razzak et al., 2018), and the correlation between vitamin D status and the depression scores of multiple sclerosis patients (El-Salem et al., 2021; Knippenberg et al., 2010).

There were 14 questions on the scale of which half of them were related to the participants' mood in the past week, e.g. "I get sudden feelings of panic:". The participants had to select 1 out of 4 multiple choice answers which they feel related to the most, e.g., "Very often indeed", "Quite Often", "Not very often", "Not at all". For questions 5, 6, 8, 9, 13, 14, all the answers were scored from 0, 1, 2, 3 ascendingly. Vice versa for the rest of the questions.

The total score was divided into two sections, one was for anxiety, and another one was for depression. Adding the relevant items up revealed the total score of the relevant scale. For example, adding the anxiety questions scores up indicated the total anxiety level scores, which was the same case for depression questions.

Design

The researcher had conducted a correlational and within-group subject design in this study targeting college students. The data was quantitative.

For the first research question, the variables were the levels of sun exposure and levels of anxiety. For the second research question, the variables were the levels of sun exposure and levels of depression. For the third research question, the variables were the levels of depression and levels of anxiety.

The values of the levels of sun exposure were scored as "< 10 minutes" = 0; "10 minutes- 1 hours" = 1; "2 -3 hours" = 2; "4-5 hours" = 3; "> 5 hours" = 4. The values of the levels of anxiety were scored as the total score of questions 1 to 7 of "0-7" = normal; "8-10" = Borderline abnormal; "11-21" = Abnormal. The values of the levels of depression were scored as the total score of questions 8 to 14 of "0-7" = normal; "8-10" = Borderline abnormal; "11-21" = Abnormal.

Procedure

To ensure ethicality and confidentiality, this research proposal has been approved by the Ethical Committee of the National College of Ireland.

The participants only had to provide their age and cognitive condition to ensure they were not in the vulnerable group. No names and gender were required. Also, the data could not be identified, and the data was stored in a password-protected hard drive, which only the researcher could have access. The researcher would not have access to it after five years.

There is a potential risk of having psychological distress in the third questionnaire of the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) because it requires the participants to think about their levels of depression and anxiety. Therefore, it was mentioned in the information sheet (see Appendix 4). In addition, the details of support helplines and services were suggested in the debriefing sheet (See Appendix 6) if some participants felt distressed during or after the study.

The information sheet stated that the participants had to right to withdraw from the study anytime by closing the tab. Also, the Consent form (See Appendix 5) asked participants to tick the consent box of understanding the content and be aware that there would be a risk of feeling psychologically distressed.

First, the researcher promoted this study on social media and let the interested participants decide to contact the researcher by email if they were interested in participating. A poster with details about this study was promoted on social media, including Facebook and Instagram. If the students were interested, they could email the researcher, in which the email address was attached to the poster. After the students had voluntarily contacted the researcher to confirm their interest in it and voluntary participate in this study, they received a URL link which is linked to a questionnaire to be completed using google form. Only students who were sent the email can have access to complete the survey to ensure only college students could participate as this study only recruited college students.

After the researcher had received their email confirming they were interested and wanted to participate in this study voluntarily, they were sent an URL link of invitation to participate in this study of "Sun exposure, Anxiety and Depression among College Students". After they had clicked on the link, there was an information sheet (see Appendix 4) explaining what this study was about, participants' criteria, risk factors, confidentiality. Then, they were asked to tick the box in the consent form (See Appendix 5) if they had understood the details and risk and confidentiality of this study to proceed to participate.

The information sheet (see Appendix 4) stated that the questionnaire was likely to take five minutes or less for the participants to complete the survey. They could voluntarily take a break if they wanted to since there was no time limit in the survey. They were informed of the risk of psychological distress about the second questionnaire of the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) as It required the participants to think about their levels of depression and anxiety. Moreover, no personal detail was needed, and data could not be identified. In addition, to ensure security, data was kept in a password protected hard drive to ensure safety and anonymity. The researcher would not have access to the data after five years. Participants had the right of withdrawal until after submission.

After they had ticked the consent box and clicked the next page, they would be shown the next page, which involved the first questionnaire called a demographic questionnaire (see Appendix 1). It asked about their age and if they had any cognitive disability. They had to write their age in blank space for the age question and select yes or no for the cognitive disability question. Then, the second questionnaire called Sun Exposure Questionnaire (see Appendix 2) asked about two sun exposure-related questions. After that, the last survey called the Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983) asked about anxiety and depression related questions (see Appendix 3).

After the last section, the overall survey was completed. A debriefing sheet (see Appendix 6) with support services if they feel distressed and the researcher's contact information if they had any further questions or inquiries.

Results

Descriptive Statistics

This research data contained 80 participants ($n = 80$) with no categorical data. The continuous data were age ($M = 22.48$ [95% $CI = 18, 49$]; $SD = 4.5$; Range = 18-49), sun exposure score ($M = 1.36$ [95% $CI = 1.22, 1.51$]; $SD = .66$; Range = 0-3), anxiety score ($M = 10.74$ [95% $CI = 9.69, 11.78$]; $SD = 4.7$; Range = 0-20) and depression ($M = 7.44$ [95% $CI = 6.65, 8.32$]; $SD = 3.94$; Range = 0-16). Details are shown in Table 1 as below:

Table 1

Descriptive Statistics of Age, Sun Exposure, Anxiety and Depression

Variable	*M* [95% CI]	*SD*	Range
Age	22.48 [18, 49]	4.43	18-49
Sun Exposure score	1.36 [1.22, 1.51]	.66	0-3
Anxiety score	10.74 [9.69, 11.78]	4.7	0-20
Depression score	7.44 [6.55, 8.32]	3.97	0-16

Inferential Statistics

Based on the result of the descriptive statistic, the significant value of age was less than 0.05, which indicated the data were non-normally distributed. The histogram of age looked like a bell curve. Also, most of the scores did not deviate from the straight line in the normal Q-Q plot, which suggested normality. There were 4 outliers in the box plot. The descriptive statistic of age was normally distributed based on the information provided.

Based on the result of the descriptive statistic of the score of sun exposure, depression and anxiety, the significant values were all less than 0.05, which indicated the data were non-normally distributed. The histogram of them looked like a bell curve. Moreover, most of the scores did not deviate from the straight line in the normal Q-Q plot, which suggested

normality. There were no outliers in the box plot. Based on the information provided, the result of the descriptive statistic of the score of sun exposure, depression and anxiety was normally distributed.

1) *Is sun exposure correlated to depression?*

The relationship between sun exposure and depression was investigated using a Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. There was a weak, negative correlation between the two variables ($r = -.142$, $n = 80$, $p = .209$). This indicated that the two variables shared approximately 2.02% of the variance in common.

2) *Is sun exposure correlated to anxiety?*

The relationship between sun exposure and anxiety was investigated using a Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. There was a weak, negative correlation between the two variables ($r = -.119$, $n = 80$, $p = .294$). This indicated that the two variables shared approximately 1.42% of the variance in common.

3) *Is depression correlated to anxiety?*

The relationship between anxiety and depression was investigated using a Pearson product-moment correlation coefficient. Preliminary analyses were performed to ensure no violation of the assumptions of normality, linearity and homoscedasticity. There was a strong, positive correlation between the two variables ($r = .57$, $n = 80$, $p < .001$). This indicated that the two variables shared approximately 32.49% of the variance in common.

Overall, lower sun exposure had a weak negative correlation with increased depression and anxiety, and it was not significantly associated with depression and anxiety ($p > .05$). In addition, higher depression was positively and significantly associated with higher anxiety ($p < .001$).

Discussion

The present research aims to investigate the correlation between sun exposure, depression, and anxiety among college students in Ireland by inviting participants to fill in a five-minute online survey. It is vital to explore the relationship between sun exposure, depression and anxiety because if the results of this study reveal that sun exposure is significantly associated with college students' depression and anxiety, then the sun could be a significant affordable intervention for college students, such as increasing physical activity (Huang et al., 2014), bright light therapy (Terman & Terman, 2005). Furthermore, based on the theory that the sun is the primary source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008), lack of vitamin D was due to lack of sun exposure (Alagöl et al., 2000; Al-Othman et al., 2012; Anderson et al., 2013; Binkley et al., 2007; Brouwer-Brolsma et al., 2016; Harinarayan et al., 2013; Holick, 2008; Holick & Chen, 2008; Lips, 2006; Looker et al., 2008; Nimitphong & Holick, 2013; Tsiaras & Weinstock, 2011), and the prior studies had stated that vitamin D was associated with depression and anxiety (Abdul-Razzak et al., 2018; AlGhamdi et al., 2019; Armstrong et al., 2007; Bicikova et al., 2015; El-Salem et al., 2021; Huang et al., 2014; Kalueff et al., 2004; Knippenberg et al., 2010; Martino et al., 2018; Parker et al., 2017; Spedding, 2014; Zhu et al., 2020), the researcher of the current study aims to explore if the sun would have a significant direct association on depression and anxiety.

To investigate the correlation between sun exposure, depression and anxiety, the researcher had suggested three hypotheses: First, lower sun exposure is correlated to higher depression. Second, lower sun exposure is correlated to higher anxiety. Third, higher depression is correlated to higher anxiety. Due to the lack of research that had studied the correlation between sun exposure and depression and anxiety, the hypothesises of this study were developed from the prior studies of the relationship between vitamin D, depression and

anxiety being significant (Abdul-Razzak et al., 2018; AlGhamdi et al., 2019; Armstrong et al., 2007; Bicikova et al., 2015; El-Salem et al., 2021; Huang et al., 2014; Kalueff et al., 2004; Knippenberg et al., 2010; Martino et al., 2018; Parker et al., 2017; Spedding, 2014; Zhu et al., 2020), as sun exposure as the primary source of vitamin D D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008).

The first hypothesis that lower sun exposure is correlated to higher depression is developed based on multiple prior studies in the past that had shown significant (Abdul-Razzak et al., 2018; Armstrong et al., 2007; Bicikova et al., 2015; Cheng et al., 2020; El-Salem et al., 2021; Huang et al., 2014; Knippenberg et al., 2010; Parker et al., 2017; Spedding, 2014). Spedding (2014) carried out systematic reviews and divided fifteen studies into nine studies with biological flaws and six studies without biological flaws. Among the group with biological flaws, the results suggested that vitamin D supplements had worsened depression significantly. However, the group without biological flaws showed that vitamin D supplements significantly benefited people with depression. Furthermore, a more recent systematic review carried out by Cheng et al. (2020) that had included 7534 participants had studied the efficiency of vitamin D supplements on reducing negative emotions. These researchers also stated that people who lacked vitamin D benefited from reducing depressive symptoms from taking vitamin D supplements.

The second hypothesis of lower sun exposure is correlated to higher anxiety is based on the prior research that studied the correlation between vitamin D and anxiety and showed a significant correlation (AlGhamdi et al., 2019; Armstrong et al., 2007; Bicikova et al., 2015; El-Salem et al., 2021; Huang et al., 2014; Kalueff et al., 2004; Knippenberg et al., 2010; Martino et al., 2018; Zhu et al., 2020). For example, Kalueff et al. (2004) had investigated how vitamin D could be linked to emotional behaviour among mice. Comparing the group of mice with vitamin D deficiency receptors and mice who had normal receptors, the researchers

observed that mice who had vitamin D deficiency showed an increased level of anxiety compared to the regular group, which indicated that lack of vitamin D could be associated with an increased level of anxiety. Similarly, a recent study carried out by Martino et al. (2018) had found that postmenopausal women who were vitamin D deficient had an increased level of behaviour change, including anxiety-related behaviour. In addition, AlGhamdi et al. (2019) discovered that vitamin D supplements intake could reduce anxiety among patients with generalised anxiety disorder. Based on these studies, the hypothesis that lack of sun exposure is correlated with increased anxiety is established.

The third hypothesis of increased depression is associated with increased anxiety among college students was based on previous studies (Beiter et al., 2015; Sahin et al., 2021). Beiter et al. (2015) recruited 184 undergraduate students, and the result revealed a significant and positive correlation between anxiety and depression. In addition, a recent study had studied the variables that could cause depression among college students, including anxiety. In that study, Sahin et al. (2021) had recruited 439 college students, and the result showed that increased anxiety had significantly predicted increased depression. Therefore, due to these prior studies that showed a significantly positive correlation between anxiety and depression and the causation relationship of anxiety predicting depression among college students, the researcher hypothesised that anxiety and depression could have a significant positive association.

Findings

The first and second research questions investigating the relationship between sun exposure, depression, and anxiety showed weak negative and non-significant correlation results ($p = >.05$), indicating that sun exposure was not linked with depression and anxiety. To simplify its meaning, it noted that if sun exposure went down, depression and anxiety went up, but not significantly. Although they were not significantly associated, there was a

negative correlation between them, suggesting that other factors could affect their correlation other than sun exposure variables. For the third research question, the researcher investigated the relationship between anxiety and depression. The result showed a strong, positive and significant correlation between depression and anxiety, which indicated that a higher level of anxiety is associated with a higher level of depression. To interpret it, it means that if the depression level went up, the anxiety level also went up significantly.

It is clear that the first and second findings have rejected the hypothesis that sun exposure is correlated with depression and anxiety. On the other hand, the third finding is consistent with the hypothesis that depression is correlated with anxiety. The possible reasons behind them will be explained as below:

Firstly, the findings of the sun exposure association with depression and anxiety of not being consistent could belong to the same reasons. One possible explanation for it is that there was no literature on the correlation between sun exposure, depression, and anxiety. It could be the start of a new finding that sun exposure may not be significantly related to depression and anxiety, which doesn't have to be the same as similar prior findings that explored vitamin D level, anxiety and depression, as vitamin D is not the same as sun exposure, and sun exposure is one of the sources to absorb vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008). Although the hypothesis of the first and second research questions was based on the prior studies that had proven vitamin D to be correlated to anxiety and depression significantly (Abdul-Razzak et al., 2018; AlGhamdi et al., 2019; Armstrong et al., 2007; Bicikova et al., 2015; Cheng et al., 2020; El-Salem et al., 2021; Huang et al., 2014; Kalueff et al., 2004; Knippenberg et al., 2010; Martino et al., 2018; Parker et al., 2017; Spedding, 2014; Zhu et al., 2020), the findings of sun exposure in related to depression and anxiety could still be inconsistent because vitamin D and sun exposure are two different variables, which could explain the inconsistency between this study and the

prior studies. This explanation could contribute to a new finding of sun exposure and mental disorders and encourage more future research to explore the correlation between sun exposure and mental disorders in more criteria.

A second explanation of the findings of the first and second research questions not being consistent with the hypothesis could be due to the distribution of sun in an area as sun exposure was stated to be the primary natural source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008), and vitamin D deficiency was significantly associated with lack of sun exposure (Alagöl et al., 2000; Al-Othman et al., 2012; Anderson et al., 2013; Binkley et al., 2007; Brouwer-Brolsma et al., 2016; Harinarayan et al., 2013; Holick, 2008; Holick & Chen, 2008; Lips, 2006; Looker et al., 2008; Nimitphong & Holick, 2013; Tsiaras & Weinstock, 2011). To elaborate from this idea, the House of Oireachtas. (2021) reported that nearly half of the people in Ireland lack vitamin D, which could be impacted by longer working hours from home due to pandemics. Moreover, another research had also stated that almost half of the world population had vitamin D deficiency (Holick, 2007). Suppose half of Ireland's population were lack of vitamin D. In that case, it could affect the result to be not significant enough, because it means that the prior studies that revealed a significant association between vitamin D and mental health disorders could be due to its selection of areas to be in high sun exposure regions, such as studies that took place in India (Harinarayan et al., 2008; Harinarayan & Joshi, 2009), the United AraEmirateses (Al Anouti et al., 2011) and Australia (Benson & Skull, 2007). A high level of the source of sun exposure may first need to be provided in an area to spot any significant relationship on the level of depression and anxiety between people who had more sun exposure and lack of sun exposure. For example, India has a high sun exposure level, which indicates that the analysis of the results will be more apparent when it comes to Indian people who stayed indoor and outdoor most of the time, in contrast to Irish people who stayed indoor and outdoor most of

the time as Ireland has far less sun exposure outdoor compare to India as it belongs to one of the low sun exposure countries, while Ireland was revealed to be lack of sun exposure for vitamin D production (Trinity College Dublin, 2017). It also indicated that Ireland's outdoor and indoor environments could be similarly low sun exposure and does not show much contrast, explaining why there was no significant association between sun exposure, anxiety, and depression in this study. This study contributes to future research focusing the region on locations with higher sun exposure for a more significant result as the result's significance may depend on the sun exposure region difference.

Another explanation for the first and second hypotheses not consistent with the result and prior research could be the invalid measurement method. Based on a systematic review that had studied the relationship between vitamin D and depression (Spedding, 2014), It specifically stated that vitamin D level, which was carried out by blood test, that was lower than 25 hydroxyvitamin D (OHD) could lead to vitamin D deficiency. It mentioned that any prior studies that did not include vitamin D levels below 25OHD were not considered valid studies to examine the relationship between vitamin D and depression. To support this statement, Holick. (2009) also stated that vitamin D level above 25OHD was considered vitamin D sufficiency.

In the current study, it is uncertain if the measurement of sun exposure level had reached 25OHD, which was the baseline threshold of determining if a person was Vitamin D insufficient or sufficient. Moreover, the current study only measured the length of time the participants spent outdoor during the daytime, which may have missed the threshold of 25OHD to cause the results of this study to be inconsistent with the hypothesis and prior studies. Although different measurement methods could lead to an inconsistent result, this study has added to the literature that more future studies about sun exposure and mental disorders are required with an approach that could meet the threshold to show significant

deficiency of vitamin D or ways to define the baseline of sun exposure level that is equivalent to severe depression and anxiety.

Although the first two findings suggested inconsistency to the hypotheses and prior studies, the last findings revealed a significant positive correlation between depression and anxiety was the same as the previous hypothesis. This finding is similar to two studies investigating the variable of anxiety of predicting depression in college students (Sahin et al., 2021; Baltaci et al., 2021). They both showed a significant result that increased anxiety could lead to increased depression. Differently from the current research, the method of those studies had used the scales of Beck Depression Inventory (BDI) and State and Trait Anxiety Scale (STAI). It was carried out using multiple linear regression analysis, while the current research measured anxiety and depression by Hospital Anxiety and Depression Score (HADS), and was carried out using correlation analysis. They both show similar results with different methods. This could add to the future literature to be more time-efficient by using HADS to carry out the correlation between anxiety and depression as HADS has shorter questions than BDI and STAI combined. Therefore, it could save more time for future research to collect data and analyse. In addition, there is a lack of research on the correlation between depression and anxiety among college students. Therefore, further studies on college students and mental health disorders are required to improve knowledge and suggest possible interventions.

Limitation and Strengths

Despite the current study's differences, similarities, and contributions compared to the prior research, some limitations could impact the results, including self-report biases.

Firstly, this study was taken during winter and the pandemic, indicating that people would go outdoors less due to the restriction. In this aspect, despite the fact that Ireland belongs to a low sun exposure area during winter, Irish colleges also promote online lecturing

during the quarantine period, which caused the college students to go outdoor less often than before (Li & Lalani, 2020), which is revealed from this study about 65% of the participants spent about less than 2 hours outdoor during day time. Such factor of the majority of sun exposure score to be at a similar level could cause the result to be non-significant due to lack of contrast of students who had received higher sun exposure.

Moreover, the limited options of self-report of sun exposure questionnaire could be impacting the result as there were only five options with the intervals of every hour. Therefore, if more multiple-choice options were given, such as every 10 minutes or half-hour instead of every hour, the correlation of sun exposure, anxiety and depression may be more significant because providing more options could lead to possible contrast and significant figures.

Additionally, the self-report of the HADS could be biased as the questions were straightforward, indicating that they were anxiety and depression related. The researcher had already informed the participants that there would be a section that measured their scores of anxiety and depression. There could be a chance of participants filling in the answers that did not apply to their situation due to social norms and fear of stigmatising mental illness.

Despite the limitations, the current study has displayed its strength by filling in the gap of prior studies on many aspects. Building from the idea that sun exposure is a major source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008), this study had added college students as a group to focus on which the prior studies had not focused. Moreover, this study had filled in the gap of the previous literature of lack of research exploring the relationship between vitamin D and anxiety as the studies on anxiety and vitamin D were far less compared to depression. In addition, since there have been no research studying about sun exposure's association with depression and anxiety yet, the present study fills in this gap by establishing this study to explore if sun exposure is

associated with depression and anxiety disorders among college students, as the sun is the primary source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008) and college students had a higher prevalence of being mentally distressed among all age groups (Blanco et al., 2008).

Furthermore, the researcher collected the data by promoting this study on college students' most active social media platforms, including Facebook and Instagram (Kubbernus, 2021), which could spread awareness and knowledge to more colleges about sun exposure and mental health illness and vitamin D. Moreover, sharing information on social media could promote more future studies and interventions related to this field to interested researchers as this is a new study that requires more future research.

For suggestions on future research, more possible factors that could affect sun exposure correlation with mental health disorders should be considered, such as gender and race. Also, the researcher should consider an appropriate method to measure sun exposure that could ensure its baseline has reached the level of vitamin D deficiency or severe anxiety and depression. Last but not least, choosing a high sun exposure region to collect data on sun exposure could show more contrast than a low sun exposure region, as higher contrast may show more significance.

Implications

The implications of the current study's findings are vital to the prior and future research because it demonstrated that the relationship between sun exposure, depression and anxiety is negative but not significant. Building from the roots of this topic, sun exposure may indicate that the idea of sun exposure being the primary natural source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008) as invalid, as this research had applied large effect size and found no significant correlation between sun exposure, depression and anxiety while other researchers had revealed a significant

relationship between vitamin D, depression and anxiety. Such finding challenges the theory of sun exposure being the primary source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008), as there should be a significant connection to show a significant correlation with depression and anxiety if the major source of vitamin D is based on sun exposure. Therefore, future research should consider that sun exposure is not associated with anxiety and depression among college students from this study and duplicate more studies on it to test its reliability and the theory of sun exposure being the primary source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008).

Building from the implication that sun exposure may not be the major source of vitamin D, other interventions that could increase vitamin D intake to improve anxiety and depression symptoms despite getting sun exposure should be considered, such as intake of vitamin D supplements (Abdul-Razzak et al., 2018; Parker et al., 2017) and vitamin D food sources, e.g., oily fish and egg yolks (NHS, 2020). Plus, sun exposure might not be the best idea for obtaining vitamin D in countries with low sun exposure. Therefore, more interventions despite sun exposure should be suggested in future research. Furthermore, considering sun exposure may not be as effective in increasing vitamin D, educational campaigns could promote this result and other effective interventions to spread awareness to the college students and public.

Furthermore, the current study has found a significant correlation between depression and anxiety in college students, which indicated that increased anxiety is related to increased depression among college students. Therefore, it could add to the literature as prior studies focused on whether anxiety was a significant variable of depression among college students instead of focusing on their correlation (Beiter et al., 2015; Sahin et al., 2021).

Conclusion

As a general conclusion, the present study found no significant association between sun exposure and the sores of depression and anxiety among college students. Still, it found a significant and positive association between depression and anxiety.

Although the finding showed no significant association between sun exposure, depression and anxiety, which was inconsistent with the first and second hypotheses and the previous literature that found a significant relationship between vitamin D and mental disorders due to sun exposure being vitamin D's primary source (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008), the current findings could challenge the theory of sun exposure being a major source of vitamin D (Brot et al., 2001; Hollis, 2005; Maeda et al., 2007; Moan et al., 2008) and suggested altering focus on other interventions, such as taking vitamin D supplements (Abdul-Razzak et al., 2018; Parker et al., 2017) and vitamin D food source (NHS, 2020). In addition, the finding of the significant relationship of depression and anxiety among college students is consistent with the hypothesis and previous literature that had studied the impact of anxiety on depression among college students and fills in the gap by adding in the correlation between anxiety and depression among college students when the prior literature was lack of it (Beiter el al., 2015; Sahin et al., 2021).

The findings of these studies have contributed to the literature by challenging theory, suggesting other interventions, and filling the gaps of prior literature. However, further research is required to investigate more factors of sun exposure and mental illness and offer more effective interventions to reduce anxiety and depression among college students.

References

Abdul-Razzak, K. K., Almanasrah, S. O., Obeidat, B. A., & Khasawneh, A. G. (2018).

Vitamin D is a potential antidepressant in psychiatric outpatients. *International

Journal of Clinical Pharmacology and Therapeutics*, *56*(12), 585–596.

https://doi.org/10.5414/cp203309

Al Anouti, F., Thomas, J., Abdel-Wareth, L., Rajah, J., Grant, W. B., & Haq, A. (2011).

Vitamin D deficiency and sun avoidance among university students at Abu Dhabi,

United Arab Emirates. *Dermato-Endocrinology*, *3*(4), 235–239.

https://doi.org/10.4161/derm.3.4.16881

Al-Othman, A., Al-Musharaf, S., Al-Daghri, N. M., Krishnaswamy, S., Yusuf, D. S.,

Alkharfy, K. M., Al-Saleh, Y., Al-Attas, O. S., Alokail, M. S., Moharram, O., Sabico,

S., & Chrousos, G. P. (2012). Effect of physical activity and sun exposure on vitamin

D status of Saudi children and adolescents. *BMC Pediatrics*, *12*(1).

https://doi.org/10.1186/1471-2431-12-92

Alagöl, F., Shihadeh, Y., Boztepe, H., Tanakol, R., Yarman, S., Azizlerli, H., & Sandalci, Ö.

(2000). Sunlight exposure and vitamin D deficiency in Turkish women. *Journal of

Endocrinological Investigation*, *23*(3), 173–177. https://doi.org/10.1007/bf03343702

AlGhamdi, S., Alsufiani, H., Alzeben, F., Alhejaili, N., Eid, A., Khoja, S., Tayeb, H. O., &

Tarazi, F. I. (2019). Vitamin D supplementation ameliorates severity of generalised

anxiety disorder (GAD). *Metabolic Brain Disease*, *34*(6), 1781–1786.

https://doi.org/10.1007/s11011-019-00486-1

Alkhatatbeh, M. J., Abdul-Razzak, K. K., Amara, N. A., & Al-Jarrah, M. (2018). Non-cardiac

Chest Pain and Anxiety: A Possible Link to Vitamin D and Calcium. *Journal of

Clinical Psychology in Medical Settings*, *26*(2), 194–199.

https://doi.org/10.1007/s10880-018-9579-2

Andersen, R., Brot, C., Jakobsen, J., Mejborn, H., Mølgaard, C., Skovgaard, L. T., Trolle, E.,

    Tetens, I., & Ovesen, L. (2013). Seasonal changes in vitamin D status among Danish

    adolescent girls and elderly women: the influence of sun exposure and vitamin D

    intake. *European Journal of Clinical Nutrition*, *67*(3), 270–274.

    https://doi.org/10.1038/ejcn.2013.3

Armstrong, D. J., Meenagh, G. K., Bickle, I., Lee, A. S. H., Curran, E. S., & Finch, M. B.

    (2007). Vitamin D deficiency is associated with anxiety and depression in

    fibromyalgia. *Clinical Rheumatology*, *26*(4), 551–554.

    https://doi.org/10.1007/s10067-006-0348-5

Baltaci, H. S., Kucuker, D., Ozkilic, I., Karatas, U. Y., & Ozdemir, H. A. (2021). Investigation

    of Variables Predicting Depression in College Students. *Eurasian Journal of*

    Educational Research (EJER), *93*, 211–225. https://doi.org/10.14689/ejer.2021.92.11

Beiter, R., Nash, R., McCrady, M., Rhoades, D., Linscomb, M., Clarahan, M., & Sammut, S.

    (2015). The prevalence and correlates of depression, anxiety, and stress in a sample of

    college students. *Journal of Affective Disorders*, *173*, 90–96.

    https://doi.org/10.1016/j.jad.2014.10.054

Benson, J., & Skull, S. (2007). Hiding from the sun-vitamin D deficiency in refugees.

    https://digital.library.adelaide.edu.au/dspace/bitstream/2440/43805/1/hdl_43805.pdf?e

    v=pub_ext_btn_xdl

Bicikova, M., Duskova, M., Vitku, J., Kalvachová, B., Ripova, D., Mohr, P., & Stárka, L.

    (2015). Vitamin D in Anxiety and Affective Disorders. *Physiological Research*, S101–

    S103. https://doi.org/10.33549/physiolres.933082

Binkley, N., Novotny, R., Krueger, D., Kawahara, T., Daida, Y. G., Lensmeyer, G., Hollis, B.

    W., & Drezner, M. K. (2007). Low Vitamin D Status despite Abundant Sun Exposure.

The Journal of Clinical Endocrinology & Metabolism, *92*(6), 2130–2135.

https://doi.org/10.1210/jc.2006-2250

Blanco, C., Okuda, M., Wright, C., Hasin, D. S., Grant, B. F., Liu, S. M., & Olfson, M.

(2008). Mental health of college students and their non-college-attending peers:

results from the National Epidemiologic Study on Alcohol and Related

Conditions. *Archives of general psychiatry*, *65*(12), 1429–1437.

https://doi.org/10.1001/archpsyc.65.12.1429

Brot, C., Vestergaard, P., Kolthoff, N., Gram, J., Hermann, A. P., & Sørensen, O. H. (2001).

Vitamin D status and its adequacy in healthy Danish perimenopausal women:

relationships to dietary intake, sun exposure and serum parathyroid hormone. *British

Journal of Nutrition*, *86*(S1), S97–S103. https://doi.org/10.1079/bjn2001345

Brouwer-Brolsma, E. M., Vaes, A. M., van der Zwaluw, N. L., van Wijngaarden, J. P., Swart,

K. M., Ham, A. C., van Dijk, S. C., Enneman, A. W., Sohl, E., van Schoor, N. M., van

der Velde, N., Uiterlinden, A. G., Lips, P., Feskens, E. J., Dhonukshe-Rutten, R. A., &

de Groot, L. C. (2016). Relative importance of summer sun exposure, vitamin D

intake, and genes to vitamin D status in Dutch older adults: The B-PROOF study. *The

Journal of Steroid Biochemistry and Molecular Biology*, *164*, 168–176.

https://doi.org/10.1016/j.jsbmb.2015.08.008

Cheng, Y., Huang, Y., & Huang, W. (2020). The effect of vitamin D supplement on negative

emotions: A systematic review and meta-analysis. *Depression and Anxiety*, *37*(6),

549–564. https://doi.org/10.1002/da.23025

Constantini, N. W., Arieli, R., Chodick, G., & Dubnov-Raz, G. (2010). High Prevalence of

Vitamin D Insufficiency in Athletes and Dancers. *Clinical Journal of Sport Medicine*,

20(5), 368–371. https://doi.org/10.1097/jsm.0b013e3181f207f2

El-Salem, K., Khalil, H., Al-Sharman, A., Al-Mistarehi, A. H., Yassin, A., Alhayk, K. A.,

Qawasmeh, M. A., Bashayreh, S. Y., Kofahi, R. M., & Obeidat, A. Z. (2021). Serum

vitamin d inversely correlates with depression scores in people with multiple

sclerosis. *Multiple Sclerosis and Related Disorders*, *48*, 102732.

https://doi.org/10.1016/j.msard.2020.102732

Furr, S. R., Westefeld, J. S., McConnell, G. N., & Jenkins, J. M. (2001). Suicide and

depression among college students: A decade later. *Professional Psychology:

Research and Practice*, *32*(1), 97–100. https://doi.org/10.1037/0735-7028.32.1.97

Gordon, C. M., DePeter, K. C., Feldman, H. A., Grace, E., & Emans, S. J. (2004). Prevalence

of Vitamin D Deficiency Among Healthy Adolescents. *Archives of Pediatrics &

Adolescent Medicine*, *158*(6), 531. https://doi.org/10.1001/archpedi.158.6.531

Hamilton, B., Grantham, J., Racinais, S., & Chalabi, H. (2010). Vitamin D deficiency is

endemic in Middle Eastern sportsmen. *Public Health Nutrition*, *13*(10), 1528–1534.

https://doi.org/10.1017/s136898000999320x

Harinarayan, C. V., & Joshi, S. R. (2009). Vitamin D status in India--its implications and

remedial measures. *JAPI*, *57*, 40-8.

https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.456.6667&rep=rep1&type

=pdf

Harinarayan, C. V., Holick, M. F., Prasad, U. V., Vani, P. S., & Himabindu, G. (2013).

Vitamin D status and sun exposure in India. *Dermato-Endocrinology*, *5*(1), 130–141.

https://doi.org/10.4161/derm.23873

Harinarayan, C. V., Ramalakshmi, T., Prasad, U. V., & Sudhakar, D. (2008). Vitamin D status

in Andhra Pradesh: a population based study. *Indian Journal of Medical

Research*, *127*(3), 211.

Hollis, B. W. (2005). Circulating 25-Hydroxyvitamin D Levels Indicative of Vitamin D Sufficiency: Implications for Establishing a New Effective Dietary Intake Recommendation for Vitamin D. *The Journal of Nutrition*, *135*(2), 317–322. https://doi.org/10.1093/jn/135.2.317

Holick, M. F. (2007). Vitamin D Deficiency. *New England Journal of Medicine*, *357*(3), 266–281. https://doi.org/10.1056/nejmra070553

Holick, M. F., Chen, T. C., Lu, Z., & Sauter, E. (2007). Vitamin D and Skin Physiology: A D-Lightful Story. *Journal of Bone and Mineral Research*, *22*(S2), V28–V33. https://doi.org/10.1359/jbmr.07s211

Holick, M. F., & Chen, T. C. (2008). Vitamin D deficiency: a worldwide problem with health consequences. *The American Journal of Clinical Nutrition*, *87*(4), 1080S-1086S. https://doi.org/10.1093/ajcn/87.4.1080s

Holick M. F. (2009). Vitamin D status: measurement, interpretation, and clinical application. *Annals of epidemiology*, *19*(2), 73–78. https://doi.org/10.1016/j.annepidem.2007.12.001

Holick, M. F. (2010). The Vitamin D Deficiency Pandemic: a Forgotten Hormone Important for Health. *Public Health Reviews*, *32*(1), 267–283. https://doi.org/10.1007/bf03391602

House of Oireachtas. (2021). *Report on addressing Vitamin D deficiency as a public health measure in Ireland*. Joint Committee on Health. https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_health/reports/2021/2021-04-07_report-on-addressing-vitamin-d-deficiency-as-a-public-health-measure-in-ireland_en.pdf

https://link.gale.com/apps/doc/A179568741/HRCA?u=anon~6829eef4&sid=googleScholar&xid=b482ff5f

Huang, J. Y., Arnold, D., Qiu, C. F., Miller, R. S., Williams, M. A., & Enquobahrie, D. A. (2014). Association of Serum Vitamin D with Symptoms of Depression and Anxiety in Early Pregnancy. *Journal of Women's Health*, *23*(7), 588–595. https://doi.org/10.1089/jwh.2013.4598

Kalueff, A. V., Lou, Y. R., Laaksi, I., & Tuohimaa, P. (2004). Increased anxiety in mice lacking vitamin D receptor gene. *NeuroReport*, *15*(8), 1271–1274. https://doi.org/10.1097/01.wnr.0000129370.04248.92

Kjærgaard, M., Waterloo, K., Wang, C. E. A., Almås, B., Figenschau, Y., Hutchinson, M. S., Svartberg, J., & Jorde, R. (2012). Effect of vitamin D supplement on depression scores in people with low levels of serum 25-hydroxyvitamin D: nested case—control study and randomised clinical trial. *British Journal of Psychiatry*, *201*(5), 360–368. https://doi.org/10.1192/bjp.bp.111.104349

Knippenberg, S., Bol, Y., Damoiseaux, J., Hupperts, R., & Smolders, J. (2010). Vitamin D status in patients with MS is negatively correlated with depression, but not with fatigue. *Acta Neurologica Scandinavica*, *124*(3), 171–175. https://doi.org/10.1111/j.1600-0404.2010.01447.x

Kroenke, K., Spitzer, R. L., & Williams, J. B. W. (2001). The PHQ-9. *Journal of General Internal Medicine*, *16*(9), 606–613. https://doi.org/10.1046/j.1525-1497.2001.016009606.x

Kubbernus, C. (2021). *16 Social Media Statistics You Need to Know for 2021*. Kubbco. https://www.kubbco.com/16-social-media-statistics-you-need-to-know-for-2021/

Li, C., & Lalani, F. (2020). *The rise of online learning during the COVID-19 pandemic*. World Economic Forum. https://www.weforum.org/agenda/2020/04/coronavirus-education-global-covid19-online-digital-learning/

Lips, P. (2006). Vitamin D physiology. *Progress in Biophysics and Molecular Biology*, *92*(1), 4–8. https://doi.org/10.1016/j.pbiomolbio.2006.02.016

Looker, A. C., Pfeiffer, C. M., Lacher, D. A., Schleicher, R. L., Picciano, M. F., & Yetley, E. A. (2008). Serum 25-hydroxyvitamin D status of the US population: 1988–1994 compared with 2000–2004. *The American Journal of Clinical Nutrition*, *88*(6), 1519–1527. https://doi.org/10.3945/ajcn.2008.26182

Low, K. G., & Feissner, J. M. (1998). Seasonal Affective Disorder in College Students: Prevalence and Latitude. *Journal of American College Health*, *47*(3), 135–137. https://doi.org/10.1080/07448489809595634

Maeda, S., Kunii, I., Hayashi, L., & Lazaretti-Castro, M. (2007). The effect of sun exposure on 25-hydroxyvitamin D concentrations in young healthy subjects living in the city of São Paulo, Brazil. *Brazilian Journal of Medical and Biological Research*, *40*(12), 1653–1659. https://doi.org/10.1590/s0100-879x2006005000162

Martino, Catalano, A., G., Bellone, F., Gaudio, A., Lasco, C., Langher, V., Lasco, A., & Morabito, N. (2018). Anxiety levels predict fracture risk in postmenopausal women assessed for osteoporosis. *Menopause*, *25*(10), 1110–1115. https://doi.org/10.1097/gme.0000000000001123

Mistler, B. J., Reetz, D. R., Krylowicz, B., & Barr, V. (2012). The association for university and college counseling center directors annual survey. http://files.cmcglobal.com/Monograph_2012_AUCCCD_Public.pdf

Moan, J., Porojnicu, A. C., Dahlback, A., & Setlow, R. B. (2008). Addressing the health benefits and risks, involving vitamin D or skin cancer, of increased sun exposure. *Proceedings of the National Academy of Sciences*, *105*(2), 668–673. https://doi.org/10.1073/pnas.0710615105

Moyad, M. A. (2009). Vitamin D: A Rapid Review. *Dermatology Nursing*, *21*(1), 25–55.

> https://web.s.ebscohost.com/ehost/detail/detail?vid=0&sid=fc22c5d0-1170-4455-
>
> ace2-
>
> eeddfabc64f4%40redis&bdata=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#A
>
> N=37193927&db=a9h

Nair, R., & Maseeh, A. (2012). Vitamin D: The "sunshine" vitamin. *Journal of pharmacology*

> *& pharmacotherapeutics*, *3*(2), 118–126. https://doi.org/10.4103/0976-500X.95506

Newbury, L., Dolan, K., Hatzifotis, M., Low, N., & Fielding, G. (2003). Calcium and Vitamin

> D Depletion and Elevated Parathyroid Hormone following Biliopancreatic Diversion.
>
> *Obesity Surgery*, *13*(6), 893–895. https://doi.org/10.1381/096089203322618722

Nimitphong, H., & Holick, M. F. (2013). Vitamin D status and sun exposure in southeast

> Asia. *Dermato-Endocrinology*, *5*(1), 34–37. https://doi.org/10.4161/derm.24054

Parker, G. B., Brotchie, H., & Graham, R. K. (2017). Vitamin D and depression. *Journal of*

> *Affective Disorders*, *208*, 56–61. https://doi.org/10.1016/j.jad.2016.08.082

Prince, M., Patel, V., Saxena, S., Maj, M., Maselko, J., Phillips, M. R., & Rahman, A. (2007).

> No health without mental health. *The Lancet*, *370*(9590), 859–877.
>
> https://doi.org/10.1016/s0140-6736(07)61238-0

Rolf, L., Muris, A. H., Bol, Y., Damoiseaux, J., Smolders, J., & Hupperts, R. (2017). Vitamin

> D 3 supplementation in multiple sclerosis: Symptoms and biomarkers of depression.
>
> *Journal of the Neurological Sciences*, *378*, 30–35.
>
> https://doi.org/10.1016/j.jns.2017.04.017

Sahin Baltaci, H., Kucuker, D., Ozkilic, I., Karatas, U. Y., & Ozdemir, H. A. (2021).

> Investigation of Variables Predicting Depression in College Students. *Eurasian*
>
> *Journal of Educational Research*, *21(92).* https://doi.org/10.14689/ejer.2021.92.11

Spedding, S. (2014). Vitamin D and Depression: A Systematic Review and Meta-Analysis Comparing Studies with and without Biological Flaws. *Nutrients*, *6*(4), 1501–1518. https://doi.org/10.3390/nu6041501

Terman, M., & Terman, J. S. (2005). Light Therapy for Seasonal and Non-seasonal Depression: Efficacy, Protocol, Safety, and Side Effects. *CNS Spectrums*, *10*(8), 647–663. https://doi.org/10.1017/s1092852900019611

Tsiaras, W., & Weinstock, M. (2011). Factors Influencing Vitamin D Status. *Acta Dermato Venereologica*, *91*(2), 115–124. https://doi.org/10.2340/00015555-0980

Wang, X., Jiao, X., Xu, M., Wang, B., Li, J., Yang, F., Zhang, L., Xu, L., & Yu, X. (2020). Effects of circulating vitamin D concentrations on emotion, behavior and attention: A cross-sectional study in preschool children with follow-up behavior experiments in juvenile mice. *Journal of Affective Disorders*, *275*, 290–298. https://doi.org/10.1016/j.jad.2020.06.043

Wepner, F., Scheuer, R., Schuetz-Wieser, B., Machacek, P., Pieler-Bruha, E., Cross, H. S., Hahne, J., & Friedrich, M. (2014). Effects of vitamin D on patients with fibromyalgia syndrome: A randomised placebo-controlled trial. *Pain*, *155*(2), 261–268. https://doi.org/10.1016/j.pain.2013.10.002

Zhu, C., Zhang, Y., Wang, T., Lin, Y., Yu, J., Xia, Q., Zhu, P., & Zhu, D. (2020). Vitamin D supplementation improves anxiety but not depression symptoms in patients with vitamin D deficiency. *Brain and Behavior*, *10*(11). https://doi.org/10.1002/brb3.1760

Zigmond, A. S., & Snaith, R. P. (1983). The Hospital Anxiety and Depression Scale. *Acta Psychiatrica Scandinavica*, *67*(6), 361–370. https://doi.org/10.1111/j.1600-0447.1983.tb09716.x

Appendices

Appendix 1 - Demographic Questionnaire

1. What is your age? _____

2. Do you have any cognitive/ intellectual disability that affects your intellectual

    functioning or adaptive behaviour?

    (e.g. autism, aphasia, dyslexia, attention deficit, dyscalculia, intellectual and memory

    loss)

    - Yes

    - No

Appendix 2 - Sun Exposure Questionnaire

Please select the box beside the reply based on the PAST WEEK.

1. How many hours per day on average did you spend outdoor in day time during

    working days (e.g. college/ job)?

    - < 10 minutes

    - 10 minutes to 1 hour

    - 1 - 3 hours

    - 3 - 5 hours

    - > 5 hours

2. How many hours per day on average did you spend outdoor in day time during non-

    working days?

    - < 10 minutes

    - 10 minutes to 1 hour

    - 1 - 3 hours

- 3 - 5 hours

- > 5 hours

Appendix 3 - Hospital Anxiety and Depression Scale (Zigmond & Snaith, 1983)

Please select the box of the reply that is closest to how you have been feeling in the PAST

WEEK. (immediate response is the best for accuracy)

1. I feel tensed or "wound up":

   - Most of the time

   - A lot of the time

   - From time to time, occasionally

   - Not at all

2. I get a sort of frightened feeling as if something awful is about to happen:

   - Very definitely and quite badly

   - Yes, but not too badly

   - A little, but it doesn't worry me

   - Not at all

3. Worrying thoughts go through my mind:

   - A great deal of the time

   - A lot of the time

   - From time to time, but not too often

   - Only occasionally

4. I can sit at ease and feel relaxed

   - Definitely

   - Usually

   - Not often

   - Not at all

5. I get a sort of frightened feeling like 'butterflies' in. the stomach:

- Not at all

- Occasionally

- Quite often

- Very often

6. I feel restless as I have to be on the move:

- Very much indeed

- Quite a lot

- Not very much

- Not at all

7. I get sudden feelings of panic:

- Very often indeed

- Quite Often

- Not very often

- Not at all

8. I feel tensed or "wound up":

- Most of the time

- A lot of the time

- From time to time, occasionally

- Not at all

9. I get a sort of frightened feeling as if something awful is about to happen:

- Very definitely and quite badly

- Yes, but not too badly

- A little, but it doesn't worry me

- Not at all

10. Worrying thoughts go through my mind:

- A great deal of the time

- A lot of the time

- From time to time, but not too often

- Only occasionally

11. I can sit at ease and feel relaxed:

- Definitely

- Usually

- Not often

- Not at all

12. I get a sort of frightened feeling like 'butterflies' in. the stomach:

- Not at all

- Occasionally

- Quite often

- Very often

13. I feel restless as I have to be on the move:

- Very much indeed

- Quite a lot

- Not very much

- Not at all

14. I get sudden feelings of panic

- Very often indeed

- Quite Often

- Not very often

- Not at all

Appendix 4 - Information sheet

Dear students, I would like to invite you to spend less than 5 minutes participating in this study called "Sun Exposure, Anxiety and Depression among College Students". A survey with 18 questions will be included. My name is King In Wong, I am a final year Psychology student at National College of Ireland. This study is my final year project which will be supervised by Rocio Galán-Megias from the psychology department of National College of Ireland. I am delighted to share more information with you as below:

Aim of this study

This study aims to find out if there is a correlation between sun exposure and the scores of anxiety and depression among college students. There are 3 research questions in this study: (1) Is sun exposure correlated to anxiety?; (2) Is sun exposure correlated to depression?; (3) Is anxiety correlated to depression? To investigate these research questions, participants are invited to complete a survey for this study. There are 3 sections in the survey: (1) Demographic Questionnaire; (2) Sun Exposure Questionnaire; (3) Hospital Anxiety and Depression Scale.

Time Commitment

There are 3 sections with 18 questions in total and there are all multiple-choice questions. It should last less than 5 minutes to complete this survey.

Who can participate?

College students that are in the age range of 18-85 and have no cognitive disability can participate in this study for ethical reasons.

Do I have to participate?

This study is completely voluntary. You can withdraw at any stage before submission without penalty during participation by closing the tab.

Risk and Benefits

It could have a potential risk of having psychological distress in the second questionnaire of Hospital Anxiety and Depression Scale as It requires the participates to think about their personal levels of depression and anxiety. The contact details of mental health support services is attached in the information sheet and debriefing sheet if it occurs.

Benefits

Sun exposure in related to anxiety and depression is an interesting topic as sun exposure is everywhere and every day, if it is published and proven to be associated with college students anxiety and depression, the sun could be a great affordable intervention for college students, such as going out for a sunny day walk.

Confidentiality

No personal information will be required in this study. Participants will only have to provide their age and cognitive health condition. The result data will be stored into a password protected hard drive that only the researcher can have access to ensure security and data protection.

Support Services

Samaritans free phone service: 116123

Pieta house free phone service: 1800247247

Free Text Service: 50808

911 (if you feel like you are at risk of self-harming or harming someone else)

Contact Details

For further questions or enquiries, please do not hesitate to contact the researcher of this study.

Name: King In Wong

Email: x19406972@student.ncirl.ie

Appendix 5 - Consent Form

- I am over 18 years old and under 85 years old.

- I have no cognitive disability.

- I have read and understood the information of this study from the information sheet.

- I wish to participate voluntarily in this study.

- I understand there is a risk of psychological distress in participation.

- I understand that I have the right of withdrawal until the submission of this survey.

   By clicking "Yes" button below, you are consenting that you are as above.

o Yes

Appendix 6 - Debriefing Sheet

Thanks for taking your time to participate in this study. This study aims to explore if there is any correlation between sun exposure and the level of anxiety and depression among college students.

Participants have the right to withdraw upon the submission of this survey. The data is kept unidentified, confidential and anonymous. To ensure this, the data will be stored in a password protected hard drive that only the researcher can have access to for research purpose and the researcher will not have access to it after 5 years.

If you have experienced any psychological discomfort after participating, here are some support services that you can contact:

Support Services

Samaritans free phone service: 116123

Pieta house free phone service: 1800247247

Free Text Service: 50808

911 (if you feel like you are at risk of self-harming or harming someone else)

Contact details of the researcher

For further questions or enquiries, please do not hesitate to contact the researcher of this study.

Name: King In Wong

Email: x19406972@student.ncirl.ie

Appendix 7 - SPSS data and output evidence

FYP ULT.sav [DataSet1] - IBM SPSS Statistics Data Editor

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure	Role
1	Age	Numeric	8	2	Age	None	None	8	Right	Scale	Input
2	Sun_Work	Numeric	16	0	1. During WORKING DAYS' day ...	None	None	16	Right	Ordinal	Input
3	Sun_NonWork	Numeric	16	0	2. During NON–WORKING DAYS...	None	None	16	Right	Ordinal	Input
4	Q1	Numeric	31	0	1. I feel tensed or "wound up":	None	None	31	Right	Ordinal	Input
5	Q2	Numeric	33	0	2. I get a sort of frightened fe...	None	None	33	Right	Ordinal	Input
6	Q3	Numeric	36	0	3. Worrying thoughts go throu...	None	None	36	Right	Ordinal	Input
7	Q4	Numeric	10	0	4. I can sit at ease and feel rel...	None	None	10	Right	Ordinal	Input
8	Q5	Numeric	12	0	5. I get a sort of frightened fe...	None	None	12	Right	Ordinal	Input
9	Q6	Numeric	16	0	6. I feel restless as I have to b...	None	None	17	Right	Ordinal	Input
10	Q7	Numeric	17	0	7. I get sudden feelings of panic:	None	None	17	Right	Ordinal	Input
11	Q8	Numeric	18	0	8. I still enjoy the things I used...	None	None	18	Right	Ordinal	Input
12	Q9	Numeric	26	0	9. I can laugh and see the funn...	None	None	26	Right	Ordinal	Input
13	Q10	Numeric	16	0	10. I feel cheerful:	None	None	16	Right	Ordinal	Input
14	Q11	Numeric	19	0	11. I feel as if I am slowed do...	None	None	19	Right	Ordinal	Input
15	Q12	Numeric	37	0	12. I have lost interest in my a...	None	None	37	Right	Ordinal	Input
16	Q13	Numeric	30	0	13. I look forward with enjoym...	None	None	30	Right	Ordinal	Input
17	Q14	Numeric	11	0	14. I can enjoy a good book or ...	None	None	11	Right	Ordinal	Input
18	Sun_Score	Numeric	8	2		None	None	11	Right	Scale	Input
19	Anxiety_Score	Numeric	8	2		None	None	15	Right	Scale	Input
20	Depression_...	Numeric	8	2		None	None	18	Right	Scale	Input
21											
22											
23											
24											
25											
26											
27											
28											

```
CORRELATIONS
  /VARIABLES=Sun_Score Anxiety_Score Depression_Score
  /PRINT=TWOTAIL NOSIG
  /MISSING=PAIRWISE.
```

Correlations

Correlations

		Sun_Score	Anxiety_Score	Depression_Score
Sun_Score	Pearson Correlation	1	−.119	−.142
	Sig. (2-tailed)		.294	.209
	N	80	80	80
Anxiety_Score	Pearson Correlation	−.119	1	.570**
	Sig. (2-tailed)	.294		.000
	N	80	80	80
Depression_Score	Pearson Correlation	−.142	.570**	1
	Sig. (2-tailed)	.209	.000	
	N	80	80	80

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

```
COMPUTE Sun_SUM=Sun_Work + Sun_NonWork.
EXECUTE.
EXAMINE VARIABLES=Anxiety_Score Depression_Score Sun_SUM
  /PLOT BOXPLOT HISTOGRAM NPPLOT
  /COMPARE GROUPS
  /STATISTICS DESCRIPTIVES EXTREME
  /CINTERVAL 95
  /MISSING PAIRWISE
  /NOTOTAL.
```