ISSN 2278-3091
Volume 9, No.1.4, 2020
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse7691.42020.pdf
https://doi.org/10.30534/ijatcse/2020/7691.42020

Developing a Depression Detector Application by integrating the DASS-21 measures: A Preliminary Study

Dinna N. Mohd Nizam[1], Nurul Hidayah Ahmad[1], Aslina Baharum[1], Zaidatol Haslinda Abdullah Sani[1], Carolyn Salimun[1], Razif Bin Abas[2]

[1] User Experience Research Lab (UXRL), Faculty of Computing and Informatics, Universiti Malaysia Sabah, Malaysia, dinna@ums.edu.my, hidayahahmad2017@gmail.com, aslina@ums.edu.my, linda.sani @ums.edu.my, carolyn@ums.edu.my

[2] Department of Human Anatomy, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia, razifabas@upm.edu.my

ABSTRACT

Depression is a serious mental problem that does not neglect university students. There has been an increase in the number of cases in recent times and several alternatives for recovery have been made. Mobile health applications and technologies for depression were initiatives to improve treatment options. However, recent studies had revealed that there was a lack of proven therapeutic outcomes associated with these health applications, especially in concerning depression disorders. Nonetheless, besides a few studies that had applied psychological measures into their depression detector application, insufficient heuristic designs (i.e., features and functions) for health and well-being technologies in depression have also been reported. Therefore the main focus of this project is to identify features/functions needed in a Depression Detector Application and to apply psychological measures that can provide accurate detection of depression among the users. The objective of this project is to identify the features needed through the observation method and to develop a depression detector mobile application using a psychological measure known as the Depression, Anxiety, and Stress Scale (DASS-21). A total of 30 participants were involved in the initial gathering phase and two experts in applying psychological measures in the development phase. The contribution of this study is to gain knowledge about the applicability of using psychological measures on mobile depression detector applications with feedback from medical experts in the development process. Future sequential studies from the study would be studying the effectiveness of the application and enhancing the usability aspects.

Key words: Depression Anxiety Stress Scale (DASS), Depression Detector Application, Mobile Application Design.

1. INTRODUCTION

Depression problems among university students have been on the rise recently around the world [3],[26]. Depression, if left untreated, can cause suicidal effects among these new generations. There are a variety of conventional treatments (e.g., prescription drugs and psychotherapy) alternatives for a potential depression patients such as students to improve their mood and emotions. Further, the rise of digital technology in recent years [18] has been said to help address depression cases among people by providing information, knowledge, and experiences available through websites and smartphones (i.e., uses browsers on smartphones) [1]. Many features and functions are made available with possible solutions that can be practiced easily by potential patients via mobile phones. A study by Carroll et al. [6] reported that younger generations with better education were among health apps users to maintain their well-being.

Nevertheless, a recent review revealed a lack of proven medical outcomes associated with these health applications on depression disorders [46]. Also, insufficient heuristic designs (i.e., features and functions) for health and well-being technologies in depression have been investigated [47]. Other than limited reliable depression tests functions on mobile applications, contents that consumed large data usage led to the disengagement of health application usage among users [23].

Therefore this study took the initiative to build a mobile depression detector application by adapting the DASS-21 instrument and further study the effectiveness in future studies. The DASS-21 measurement helps ensure accurate detection of depression among potential patients, thus increasing the application's efficacy.

In this preliminary study, useful features were collected through a qualitative approach and summarized in Section 3.1. Expert participants (i.e., psychologists and psychiatric physicians) were involved in employing the DASS-21 measurement into the Depression Detector application besides giving constant feedback. The contribution of this study is twofold the features needed for a mobile depression detector through observation and to gain knowledge about the applicability of using psychological measures on mobile

depression detector applications with the involvement of medical experts.

2. RELATED WORK

Depression is a major depressive disorder that causes persistent sadness [38] and a pro-long emotional downturn. A person diagnosed with depression feels constant sadness and loses interest in an activity of a completed task. Performance in work or study achievement can also be seen as declining. Some individuals may suffer changes in appetite, weight loss, sleeping patterns, and unexplainable energy loss.

Generally, depression can be treated and controlled with medicine and psychotherapy. A face-to-face psychotherapy session usually delivers a better and more effective outcome. Since the depressed patient can communicate better and build engagement, psychologists and psychiatrists can detect mental health problems among patients because they have proper background experiences with mental disorders besides possessing relevant qualifications. Symptoms of depression must be present for at least two weeks to be diagnosed. Various forms of depression are caused by certain factors, as described below:

Persistent Depressive Disorder (PDD) or Dysthymia is a mood depression experienced by individuals for at least two years [24]. Although it is common among individuals, however, it is categorized as chronic depression. PDD symptoms include poor appetite or overeating, insomnia, continuous tiredness, poor concentration, hopeless and low self-esteem [22]. The causes of PDD remain unknown however it can be associated but not limit to anxiety, trauma, genetics, social factors, stress, and mental illness history [34].

Postpartum Depression (PPD), on the other hand, is a major depression that usually occurs to women after giving birth [40] and can range from mild to severe. There are also cases in which men whom experience PPD been identified [36]. Many factors cause PPD, which are not limited to sleep disturbance, anxiety, hormone changes, genetic factors, social factors, and adverse life events [42]. However, PDD's main factor is having a history of anxiety and mood disorder [48].

Another type of major depressive disorder is Psychotic depression (PD), where it usually relates to suicidal behaviour and mortality [13] however, this remains controversial [11]. Individuals with PD usually experiences delusions and hallucinations [16]. Other symptoms include irregular sleeping patterns, medical attention, and functional impairment [20]. PD is usually genetic cause [9] however, other factors may contribute such as old age and bipolar disorder history [17].

Seasonal Affective Disorder (SAD) is a depression disorder associated with seasonal changes in four-season countries. SAD usually occurs during winter [32] when the night time is longer than the day and individual tends to sleep more due to overproduction of melatonin [25]. Overproduction of melatonin causes an individual to become drowsy and poor mood swings. Individuals with SAD have difficulty balancing mood swings due to lack of serotonin [27] caused by less vitamin D exposure [31] and therefore increase symptoms of depression [35].

Bipolar Disorder (BD) is another type of major depressive disorder associated with suicide [19] if not treated. However, some studies have categorized BD as a major mood disorder associated with psychotic symptoms [21] (e.g., delusions and hallucinations). Individuals with BD experience symptoms such as rapid speech, behaviour changes, increased energy [15], and reduced sleep [8]. Some studies have reported that the trigger for BD is related to genetic factors [45].

Therefore with these groups of major depressive disorder and symptoms, it is important to identify which depression category an individual falls within to provide appropriate support for treatment and recovery.

2.1 Depression Detection Approaches

Depression detection research has been carried out using several approaches. A study by Cai et al. [5] used Electroencephalography (EEG) signals to detect depression among normal and depressed patients and found it was a feasible method to diagnose depression. Similarly, an approach using machine learning to create a model from neuro-images to identify potential and non-potential patients was investigated by Patel [33]. Besides, Suhara [44] investigated depression moods through self-reported patient histories using recurrent neural networks and found that long-term historical information would be more beneficial in predicting depression.

Depression Detection was not only used for closed laboratory settings but was also used for mobile applications outside a laboratory arrangement. A study by Belisario et al. [4] explored a longitudinal assessment of a bespoke mobile application to detect depression among pregnant women, which was useful for further studies. Similarly, Faherty [10] also investigate depression disorders on pregnant women using a bespoke mobile application that applied the Patient Health Questionnaire (PHQ-9) and Generalized Anxiety Disorder (GAD-7) psychological measure.

Nevertheless, since this study was to develop a mobile depression detection application that was to be available to everyone via smartphone, the detection approach also applied a psychological measure similar to Faherty [10] and Belisario [4] studies however the self-report instrument used was different known as DASS-21.

2.2 Depression, Anxiety, Stress Scale (DASS)

Several studies have shown considerable interest in utilising instruments investigating mental disorders of patients and society. Two types of approaches to obtain diagnostic information are self-reported measures that reflect general psychological distress and structured interviewing protocols that identify specific psychiatric disorders. Earlier types of psychopathology instruments were the General Health Questionnaire (GHQ) by Goldberg [12] and the Centre for Epidemiological Studies Depression Scale (CES-D Scale) by Radloff [37]. Later instruments were the Diagnostic Interview Schedule (DIS) by Robins et al. [38] and the Primary Care Evaluation of Mental Disorders (PRIME-MD) by Spitzer et al. [41]. The most efficient and inexpensive approach to obtaining diagnostic information of symptoms is self-reporting. Nevertheless, the disadvantage of the self-reporting approach is that it can be biased and misunderstood; however, it is very useful to identify depression assuredly [43] in a large scale study.

For this study, the Depression, Anxiety, and Stress Scale (DASS) instrument were used for the proposed Depression Detection application. The full-length DASS version, that is divided into three diverse components, "Depression", "Anxiety" and "Stress", consisted of 42-item self-report measures [7]. The shorten DASS version known as DASS-21 only involved 21-item self-report measures and still retains adequate and reliable [30]. Each component has its specific scoring guide and questions. DASS is well known as the best psychometric approach for clinical and non-clinical use [28]. DASS's advantage is that the questionnaire does not include cultural and racial elements, which are both very sensitive issues [29].

3. METHODOLOGY

Figure 1 illustrates the three phases of the entire study, consisting of the initial phase, the development phase and the evaluation phase. However, in this article, the study only reports until the development phase. In phase 1, the Initial Phase consists of a literature review and several current application reviews. An observation approach involving participants has been implemented to extract useful features for the proposed depression application. While in phase 2, the Development Phase, an agile approach was used to develop the application. Expert participants were involved in this process and included assessment based on the depression, anxiety, and stress scale (DASS-21). In phase 3, the MeCUE (Method Component User Experience) approach [2] was applied during the evaluation phase to study the proposed application's effectiveness. That being said, phase 3 will not be discussed in this preliminary study since it is beyond the scope of the article.

In phase 1, 30 participants were involved in observing existing applications and identifying features beneficial to the proposed application. A comparison summary of existing applications is explained in Section 3.1. As for phase 2, two expert participants were involved, a psychologist and a psychiatric physician. The experts' task was to identify which questions from the DASS-21 were directly involved in diagnosing depression (Section 3.2) in patients. Additionally, they were also asked to provide feedback on the application during the development phase constantly.

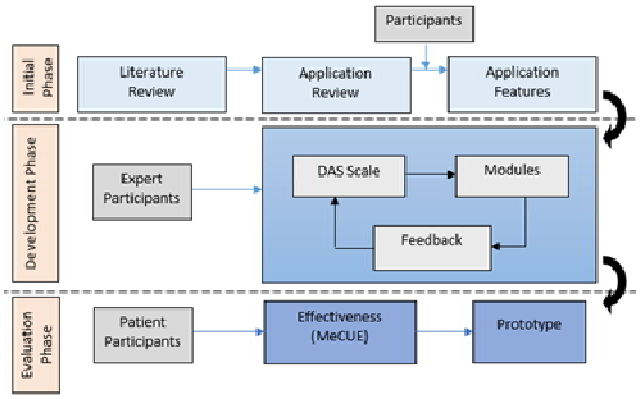

Figure 1: Research Framework Overview

3.1 Identifying Depression Detector Features

Analysis of functions and application features from the existing application was carried out before the development of the proposed Depression Detector application. Observation from the participant on the existing application is summarized in Table 1. The top three applications that were used for feature comparison purposes were the Depression Test Application [1] ,PHQ-9 Depression Test Questionnaire[2]and MoodTools Depression Aid[3].

Response from the participants resulted that the Depression Detector will include features such as "Thought Diary" for patients to express their feelings through writing, "Guided Meditation" to assist patients in decision making when negative thinking develops, "Treatment" section to promote motivation, "Safety plan" for patients to document procedures that need to be followed during the depression, and "Activities" that can be used by the patients to relieve stress. Additionally, a special feature of the proposed Depression Detector is the Depression Test based on the DASS-21 instrument to detect depression in patients accurately. These features will be discussed in Section 4.1.

[1] Marshal Underground. 2017. Depression Test (from Zung). Google Play Store.
[2] Andrey Fetsov. 2016. PHQ-9 Depression Test Questionnaire. App Store. Retrieved from https://apps.apple.com/us/app/id1086388343
[3] Eddie Liu. 2019. MoodTools: Depression Aid. App Store. Retrieved from https://apps.apple.com/app/id1012822112

Table 1: Comparison of the proposed Depression Detector Application with Existing Applications.

Functionality	Depression Test Application	PHQ-9	MoodTools	Proposed Application (Depression Detector)
Psychology-based Questions	No	No	Yes	Yes Applied: Depression Anxiety Stress Scale.
Psychiatry Contact Details	No	No	Yes	Yes
Thought Diary	No	No	No	Yes
Guided Meditation	Yes	No	Yes	Yes
Treatments	No	No	No	Yes
Activities	No	No	No	Yes
Safety Plan	No	No	No	Yes

3.2 DASS Measurements

The Depression Anxiety Stress Scale-21 (DASS-21) [15] is used to measure individual mental health based on responses given. The DASS score consists of points that are summarized based on the total answers of the user. Points are then multiplied by two before being determined by comparing the points to the score guide [28]. As this study focused on depression, the DASS instruments were modified to apply depression measurements only. The two experts selected the depression-related statements. Table 2 shows the selected statements used in the development of the proposed Depression Detector. The digits in brackets in the table are the number of items from the initial DASS that had 21 items.

Table 2: Depression statements filtered by experts. (Digit in brackets are No. of item from the initial DASS-21).

No	Depression Statements
1	*I couldn't seem to experience any positive feelings at all. (3)*
2	*I found it difficult to work up the initiative to do things. (5)*
3	*I felt that I had nothing to look forward to.(10)*
4	*I felt down-hearted and blue.(13)*
5	*I was unable to become enthusiastic about anything.(16)*
6	*I felt I wasn't worth much as a person.(17)*
7	*I felt that life was meaningless.(21)*

4. DEPRESSION APPLICATION DEVELOPMENT

Figure 2 illustrates the algorithm that was used in the development of the depression detector. The algorithm was designed to determine the level of depression based on the depression test scores and to identify which appropriate consultation practitioner (i.e., psychiatrist or psychologist) to visit. First, the values are determined by summing up the scores of the users, which are then multiplied by 2. The algorithm will then compare the value and identify which category the user falls into. Values above 28 are considered to have extremely severe depression while values between 21 and 27 are severe depression. Users of both of these categories are required to meet the psychiatrist. On the other hand, values between 14 and 20 are considered as moderate depression and values between 10 and 13 are considered as mild depression. These users should meet the psychologist. A user that has a value of 9 and below are considered to be normal.

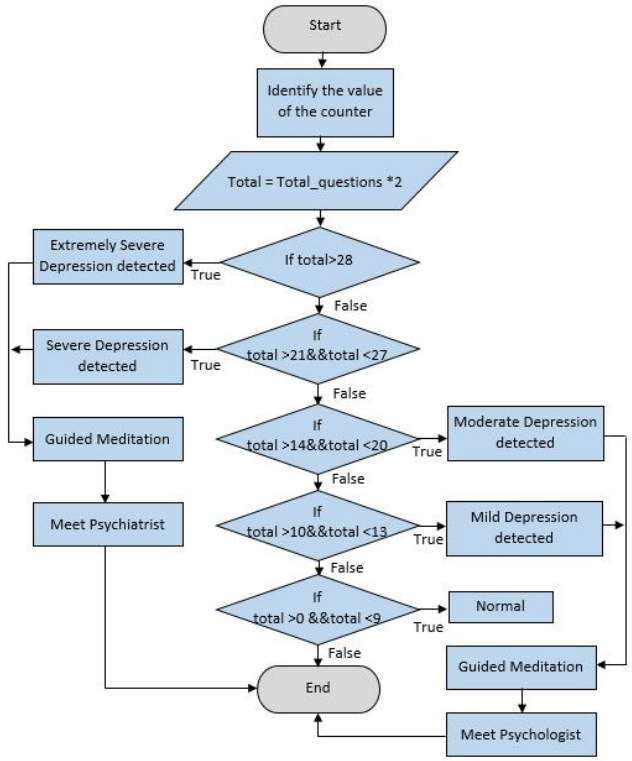

Figure 2: The Algorithm flow used for Depression Detector development.

4.1 Depression Detector Prototype

The development of the Depression Detector used XML and JAVA programming language on Android Studio platforms. Figure 3(a) shows the "Depression test" based on the DASS instrument which requires users to answer to know their level of depression. The questions are valued based on the response given. "Not At All", "Several Days", "More Than Half The Days" and "Nearly Every Day" are each associated with a value of 0, 1, 2 and 3 respectively. If a user is detected

with depression, the user will receive support and advice. An associated psychiatry contact detail will also be provided for further support. Users can repeat the test multiple times, and the result will be recorded and displayed in a graphical presentation (Figure 3(b)).

Figure 3(c) shows the "Thought Diary" section. This section allows the user to enter their feelings in terms of text or words to help alleviate untold feelings or thoughts. By releasing their thoughts in words, this can help them reduce the depression they encounter. When they regain afterward, they can revisit what they have written to type a solution for a future downturn session (Figure 3(d)).

Figure 3: Several pages of the Depression Detector Application.

Figure 3(e) shows the customised "Activities" entered in advance by the user and rank the level of satisfaction on the particular activity. A suggestion for other activities is also available for the user to choose and rank them. Users can review back the level of satisfaction ranked earlier and see the changes themselves after an activity. Subsequently, Figure 3(f) shows the "Safety Plan" section, which designed to deal with suicidal thoughts. Users can enter their customised warning signs of depression, coping strategies, record the reasons to live, enter important contacts, and list places of distractions. Other features in the Depression Detector not shown here include "Treatments" and "Entertainment" section that links to an external website to listen to peaceful music and motivational videos.

5. CONCLUSION

Depression has become an issue that needs to be taken seriously to avoid more suicidal cases since the number of depressions is increasing daily. The lack of proven medical outcomes, insufficient heuristic designs, and the adoption of reliable depression tests on mobile applications motivated this study. A brief understanding of depression, psychological instruments, and the existing depression detector system were demonstrated. Features from existing mobile depression applications were identified and summarised via an observation approach. The Depression Detector (DD) application applied the Depression, Anxiety, and Stress Scale (DASS-21) instrument to accurately detect depression among potential patients. Expert participants were involved during the development of the application. As a whole, the proposed DD is to support potential patients (i.e., users), psychiatrists, and psychologists with useful supportive applications in managing and coping depression.

Nevertheless, for future research, a study on the effectiveness of the application and enhancing usability will be implemented. Currently, the application can only be operated using an Android platform. This application can be enhanced and coded for iOS platforms to ensure a wider range of accessibility for users.

REFERENCES

[1] Baharum, A., Chai, M., Tanalol, S.H., Zain, N.H.M., Zulhemay, M.N., Rahim, E.A. and Omar, M. 2017. Stress monitoring using mobile phone and wearable technology: Stress catcher. *Journal of Telecommunication, Electronic and Computer Engineering*. 9, 2–3 (2017), 21–26.

[2] Baharum, A., Nazlan, N.H., Noor, N.A.M, Hanapi, R., Ismail, I., Noh, N.A.M. 2019. Information Visualization For Food Mobile Application: Hangri 2.0. International Journal of Advanced Trends in Computer Science and Engineering, Volume 8, No.1.3, 2019, pp. 306-314. ISSN 2278-3091. https://doi.org/10.30534/ijatcse/2019/5781.32019

[3] Barker, E.T., Howard, A.L., Villemaire-Krajden, R. and Galambos, N.L. 2018. The Rise and Fall of Depressive Symptoms and Academic Stress in Two Samples of University Students. *Journal of Youth and Adolescence*. 47, 6 (2018), 1252–1266. DOI:https://doi.org/10.1007/s10964-018-0822-9.

[4] Belisario, J.S.M., Doherty, K., O'Donoghue, J., Ramchandani, P., Majeed, A., Doherty, G., Morrison, C. and Car, J. 2017. A bespoke mobile application for the longitudinal assessment of depression and mood during pregnancy: Protocol of a feasibility study. *BMJ Open*. 7, 5 (2017), 1–8. DOI:https://doi.org/10.1136/bmjopen-2016-014469.

[5] Cai, H., Han, J., Chen, Y., Sha, X., Wang, Z., Hu, B., Yang, J., Feng, L., Ding, Z., Chen, Y. and Gutknecht, J. 2018. A Pervasive Approach to EEG-Based Depression Detection. *Complexity*. 2018, (2018). DOI:https://doi.org/10.1155/2018/5238028.

[6] Carroll, J.K., Moorhead, A., Bond, R., LeBlanc,

W.G., Petrella, R.J. and Fiscella, K. 2017. Who uses mobile phone health apps and does use matter? A secondary data analytics approach. *Journal of Medical Internet Research*. 19, 4 (2017), 1–9. DOI:https://doi.org/10.2196/jmir.5604.

[7] Crawford, J.R. and Henry, J.D. 2003. The Depression Anxiety Stress Scales (DASS): Normative data and latent structure in a large non-clinical sample. *British Journal of Clinical Psychology*. 42, 2 (2003), 111–131. DOI:https://doi.org/10.1348/014466503321903544.

[8] Cretu, J.B., Culver, J.L., Goffin, K.C., Shah, S. and Ketter, T.A. 2016. Sleep, residual mood symptoms, and time to relapse in recovered patients with bipolar disorder. *Journal of Affective Disorders*. 190, (2016), 162–166. DOI:https://doi.org/10.1016/j.jad.2015.09.076.

[9] Domschke, K. 2013. Clinical and molecular genetics of psychotic depression. *Schizophrenia Bulletin*. 39, 4 (2013), 766–775. DOI:https://doi.org/10.1093/schbul/sbt040.

[10] Faherty, L.J., Hantsoo, L., Appleby, D., Sammel, M.D., Bennett, I.M. and Wiebe, D.J. 2017. Movement patterns in women at risk for perinatal depression: Use of a mood-monitoring mobile application in pregnancy. *Journal of the American Medical Informatics Association*. 24, 4 (2017), 746–753. DOI:https://doi.org/10.1093/jamia/ocx005.

[11] Fredriksen, K.J., Schoeyen, H.K., Johannessen, J.O., Walby, F.A., Davidson, L. and Schaufel, M.A. 2017. Psychotic Depression and Suicidal Behavior. *Psychiatry (New York)*. 80, 1 (2017), 17–29. DOI:https://doi.org/10.1080/00332747.2016.1208002.

[12] Goldberg, D.P. 1972. *The detection of psychiatric illness by questionnaire: A technique for the identification and assessment of non-psychotic psychiatric illness*. Oxford U. Press.

[13] Gournellis, R., Tournikioti, K., Touloumi, G., Thomadakis, C., Michalopoulou, P.G., Christodoulou, C., Papadopoulou, A. and Douzenis, A. 2018. Psychotic (delusional) depression and suicidal attempts: a systematic review and meta-analysis. *Acta Psychiatrica Scandinavica*. 137, 1 (2018), 18–29. DOI:https://doi.org/10.1111/acps.12826.

[14] Harrison, P.J., Geddes, J.R. and Tunbridge, E.M. 2018. The Emerging Neurobiology of Bipolar Disorder. *Trends in Neurosciences*. 41, 1 (2018), 18–30. DOI:https://doi.org/10.1016/j.tins.2017.10.006.

[15] Henry, J.D. and Crawford, J.R. 2005. The short-form version of the Depression anxiety stress scales (DASS-21): Construct validity and normative data in a large non-clinical sample. *British Journal of Clinical Psychology*. 44, 2 (2005), 227–239. DOI:https://doi.org/10.1348/014466505X29657.

[16] Heslin, M. and Young, A.H. 2018. Psychotic major depression: Challenges in clinical practice and research. *British Journal of Psychiatry*. 212, 3 (2018), 131–133. DOI:https://doi.org/10.1192/bjp.2017.43.

[17] Jääskeläinen, E., Juola, T., Korpela, H., Lehtiniemi, H., Nietola, M., Korkeila, J. and Miettunen, J. 2018. Epidemiology of psychotic depression - Systematic review and meta-analysis. *Psychological Medicine*. 48, 6 (2018), 905–918. DOI:https://doi.org/10.1017/S0033291717002501.

[18] Jack L.P., Khamis, N., Salimun, C., Nizam, D.M., Haslinda, Z. and Baharum, A. 2019. Learn programming framework for Malaysian preschoolers. *International Journal of Advanced Trends in Computer Science and Engineering*, 8(1.6), 431 - 436.

[19] Jamison, K.R. 2000. Suicide and bipolar disorder. *The Journal of Clinical Psychiatry*. 61, Suppl9 (2000), 47–51.

[20] Johnson, J., Horwath, E. and Weissman, M.M. 1992. The validity of major depression with atypical features based on a community study. *Journal of Affective Disorders*. 26, 2 (1992), 117–125. DOI:https://doi.org/10.1016/0165-0327(92)90043-6.

[21] Keck, P.E., McElroy, S.L. and Arnold, L.M. 2001. BIPOLAR DISORDER. *Medical Clinics of North America*. 85, 3 (2001), 645–661. DOI:https://doi.org/https://doi.org/10.1016/S0025-7125(05)70334-5.

[22] Keller, M.B., Klein, D.N., Hirschfeld, R.M., Kocsis, J.H., McCullough, J.P., Miller, I., First, M.B., Holzer, C.P. 3rd, Keitner, G.I. and Marin, D.B. 1995. Results of the DSM-IV mood disorders field trial. *The American journal of psychiatry*. 152, 6 (Jun. 1995), 843–849. DOI:https://doi.org/10.1176/ajp.152.6.843.

[23] Krebs, P. and Duncan, D.T. 2015. Health App Use Among US Mobile Phone Owners: A National Survey. *JMIR mHealth and uHealth*. 3, 4 (2015), e101. DOI:https://doi.org/10.2196/mhealth.4924.

[24] Kriston, L., Von Wolff, A., Westphal, A., Hölzel, L.P. and Härter, M. 2014. Efficacy and acceptability of acute treatments for persistent depressive disorder: A network meta-analysis. *Depression and Anxiety*. 31, 8 (2014), 621–630. DOI:https://doi.org/10.1002/da.22236.

[25] Lewy, A.J., Lefler, B.J., Emens, J.S. and Bauer, V.K. 2006. The circadian basis of winter depression. 2006, (2006). DOI:https://doi.org/10.1073/pnas.0602425103.

[26] Lun, K.W.C., Chan, C.K., Ip, P.K.Y., Ma, S.Y.K., Tsai, W.W., Wong, C.S., Wong, C.H.T., Wong, T.W. and Yan, D. 2018. Depression and anxiety among university students in Hong Kong. *Hong Kong Medical Journal*. 24, 5 (2018), 466–472. DOI:https://doi.org/10.12809/hkmj176915.

[27] Mc Mahon, B., Andersen, S.B., Madsen, M.K., Hjordt, L. V., Hageman, I., Dam, H., Svarer, C., Da Cunha-Bang, S., Baare, W., Madsen, J., Hasholt, L., Holst, K., Frokjaer, V.G. and Knudsen, G.M. 2016. Seasonal difference in brain serotonin transporter binding predicts symptom severity in patients with seasonal affective disorder. *Brain: A Journal of*

Neurology. 139, 5 (2016), 1605–1614. DOI:https://doi.org/10.1093/brain/aww043.

[28] Musa, R., Fadzil, M.A. and Zain, Z. 2007. Translation, validation and psychometric properties of Bahasa Malaysia version of the Depression Anxiety and Stress Scales (DASS). *ASEAN Journal of Psychiatry*. 8, 2 (2007), 82–89.

[29] Norton, P.J. 2007. Depression Anxiety and Stress Scales (DASS-21): Psychometric analysis across four racial groups. *Anxiety, Stress and Coping*. 20, 3 (2007), 253–265. DOI:https://doi.org/10.1080/10615800701309279.

[30] Osman, A., Wong, J.L., Bagge, C.L., Freedenthal, S., Gutierrez, P.M. and Lozano, G. 2012. The Depression Anxiety Stress Scales-21 (DASS-21): Further Examination of Dimensions, Scale Reliability, and Correlates. *Journal of Clinical Psychology*. 68, 12 (2012), 1322–1338. DOI:https://doi.org/10.1002/jclp.21908.

[31] Partonen, T. 1998. Vitamin D and serotonin in winter. *Medical Hypotheses*. 51, 3 (1998), 267–268. DOI:https://doi.org/10.1016/S0306-9877(98)90085-8.

[32] Partonen, T. and Lönnqvist, J. 1998. Seasonal affective disorder: A guide to diagnosis and management. *CNS Drugs*. 9, 3 (1998), 203–212. DOI:https://doi.org/10.2165/00023210-199809030-00004.

[33] Patel, M.J., Khalaf, A. and Aizenstein, H.J. 2016. Studying depression using imaging and machine learning methods. *NeuroImage: Clinical*. 10, (2016), 115–123. DOI:https://doi.org/10.1016/j.nicl.2015.11.003.

[34] Patel, R.K. and Rose, G.M. 2019. Persistent depressive disorder (Dysthymia). *StatPearls [Internet]*. StatPearls Publishing.

[35] Patrick, R.P. and Ames, B.N. 2015. Vitamin D and the omega-3 fatty acids control serotonin synthesis and action, part 2: Relevance for ADHD, bipolar disorder, schizophrenia, and impulsive behavior. *FASEB Journal*. 29, 6 (2015), 2207–2222. DOI:https://doi.org/10.1096/fj.14-268342.

[36] Paulson, J.F., Bazemore, S.D., Prevalence, H.E. and Fac, R. 2010. CLINICIAN ' S CORNER Prenatal and Postpartum Depression in Fathers. *Methods*. 303, 19 (2010), 1961–1969.

[37] Radloff, L.S. 1977. The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*. 1, (1977), 385. DOI:https://doi.org/10.1063/1.4932809.

[38] Robins, L.N. 1981. National Institute of Mental Health Diagnostic Interview Schedule. *Archives of General Psychiatry*. 38, 4 (1981), 381. DOI:https://doi.org/10.1001/archpsyc.1981.01780290015001.

[39] Rondón Bernard, J.E. 2018. Depression: A Review of its Definition. *MOJ Addiction Medicine & Therapy*. 5, 1 (2018), 7–8. DOI:https://doi.org/10.15406/mojamt.2018.05.00082.

[40] Sarberg, M., Bladh, M., Svanborg, E. and Josefsson, A. 2016. Postpartum depressive symptoms and its association to daytime sleepiness and restless legs during pregnancy. *BMC Pregnancy and Childbirth*. 16, 1 (2016), 1–8. DOI:https://doi.org/10.1186/s12884-016-0917-9.

[41] Spitzer, R.L., Williams, J.B.W., Kroenke, K., Linzer, M., deGruy, F.V., Hahn, S.R., Brody, D. and Johnson, J.G. 1994. Utility of a new procedure for diagnosing mental disorders in primary care: The PRIME-MD 1000 study. *JAMA: Journal of the American Medical Association*. American Medical Association.

[42] Stewart, D.E. and Vigod, S. 2016. Postpartum Depression. *New England Journal of Medicine*. 375, 22 (2016), 2177–2186. DOI:https://doi.org/10.1056/NEJMcp1607649.

[43] Stuart, A.L., Pasco, J.A., Jacka, F.N., Brennan, S.L., Berk, M. and Williams, L.J. 2014. Comparison of self-report and structured clinical interview in the identification of depression. *Comprehensive Psychiatry*. 55, 4 (2014), 866–869. DOI:https://doi.org/10.1016/j.comppsych.2013.12.019.

[44] Suhara, Y., Xu, Y. and Pentland, A.S. 2017. DeepMood: Forecasting depressed mood based on self-reported histories via recurrent neural networks. *26th International World Wide Web Conference, WWW 2017*. (2017), 715–724. DOI:https://doi.org/10.1145/3038912.3052676.

[45] Uher, R. 2014. Gene-environment interactions in severe mental illness. *Frontiers in Psychiatry*. 5, MAY (2014), 1–10. DOI:https://doi.org/10.3389/fpsyt.2014.00048.

[46] Wahle, F., Bollhalder, L., Kowatsch, T. and Fleisch, E. 2017. Toward the Design of Evidence-Based Mental Health Information Systems for People With Depression: A Systematic Literature Review and Meta-Analysis. *Journal of medical Internet research*. 19, 5 (2017), e191. DOI:https://doi.org/10.2196/jmir.7381.

[47] Wahle, F. and Kowatsch, T. 2014. Towards the design of evidence-based mental health information systems: A preliminary literature review. *35th International Conference on Information Systems "Building a Better World Through Information Systems", ICIS 2014*. (2014), 1–12.

[48] Wisner, K.L., Sit, D.K.Y., McShea, M.C., Rizzo, D.M., Zoretich, R.A., Hughes, C.L., Eng, H.F., Luther, J.F., Wisniewski, S.R., Costantino, M.L., Confer, A.L., Moses-Kolko, E.L., Famy, C.S. and Hanusa, B.H. 2013. Onset timing, thoughts of self-harm, and diagnoses in postpartum women with screen-positive depression findings. *JAMA Psychiatry*. 70, 5 (2013), 490–498. DOI:https://doi.org/10.1001/jamapsychiatry.2013.87.