A Personalised Lifestyle Management Framework for Decision Support System in Mental Health

Sakirulai Olufemi Isiaq
Department of Computing
Southampton Solent University
Southampton, United Kingdom
email:femi.isiaq@solent.ac.uk

Katie Hamling
Department of Computing
Southampton Solent University
Southampton, United Kingdom
email:katie.hamling@solent.ac.uk

***Abstract*— According to the World Health Organisation (WHO), over 600 million people suffer a form of mental health associated symptoms and about 350 million people are affected by depression, worldwide. Although symptoms such as restlessness, isolation and lack of confidence among many others have been attributed to the causes of depression, its alleviation has proven challenging over the years. Therefore, depression has become one of the most challenging health difficulty to manage in recent times. While common depression alleviation techniques include antidepressant medications and various therapies, such as Cognitive Behaviors Therapy (CBT), this work embraces a technology-based lifestyle management approach to effectively manage depression, in terms of Diagnosis, Prevention and Alleviation (DPA). A robust iterative-Documents and Stakeholders Analysis for Development (*i-DaSAD*) methodology was adopted to develop a Framework for Lifestyle and Depression Management – *FLaDM*. This framework underpins a decision support system that revealed its suitability for the development of lifestyle management system for depression, particularly in the area of early diagnosis, prevention and alleviation.**

Keywords - eHealth; stakeholders; depression management; diagnosis; prevention; alleviation; i-DaSAD; FLaDM.

I. INTRODUCTION

In recent years, mental health conditions have increasingly become a reckoning factor. In the United States, one in five adults (44.7 million in 2016) suffers a form of mental health disorder [1] i.e., a failing of certain aspects of human health, such as intelligence, imagination and thought. Similarly, according to EPIBUL [2], one in five residents has experienced some common form of mental issues during their lifetime.

Recent records have shown between 7 and 12 per cent of the adult population lives with mental health maladies such as depression and anxiety and a significant proportion of these sufferers do not get any form of intervention. Currently, about 322,000,000 people suffer from depression and 264,000,000 people experience anxiety worldwide [3]. By 2020, depression has been predicted to be the second most impactful condition with estimated annual mental illness cost of about 6 trillion USD by 2030, thereby, doubling its cost in 2010 [4]. In developed nations, depression has not only become one of the most common health disorder but it is also responsible for a greater burden of disability than any other cause [5]. Currently, depression is responsible for more loss of years at work than any other disability or health conditions. By 2026, it is expected to cost up to 3 billion USD in England [4]-[6].

As the demand for mental health treatment becomes higher, the gap between treatment and accessibility is increasingly becoming wider, estimated between 35% and 50% [7]. Although a significant number of mental health conditions remained widely undiagnosed and untreated, the causes and alleviations techniques are not unknown. Moreso, only fewer than half of those diagnosed receive treatment due to reasons substantiated to stigma, ineffective therapies and inadequate access to mental health supports and resources amongst other reasons.

Conventionally, the diagnosis of mental health disorders such as depression involves the utilisation of tools like the DSM-5 [8] criteria by healthcare practitioners (GP or a psychiatrist) to determine the presence of depression symptoms. Subsequently, medications and/or prescriptions are recommended as appropriate. However, more than half of the world's population lives in a country with two psychiatrists per hundred thousand people [9]. In additions, other diagnostic tools such as the Beck Depression Inventory (BDI) [10] requires a level of sophistication (minimum of fifth or sixth grade) to sufficiently comprehend the tool items [11]. Besides, a clinical study conducted in 2006 about conventional treatment indicated common antidepressants produce responses in just under half of the participants and was only able to achieve 28% full remission [12]. Conversely, effective lifestyle changes and management have proven to lift people out of mental health conditions such as depression without the possibility of reoccurrence or known side effect. Since the demand for mental health treatment clearly outnumbers the available practitioners, the demand for support tools and/or potent approach of treatment remains undoubtedly imperative.

The recorded advances in technology have been influencing the pivotal role played by technology in the daily management of human activities. Perhaps, it is not improper to consider technological approaches for proactive management of human mental health states. For example, smartphone technology combines mobile communication and computation in a handheld device, facilitating mobile computing as a point of care [13]. Nowadays, mobile devices and the internet facilitate different health activities and communication online. For instance, a computer-based CBT program via the internet has proven to be clinically effective just like face to face [7]. Therefore, this approach is becoming increasingly popular due to associated benefits that include the ability to reach larger audiences with low

 ISBN: 978-1-61208-688-0

cost among others[14]. Nevertheless, the lack of known technological standards raises potential questions about the reliability and acceptability of this approach. For example, online tests and BDI for depression face difficulties such as exaggeration or misunderstanding, which can sway diagnosis thus, constituting a negative effect. This paper proposed a research-oriented *Framework for Lifestyle and Depression Management* - FLaDM to eliminate such anomalies. The framework is based on a robust i-DaSAD methodology, which considers stakeholders and other components necessary for the development of a personalised support system for depression management. The remainder of this paper is divided into sections as follows: Section II covers related work while Section III and IV discuss i-DaSAD methodology and the framework (FLaDM) respectively. The framework was evaluated using a developed decision support system in section V, while the conclusion and future work are presented in Section VI.

II. RELATED WORK

Easy accessibility and affordability increase the deployment of mobile devices for the management of mental health conditions. Mobile devices now play valuable roles in regular face-to-face therapy [7] making such service accessible from anywhere at any time. Evidence emerging indicates that psychotherapy delivery via video conferencing and telephone gives equivalent efficacy to face-to-face delivery [15]. Therefore, with fewer psychiatrists indicated in Section I, sufferers of mental health conditions may access psychotherapy treatments anytime from any part of the world. Over the years, significant advances have been recorded in the application of technology for health management and decision-making. For example, the traditional approach of measuring blood alcohol, nicotine and vitamin D levels will soon be substituted with other technological advances in the near future. Although yet to be widely adopted, devices such as PROOF alcohol tracking wearable [16], BACtrack alcohol tracker [17], SmartStop wearable device [18], and Chrono Band [19] are gaining prominence in carrying out these activities.

In recent times, internet-based CBT protocols are becoming more prominent for treating common mental disorders [14] and have proven impactful and useful, particularly in reaching out to a larger number of people. In addition, behavioural intervention technologies (BITs) - a technological application of behavioural and psychological intervention to address behavioural, cognitive and affective targets - are commonly used to support physical and behavioural mental health [15]. More recently, mobile applications are used to trigger momentary interventions to assist mental health candidates in difficult and stressful situations, particularly when treatment is urgent. To expressly explain the technological applications of lifestyle management in terms of Diagnosis, Prevention and Alleviation (DPA) of mental health, this work laid emphasis on depression as a case study. While various depression applications are readily available for users, many are less robust in terms of managing depression symptoms. Importantly, many depression applications are prone to the risk of misdiagnosis causing the users a potential health retrogression through incorrect health management.

A few of the highly rated and readily available applications include Depression Test [20], which presents users with diagnosis and progress tracking functionalities. While Moodtrack diary [21] and Depression screening test [22] allows activities progress tracks and diagnosis respectively, applications, such as Pacifica [23] and Relieve depression PRO [24] provide prevention and alleviation functionalities, although without diagnosis or personalisation features. To the best of our knowledge, most applications have not been able to successfully combine all the necessary aspects of lifestyle management in terms of Diagnosis, Prevention, Alleviation, Personalisation and Tracking, DPA/PT. Hence, our proposition of a Framework for Lifestyle and Depression Management - FLaDM as a standard framework for the development of a depression management decision support system. Following, Section III explains iterative-Document and Stakeholders Analysis Development, i-DaSAD, methodology adopted for the development of FLaDM framework.

III. ITERATIVE-DOCUMENT AND STAKEHOLDER ANALYSIS DEVELOPMENT (I-DASAD)

To adequately replicate the process of development, study methods need to be clearly defined. Kothari [25] highlighted various methodologies including descriptive versus analytical, quantitative versus qualitative, and conceptual versus empirical among others. This work considered a mixed-method approach that combines elements of multiple methodologies from the initiation phase of defining a generic area of interest, to the final phase of artefact development. Document analysis and stakeholder analysis were carried out in conjunction with other scientific methods to develop the FlaDM artefact. The methodology combines different suitable techniques or methods in each of its five phases to derive a robust artefact. The first phase of the methodology, defining a generic area of interest, is explained as follows.

A. Defining Generic Area of Interest (G-AoI)

The i-DaSAD methodology commences with the identification of a generic area-of-interest. This generic area of interest is usually instigated by investigators' curiosity, research questions or matters arising that require resolutions. For instance, an area of interest can be as general as 'mental health' triggered by questions such as: why is mental health becoming increasingly prevalent? A substantial study of literature is expected at this stage to build a context around the history and state-of-the-art of the topic in question. Document analysis including publications, primary and secondary research and white papers certainly leads to the definition of a specific area-of-interest. For instance, exploring the body of knowledge about mental health can be narrowed to an area of focus such as eating disorder, anxiety or depression. An output of this phase is usually specifics of the general area of interest. Although there can be multiple specifics from a general interest, each specific are treated independently to improve clarity. For example, while mental health is a generic area of interest, its specifics include depression and anxiety among others. These specifics are examined independently in separate iterations.

 ISBN: 978-1-61208-688-0

B. *Evaluating Specific Area of Interest (S-AoI)*

In this phase, further document exploration is conducted on the identified specific area-of-interests. For example, if the area of interest has been narrowed down to depression, barriers, symptoms and alleviation of depression amongst other attributes are evaluated at this stage. An outcome of this phase is a comprehensive knowledge and data about the specifics. Data acquisition and statistical analysis about the specific area of focus are also carried out at this stage. For instance, statistical analysis of secondary data about depression from multiple sources is carried out at this stage. A pyramidal approach is adopted, i.e., having more general information at the bottom up. For example, if depression is the main focus, at the bottom will be statistics about depression followed by the type, method of diagnosis, prevention and alleviation and associated limitations respectively. Having comprehensive knowledge about the specific area-of-interest will help accomplish a robust analysis in the following phase (Identify Stakeholders, Problems & Solutions). Statistics about depression, diagnosis, prevention, alleviation and associated technologies were identified at this stage.

C. *Identifying Stakeholders, Problems & Solutions*

Further data analysis is performed on the outcome of the preceding phase (evaluating specific area-of-interest). A stakeholder analysis is conducted to identify all stakeholders. Problems and potential solutions about the specific area-of-interest are then derived from the previous phase of data collection. For example, in our analysis, we identified stakeholder categories to include poor people, students, career, medical practitioner among others. Following is the identification of potential solutions for the identified stakeholders' problems. For instance, one of the identified problems derived from the knowledge evaluation is stigmatisation and a corresponding solution is the increase of awareness and making the process of contacts and supports easier. Techniques such as root cause analysis are employed to identify similarities between symptoms and causes in order to define the hierarchy of importance. Findings in terms of problems and solutions will then be validated using tools such as questionnaires, surveys, interviews or focus group amongst others to improve stakeholders' involvement. In this case, participants regarded as potential stakeholders were asked to complete a 'seventeen-question' survey via an online medium. Results of the survey were used to authenticate the designed stakeholders, problems and potential solutions about depression. The validation exercise of this phase provides clarity on the level of the importance of the stakeholders, problems and potential solutions.

D. *Mapping Stakeholders, Problems and Solutions*

Knowledge about the identified stakeholders, potential problems and solutions are mapped based on the priority of importance or interest in this phase. Techniques such as priority matrix and rate and ranking scale are used to formulate stakeholders' solutions for an intended artefact. For instance, symptoms of depression include 'recurrent thoughts of suicide', 'recurrent thought of self-harm', 'affected sleep pattern', 'reduced mood' and 'affected appetite' etc. The ultimate consequence of these symptoms is death. The closest to death among these symptoms is a 'recurrent thoughts of suicide', followed by 'recurrent thought if self-harm'. A ranking and rating scale is utilised to rank and rate these symptoms in the order of impacts. Also, a priority matrix is used to determine the influence of these symptoms on the system functionalities. Further validation techniques such as focus groups and interviews are used to validate the proposed stakeholders' solutions. In this case, a survey result of 114 respondents was evaluated to validate the proposed framework components. For example, a question such as 'will you like to see an update of your mental wellbeing' validates the necessity of a 'progress track' as a measure of state in the implied framework.

E. *Developing the Artefact*

The final stage is the development of the artefact based on the needs of the stakeholders, corresponding problems and intended solutions. Key defined components are integrated at this stage to produce an artefact. After the ranking and validation of important components, the uppermost components are composed using techniques such as associative rules. To make a system a whole, self-dependent and more generalised components are placed at the uttermost layer while dependent or associated components are further embedded with their corresponding associated components. Taking that the processes within the methodology (in Figure 1) are iterative, multiple and various techniques, methods, approaches can be adopted in different phases until all requirements of each phase are satisfied. A clear benefit of the i-DaSAD methodology is its element of robustness, which allows the necessary requirements to be satisfied iteratively. See Figure 2 for FLaDM components and their corresponding layers. Section IV below explains the FLaDM and the corresponding components as derived artefact of the i-DaSAD process.

Figure 1. Schematic representation of i-DaSAD

IV. Framework For Lifestyle And Depression Management (FLaDM)

Artefact realised through i-DaSAD methodology as discussed in section III is the *Framework for Lifestyle and Depression Management* (FLaDM). An iterative process of survey and analysis of the literature on mental health, depression systems and stakeholders yielded the framework, which serves as a base for the development of a depression

 ISBN: 978-1-61208-688-0

management system. Our proposal is that FLaDM based systems will consider the core components of the framework for the development an effective depression management system in terms diagnosis, prevention, alleviation, personalisation, and progress tracking, DPA/PT.

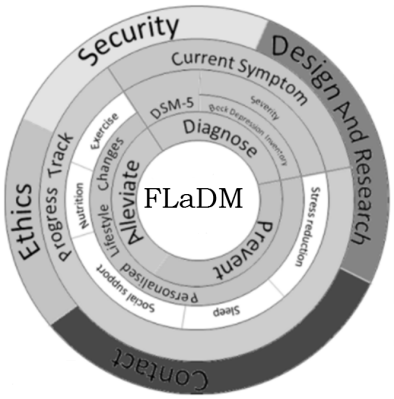

Fig 2. Framework for Lifestyle and Depression Management (FLaDM)

A. Diagnosis (Presence & Severity)

The diagnosis component of the framework comprises of two sub-components (primary and secondary). The primary sub-component focuses on examining the presence of depression symptoms in a user and secondary sub-component considers its severity if present. A flexible approach is embraced in order to allow developers adopt a preferred standard diagnostic tools, questionnaire or criteria. For example, we adopted the DSM-5 [8] as diagnostic tools for the presence of depression and the Beck Depression Inventory, BDI is utilised to determine its severity. Other tools such as ICD 10, PH9 [26] and GAD7 [27] may be flexibly adopted by the developer for depression and anxiety respectively. As earlier discussed in Section II (related work) that a minimum level of sophistication is required to comprehensively utilise the BDI tool, it is expected that a decision support system caters for its simplification. In this case, users with a basic smartphone operation should find it easy to consume the information meaningfully.

B. Prevention/Alleviation

The Prevention and Alleviation components consider the lifestyle change required for a potential or identified depressed candidate. Similar to the diagnosis, these components allow development's flexibility thereby, providing system developers with the opportunity to determine the lifestyle activities they classify suitable for depression management. As discussed in Section III, comprehensive document analysis was used to derive key lifestyle activities associated with depression. For instance, the study of 1046 women by Jacka et al., [28] reflected an odds ratio of 0.87 and 0.08 lower for depression with diets of fresh fruit and vegetables, grains and meats, than heavily processed diet respectively. This study provides the associative significance of diets with depression and its management. Analysis by Tanaka et al., [29] in the Komo-Ise study found that 1.3% fewer men had depression with exercise, and positive associations with sleeping 6-9 hours per night, small amounts of alcohol consumption as compared to an 'over' or ‘under’ alcohol consumption, and negative associations with poor physical health and chronic disease. Similarly, Gregory et al., [30] analyses of 1556 participants on wave-4 G1219 and G1219 twins longitudinal studies found a significant correlation between poor sleep and depression/anxiety symptoms. Also, the lack of sleep may prevent brain repair, making it exceedingly prone to various symptoms of depression [31]. Analysis of these works paves way for the consideration of lifestyle activities management such as stress, sleep, diet and exercise amongst others. While the framework permits the inclusion of other activities to be managed, these activities are considered fundamental lifestyle for our system.

C. Personalisation & Progress Tracking

Forasmuch as FLaDM considers depression management from the perspective of lifestyle management, a significant consideration is given to lifestyle variation. Therefore, personalisation is considered as a prerequisite component for Diagnosis, Prevention and Alleviation. This is similar to the action of a conventional practitioners while dealing with individual cases. Personalising recommendation of lifestyle changes will not only improve the effectiveness of the system but it will also help enhances the decision support process of the system. In doing so, such systems are expected to retain the capability of tracking the progress of corresponding activities to provide effective supports. For example, in this case, progress tracking is accomplished using CESD-R scale [32] to measure the users' progress in specific areas of the scale.

D. DPA/PT Wrapper

The DPA/PT Wrapper is the outermost layer shielding all other components of the framework. The wrapper consists of four basic features namely; design and research, contacts, ethics, and security. The features are expected to be considered for any decision support management system in mental health. Considering the state of mental health stakeholders, particularly the mentally ill candidate, it is expected that any adopted management for diagnosis, prevention or alleviation is highly intuitive, supportive, less demanding, moderately automated. Perhaps, such a system should be undoubtedly simple so as not to aggravate the state of stakeholders in any way. Therefore, the design of such systems requires utmost consideration of simplicity and usability of the system. Concepts including impacts of colours, fonts, navigation and overall comprehension of such system are expectedly thought through. That is, a significant research needs to be considered in the process of design. Also, the importance of the topic in terms of sensitivity to stakeholders necessitate the adoption of robust ethics and security architecture. For example, in considering the process of data handling within the system, issues such as user privacy, encryption and access level are thoroughly considered. In taking cognisance that a decision support system is not expected to replace practitioners, FLaDM based systems are expected to make provision for easier communication between stakeholders, i.e., the practitioner

 ISBN: 978-1-61208-688-0

(GP, psychiatrist, career) and patients' communications must be uncomplicated.

V. FLADM- BASED DECISION SUPPORT SYSTEM

In order to evaluate the framework, a FLaDM based decision support system was developed to measure its effectiveness and usability. A Hierarchical Task Analysis (HTA) approach is utlised for definition of system tasks. A schematic representation of the system hierarchical layout is shown in Figure 3.

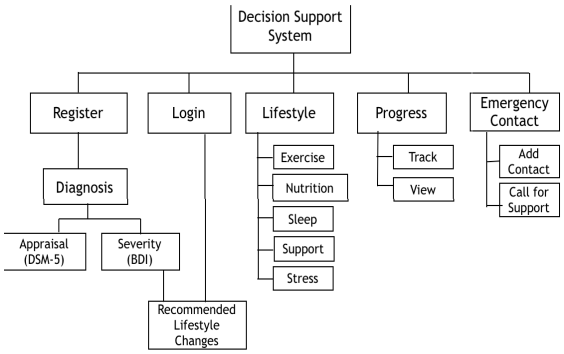

Figure 3. Hierarchical Representation of FLaDM-based DSS

Test metrics were designed to measure the effectiveness of the framework. The test activities were carried in a usability laboratory. It is noteworthy that the test was conducted to measure the suitability of the framework for system implementation. Since all usability problems can be derived from conducting the test with five participants, not so much will be derived from any more participants [33]. Effectively, five participants were recruited for the usability test of a FLaDM based system. A supplementary 'ten-question' pre-test questionnaire and 'fifteen-question' post-test questionnaire were completed by the participants to investigate the system's effectiveness, particularly in terms of diagnosis, prevention and alleviation. Examples of Pre-test and post-test questions are as shown in table I.

TABLE I. EXCERPT OF QUESTIONS FROM TEST QUESTIONNAIRE

No	Pre-test Questions	Post-test Questions
1	Have you ever been diagnosed with depression	Do you feel the application should ask for more personal information?
2	Are you at risk of suffering from depression in future?	Do you think three emergence contacts is suitable for the application?
3	What make you at risk of depression in future?	How do you find the process of diagnosis in general?
4	When were you diagnosed with depression?	Do you think the emergency contacts should include medical practitioners?
5	What are your known symptoms of depression?	Have you been correctly diagnosed using the application?

Five test metrics were designed to evaluate area of concentration including *Registration* (setting up the user), *Diagnosis* (presence and severity), *Lifestyle management and recommendations* (symptom prevention and alleviation) and *Contacts* (stakeholder communication). During the test, participants were requested to provide a self-rating perception of the tasks completed under each metric using a rating scale of 1-10 with 10 being the highest and 1 being the lowest. To ensure participants' actions correlates with the task and their rating, a 'eye-tracking software' was utilised to track participant's eye movement as seen in Figure 4. The red dot indicates the user's area of concentration at a specific time.

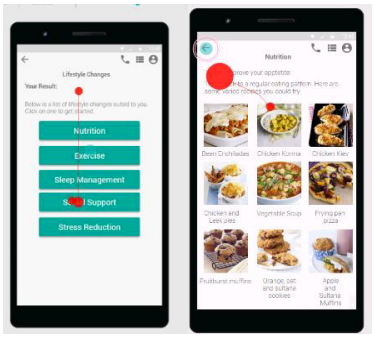

Figure 4. Eye tracking system indicating users concentration

Results of evaluations indicated appropriate diagnosis with overall users rating of 93.5% accuracy. It is interesting to note that all participants believed the lifestyle recommendations for prevention and alleviation are appropriate with 97% accuracy. Table II. represents the test metrics with a corresponding user rating of functional accuracy in terms of DPA/PT and ease of use.

TABLE II. TEST METRICS VERSUS USER RATINGS.

Metrics No	Test Metrics	Overall participants rating
1	Registration	96.5%
2	Diagnosing for Presence (DSM-5)	93.5%
3	Diagnosing Severity (BDI)	93.5%
4	Lifestyle change and progress track	97%
5	Emergency contacts and ease	82%

Although with a smaller sample size, usability problems are experienced with great variation among the test participants. Three of the participants are confirmed to suffer depression as established in the post-test question, one participant was confirmed not depressed and one was on the verge of being depressed. All participants are correctly diagnosed. Also, the test participants were of varied genders, ages and backgrounds, yet all participants were able to use the application for DPA. In addition, all participants expressed confidences in the recommended lifestyle activities to help alleviate their situations. All participants agreed that the most important feature is the emergency contact mechanism that connects them with the relevant support authority (GP and career, etc.) when needed. Most participants expressed that the emergency contact feature should be more intuitive and accessible from any part of the system.

 ISBN: 978-1-61208-688-0

VI CONCLUSION AND FUTURE WORK

The study conducted by Trivedi, M. H. et al. [12] indicated a normal antidepressant produces responses just under half of the participants and only achieved 28% full remission; hence, the need for other treatment options. This work adopts a lifestyle change approach for the development of a framework for lifestyle and depression management that underpins a decision support system. The approach involves extensive document and stakeholder analysis to identify the necessary stakeholders and their requirements for depression management DSS. The framework was evaluated in a usability laboratory to appraise the ease of use, intuitiveness and effectiveness. Results evidenced the suitability of the framework's adoption for the development of DSS for depression management. Further work will be carried out on expanding the framework to other categories of mental health disorder. Also, the system evaluation will be conducted with a larger sample. In additions, the adoption of machine learning and artificial intelligence techniques in the recommendation of change in lifestyle activities will be explored in the area of decision support system development.

REFERENCES

[1] National Institute of Mental Health, (NIMH). "Transforming the understanding and treatment of mental illnesses". [Online]. Available from: https://www.nimh.nih.gov/health/statistics/mental-illness.shtml. [retrieved: 2019.01.03].

[2] Samele, Chiara, Stuart Frew, and Norman Urquia, eds. Mental Health Systems in the European Union Member States, Status of Mental Health in Populations and Benefits to be Expected from Investments Into Mental Health: European Profile of Prevention and Promotion of Mental Health (EuroPoPP-MH):[main Report]. European Commision, Executive Agencz for Health and Consumers Tender, 2013.

[3] World Health Organization, "Suicide data," [Online]. Available from: www.Who.Int/Mental_health/Prevention/Suicide/Suicideprevent/En, 2015, [retrieved: December, 2018

[4] D. E. Bloom, E. T. Cafiero, E. Jané-Llopis, S. Abrahams-Gessel, L. R. Bloom and S. Fathima, "The Global Economic Burden of Noncommunicable Diseases (World Economic Forum, Geneva)," 2011.

[5] M. Lech, L. Low and K. E. Ooi, "Detection and prediction of clinical depression," in Mental Health Informatics, Springer, 2014, pp. 185-199.

[6] P. R. McCrone, S. Dhanasiri, A. Patel, M. Knapp and S. Lawton-Smith, Paying the price: the cost of mental health care in England to 2026, King's Fund, 2008, .

[7] D. Becker, "Acceptance of mobile mental health treatment applications," Procedia Computer Science, vol. 98, pp. 220-227, 2016.

[8] American Psychiatric Association, "Diagnostic and Statistical Manual of Mental Disorders," vol. 2018, "". October 1, 2018.

[9] K. Smith, "Mental health: a world of depression," Nature News, vol. 515, pp. 180, 2014.

[10] Psych Congress, "Beck Depression Inventory-II (BDI-II)," vol. 2018, "". 2018.

[11] G. Groth-Marnat, Handbook of psychological assessment, John Wiley & Sons, 2009, .

[12] M. H. Trivedi, A.J. Rush, S. R. Wisniewski, A. A. Nierenberg, D. Warden, L. Ritz, G. Norquist, R. H. Howland, B. Lebowitz and P. J. McGrath, "Evaluation of outcomes with citalopram for depression using measurement-based care in STAR* D: implications for clinical practice," Am.J.Psychiatry, vol. 163, pp. 28-40, 2006.

[13] R. Alnanih, O. Ormandjieva and T. Radhakrishnan, "Context-based user stereotype model for mobile user interfaces in health care applications," Procedia Computer Science, vol. 19, pp. 1020-1027, 2013.

[14] S. Rosenbaum, J. M. Newby, Z. Steel, G. Andrews and P. B. Ward, "Online physical activity interventions for mental disorders: a systematic review," Internet Interventions, vol. 2, pp. 214-220, 2015.

[15] D. C. Mohr, M. N. Burns, S. M. Schueller, G. Clarke and M. Klinkman, "Behavioral intervention technologies: evidence review and recommendations for future research in mental health," Gen.Hosp.Psychiatry, vol. 35, pp. 332-338, 2013.

[16] PROOF(TM) Weables, "Alcohol Tracking Wearable," [Online]. Available from: www.proofwearable.com/.

[17] BACtrack, 2018 [Online]. Available from: www.bactrack.com

[18] Digital Health Age, "SmartStop wearable to help smokers quit," 2016, [Online]. Available from: digitalhealthage.com

[19] Vandrico Inc, "Chrono Solution, 2018" [Online]. Available from: www.vandrico.com. [retrieved: 2018.12.10].

[20] Psych Central, "Depression Test," vol. 2018, "". 2018.

[21] PsyberGuide, "MoodTrack Diary:Mood Tracker," vol. 2018, "". 2018.

[22] BC Partners for Mental Health and Addictions Information, "Online Screenings," vol. 2018, "". 2018.

[23] Pacifica, "Pacifica is more than a meditation app," vol. 2018, .

[24] L. Surf City Apps, "Relieve Depression Pro," vol. 2018, "". 2018.

[25] C. R. Kothari, Research methodology: Methods and techniques, New Age International, 2004, .

[26] Caremark, "Patient Health Questionnaire—PHQ-9," www.Psycho-Oncology.Info/PHQ9_depression.Pdf, "August ". 2003.

[27] Psychiatric Times, "GAD-7," vol. 2018, "Apr 26, ". 2013.

[28] F. N. Jacka, J. A. Pasco, A. Mykletun, L. J. Williams, A. M. Hodge, S. L. O'reilly, G. C. Nicholson, M. A. Kotowicz and M. Berk, "Association of Western and traditional diets with depression and anxiety in women," Am.J.Psychiatry, vol. 167, pp. 305-311, 2010.

[29] H. Tanaka, Y. Sasazawa, S. Suzuki, M. Nakazawa and H. Koyama, "Health status and lifestyle factors as predictors of depression in middle-aged and elderly Japanese adults: a seven-year follow-up of the Komo-Ise cohort study," BMC Psychiatry, vol. 11, pp. 20, 2011.

[30] A. M. Gregory, F. V. Rijsdijk, T. C. Eley, D. J. Buysse, M. N. Schneider, M. Parsons and N. L. Barclay, "A longitudinal twin and sibling study of associations between insomnia and depression symptoms in young adults," Sleep, vol. 39, pp. 1985-1992, 2016.

[31] Pallab Ghosh, "Why do we sleep?" vol. 2018, "May, 2015.

[32] Center for Epidemiologic Studies Depression Scale, CESD-R, "Depression", "". 2018.

[33] R. Molich, K. Bachmann, J. Biesterfeldt and W. Quesenbery, "Five users will find 85% of the usability problems," in and other myths about usability testing. Proceedings of the Usability Professional's Association-International Conference, 2010.

 ISBN: 978-1-61208-688-0