American Journal of Aging Science and Research

Sagiadinou et al., Am J Aging Sci Res. 2022;3(1):14-21.

Research Article

Implementation study of a Web-App, which facilitates dementia screening for general and multicultural population in primary care settings

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Received date: August 28, 2022
Accepted date: September 16, 2022

Citation: Sagiadinou MM, Vlamos P, Exarchos T, Dimitrios V, Bringiotti P, Galanis S. Implementation study of a Web-App, which facilitates dementia screening for general and multicultural population in primary care settings. Am J Aging Sci Res. 2022;3(1):14-21.

Abstract

Background: Primary care professionals are well positioned to help identify patients at risk of developing dementia, support them and proceed to referral to a specialist. Individuals from multicultural backgrounds belong to a vulnerable group, as they often face underdiagnosis of dementia, for various reasons.

Objectives: Our aim was to present the implementation study of a web-based app, called *Dementia,* which was modeled and designed in previous study, focusing on screening dementia in primary care settings both for general and multicultural population.

Outcomes: 16 primary care professionals, form individual and public domain, assessed the web-app *Dementia* to 132 of their casual patients (final n=104, as 28 patients were excluded, due to dementia, according to GDS-4). Thirty-eight (n=38) participants were individuals from multicultural environment and no statistically significant differences emerge between participants from different countries of origin ($p>0.05$ in all cases), as the distribution appears the same within the groups for all the tests included in the app. The System Usability Scale was assessed to the 16 professionals, resulting to excellent outcomes.

Discussion: Screening dementia web-apps could be incorporated into the routine practices of existing health care services, following tailoring to the resources and features of primary care settings.

Keywords: Screening dementia, eHealth web-apps, Primary care, Immigrants, Cognitive tests, Biomarkers

Introduction

Health screening is a key component in disease prevention framework [1]. Although the vast majority of older people worry about their memory and their cognitive ability, though they hesitate to discuss their concerns with their general practitioner [2]. While in many cases mild cognitive impairment (MCI) progresses to dementia [3], it is of great importance the early detection of measurable indications of the illness. Individuals with dementia face mortality risks two times more than individuals without dementia and in many cases, dementia comes along with other comorbidities that the patient alone and the patient's environment has to handle before the deterioration stage [4]. These comorbidities often lead to extended hospital stays and increased healthcare costs [5]. Screening for MCI is crucial, so as to motivate the patient at risk to address to an expert for diagnosis and the planning of a therapeutic intervention [6,7].

Evidence in general populations suggest that technology-based screening improves patient-centered care [8]. Recent lliterature confirms that eHealth is effective/cost-effective or at least suggest evidence is promising, which is consistent with previous findings [9]. eHealth contains the following 3 key elements: (1) data obtained from the patient; (2) electronic transfer of data over a distance; and (3) patient-tailored feedback from a health care professional [9], which are fundamental elements for patient-centred health provision.

Also, the issue of dementia in immigrants is emerging and poses additional challenges in terms of clinical approach and screening procedure. Back in 2019, 272 million international migrants were estimated worldwide, while older immigrant population accounted for 12% of overall international migrants, who are exposed, among others, to the risk of dementia [10]. It is estimated that the number of persons, living outside of their country of origin, reached 281 million in 2020 and Europe was the region with the largest number of international migrants [11]. Around the world, median age of immigrants has increased to 39.1 years in 2020 and specifically in Europe median age has increased to 43.4 years, whereas 12 per cent of international migrants worldwide were at least 65 years old, compared to 9 per cent in the total population [12]. For most of the cases, cultural, spiritual and economic barriers, as well as healthcare inadequacies may act as barriers for the screening of dementia [13,14]. Regarding the case of immigrant dementia screening, recent literature highlights late diagnosis by a health professional, as in many cases symptoms of cognitive disorders are accepted as normal memory symptoms [15]. Also, language or cultural barriers make it complicated for general practitioners to diagnose such cases, as assessing cognitive abilities with the help of tests is an additional challenge [16].

Indeed, primary care serves as the first point of contact for people with dementia and is therefore a promising setting for screening, assessment and initiation of dementia-specific treatment and care [17]. However, primary care physicians are reported to underuse standardized instruments, leading to underdiagnosis of dementia, fact which may also be attributed to the prioritization of somatic diseases over cognitive problems among the elderly [18]. Proposals have been submitted of patient-centered health risk assessments (HRAs), which screen for health risks, allow patients to prioritize concerns, provide them with immediate feedback about positive screens and potential next steps, support goal setting, and alert clinicians to patients' concerns [19,20].

The development of Information and Communication Technology (ICT) has created an opportunity to improve health [9], through various eHealth interventions using sophisticated platforms, such as web applications. Studies show that these online applications can be effective in changing health behaviors and improving overall health status by addressing different needs, such as screening, promotion of health, and health counseling [21]. Online screening has the added advantage of being an attractive and effective method for primary prevention and health promotion strategy [22].

Taking into consideration that changes in the brains of affected individuals could be detected as early as 10 years before the onset of symptoms, screening research should take into account this time frame [23]. Cognitive assessment can play an important role in facilitating the screening process and even diagnosis of dementia [24]. In some cases, cognitive tests can detect cognitive deficits ten (10) years before clinical diagnosis of dementia, and recent research suggests that dementia screening can even precede clinical dementia by eighteen years the final diagnosis of Alzheimer's disease [25]. Clinical studies demonstrate several assessment methods with high accuracy, such as brain scans, cerebrospinal fluid or blood tests that provide diagnostically relevant information in the early disease stages of dementia [26].

The aim of this study was to implement a web-based application, called *Dementia,* which will integrate a multi-domain approach, including cognitive assessment and biomarkers, addressed in primary care settings for the detection of early dementia in general and multicultural population. In addition, depending on the outcome of the app's personalized administration, it will provide personalized guidance on next steps, such as referral to a specialist and recommendations for lifestyle changes that would reduce the risk of developing dementia. The modeling and the development of the app was presented in previous article [27].

Methodology

The full version of methodology process was presented in earlier article [27], but is also appropriate a reference in brief to take place at the present study.

Hypotheses

Our basic research hypothesis was formulated as followed: a) "*If cognitive markers are combined with biomarkers and individual risk factors, then we will have the best results for identifying highly vulnerable dementia patients.*" Additional research hypotheses: b) "*If dementia screening can be assessed through an online application, then it could be easily and reliably administered by primary health care professionals at regular patient check-ups*", c) "*If the appropriate psychometric tools and biomarker models are utilized, then it is possible to assess with the same online application different population groups, such as general and multicultural*".

The study has received the approval of the Research Ethics and Ethics Committee of the Ionian University and of 6th Health Region of Greece, where Corfu Island belongs.

Participants

Due to the complex research design, different sample groups participated in the study, depending on the phase of the research process. According to this, three sample groups were formed: a) two groups of experts, who were responsible for proposing adequate psychometric cognitive tools and a variety of biomarkers b) one group of primary care professionals, who used the application and c) a group of patients, who were assessed with the application (**Table 1**).

Inclusion criteria

The only inclusion criteria for primary health professionals, either working in private or public sector, was to maintain an active clinical practice, while for the patients was the age limit, which should not be less than 45 years and the absence of depression, according to Geriatric Depression Scale (GDS-4) [28]. The selection of experts in both groups was based on specific criteria, such as professional position, relevance to the subject of the research, their availability, their experience in clinical work and the ability to evaluate scientific data.

Tools

According to the literature review for tools' selection, the following criteria list was formed: short evaluation time (<7'), good psychometric values (reliability and validity), availability of norms, no or low restrictions on education/language/socio-economic level biases, availability of multiple language translations, absence of license commitment, online availability, proven reliability and validity in a primary health setting.

Table 1. Participants of the study.

Participants			
Groups of experts		**Users**	**Patients**
(I)	**(II)**		
5 clinical/experimental psychologists Target: proposeadequate cognitive tools for screening dementia in primary health settings	3 General Practitioner Physicians (GPs) 2 Neurologists Target: propose adequate biomarkers for screening dementia in primary health settings	GPs (n=8) Neurologists ((n=2) Primary care staff (nurses, social workers, psychologists) (n=6) Target: 1. Assess Dementia app 2. Measure app's usability	Without dementia diagnosis (n=64) With dementia diagnosis (n=40) Individuals from multicultural environment (n=38)

We took into consideration variables related to modifiable and nonmodifiable risk factors in the following categories: demographic, lifestyle, medical history, basic medical examination, physical examination, psychological assessment, cognitive assessment, and multiple health instruments relevant to the dementia evaluation. Great importance was given to the selection of cognitive tests, which would assess both episodic memory and executive function, as they are the areas first affected by dementia. Selected tests, which could be administered by general practitioners (GPs) or other health staff with minimal training, are suitable for primary care settings and are recommended by the Department of Health's Mental Health Directorate in their Dementia Guidelines [29].

The final selected tests to assess cognition were: a) General Practitioner Assessment of Cognition-GPcog [30]. In the initial validation study, the sensitivity and specificity for the clinical diagnosis of dementia were 85% and 86% respectively, while assessment time takes about 4 minutes, b) Rowland Universal Dementia Assessment -RUDAS [31]. RUDAS was designed as a multicultural cognitive test, the reliability of the test reaches 83% and the validity 86%, while the assessment time takes about 6 minutes.

For assessing biomarkers, the Cardiovascular Risk Factors, Aging and Dementia (CAIDE) Risk Score was qualified, which is the first midlife tool, that combines modifiable and nonmodifiable factors and is developed for dementia prediction [32]. It is composed of vascular and sociodemographic risk factors, such as: age, education, blood pressure, cholesterol, body mass index (BMI), and physical activity, and is based on the midlife risk profile, it provides a 20-year dementia risk estimate.

Detection for depression was assessed with Geriatric Depression Scale four items-GDS-4 [28]. The total usability of the web-app *Dementia* was measured with the standard System Usability Scale -SUS (Brooke, 1996).

Procedure

The consensus phase of developing the app [27], was followed by the development of a prototype of the web-app and once again the opinion of the experts was asked and the feedback led to upgraded version of *Dementia* app.

For the implementation phase 16 users/primary health care professionals both from public and private sectors participated, after addressing the Local Medical Association of Corfu and from the personal network of the researcher. The first approach was by telephone, during which, basic information about the identity of the researcher, the objectives of the study were provided and their participation was requested. All users had a personal meeting with the researcher, in which the purpose of the study, the methodology, and basic information about the application were explained thoroughly. An *in vivo* administration of the application to one of the user's patients was then performed in real time to familiarize them with the tool. Consent forms were given to all participants. The assessment was carried out as part of the programmed regular patient visit. When the administration phase was completed, along with a thank you e-mail, an online version of the questionnaire SUS was sent to the users/primary health care professionals, asking them to evaluate the usability of the application.

Results

Over a period of 12 weeks, from May 2022 to July 2022, 132 patients were screened by the 16 primary care professionals during routine consultations. From the initial 132 patients, 28 were excluded from the study, due to depression, according to GDS-4 [28]. Of the final 104 participants, 56 (54%) were females and 48 males (46%), while their average age was 61.49 years with an age range of 45-85 years. The 38% (n=40) of the participants had dementia, according to formal medical certificate.

Thirty-eight (n=38) participants were individuals from multicultural environment. In relation to the subjects' countries of origin, 63.4% (n=66) were from Greece, 22.1% (n=23) from Albania, 6.7% (n=7) from Great Britain, 4.8% (n=5) from Italy, 2% (N=2) from Denmark and 1% (N=1) from Qatar.

A high proportion of participants, around 50%, failed the total results (due to failing at least one of the tests), without having a diagnosis of dementia. However, none of the participants with a diagnosis of dementia were successful on the overall outcomes (**Table 2**).

Country of origin

Regarding the country of origin, as the distribution of the sample is non-normal, the non- parametric test of independent samples Kruskal-Wallis was carried out. According to the results (**Table 3**), no statistically significant differences emerge between participants from different countries of origin ($p>0.05$ in all cases) and the distribution appears the same within the groups for all three tests (GPCOG, CAIDE and RUDAS).

Table 2. Crosstab of total results and dementia diagnosis.

Total Result					Total
Failed				Success	
Dementia	NO	Count	40	24	64
		% within Total Result	50.0%	100.0%	61.5%
	YES	Count	40	0	40
		% within Total Result	50.0%	0.0%	38.5%
Total		Count	80	24	104
		% within Total Result	100.0%	100.0%	100.0%

Table 3. Asymptotic significances are displayed. The significance level is .05

Hypothesis Test Summary

	Null hypothesis	Test	Significance	Decision
1	The distribution of GPCOG points is thesame across categories of Country of origin	Independent Samples –Kruskal-Wallis Test	0.888	Retain the nullhypothesis
2	The distribution of RUDAS points is the same across categories of Country of origin	Independent Samples –Kruskal-Wallis Test	0.499	Retain the nullhypothesis
3	The distribution of CAIDE points is the same across categories of Country of origin	Indipendent Samples –Kruskal-Wallis Test	0.148	Retain the nullhypothesis

To further explore the correlations, an independent samples t-test was conducted for the variables of age and years of education, in relation to the overall results (succeed/fail) in the tests of the present investigation. According to descriptive statistics (**Table 4**), participants who failed at least one of the tests tended to have a higher mean age and lower mean years of education, compared to participants who passed all three tests. According to the results of the independent samples t-test (**Table 5**), these differences are statistically significant both in terms of age (p=0.000) and years of education (p=0.000).

Table 4. Descriptive statistics (years of education, age).

	Total Result	N	Mean Difference	Standard Deviation
Years of education	Failed	80	5.9125	4.77916
	Success	24	13.3750	5.26525
Age	Failed	80	64.3500	9.50163
	Success	24	51.6667	4.34057

Table 5. Independent samples t-test results.

Levene's Test for Equality of Variances				t-test for Equality of Means						
F			Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Years of education	Equal variances assumed	0.573	0.451	- 6.553	102	0	-7.46250	1.13878	- 9.72127	-5.20373
	Equal variances not assumed			- 6.217	35.149	0	-7.46250	1.20026	- 9.89879	-5.02621
Age	Equal variances assumed	14.111	0	6.328	102	0	12.68333	2.00441	8.70760	16.65906
	Equal variances not assumed			9.169	85.323	0	12.68333	1.38331	9.93310	15.43357

Table 6. System Usability Scale Scores.

Number	Item	Agree/Strongly agree	Disagree/Strongly disagree
1	I think that I would like to use this website frequently.	87.5%	
2	I found this website unnecessarily complex.		68.8%
3	I thought this website was easy to use.	50%-50%	
4	I think that I would need assistance to be able to use this website.		75%
5	I found the various functions in this website were well integrated.	75%	
6	I thought there was too much inconsistency in this website.		81.3%
7	I would imagine that most people would learn to use this website very quickly	50%/50%	
8	I found this website very cumbersome/awkward to use.		81.3%
9	I felt very confident using this website.	56.3%/31.3%	
10	I needed to learn a lot of things before I could get going with this website.		68.8/25%

Evaluation of the usability of the *Dementia* application

When the administration phase of the application was completed, an electronic questionnaire (System Usability Scale) was sent to the users/physicians, together with the letter of thanks for their participation in the research, which evaluated the usability of the application (**Table 6**). The questionnaire was in Google Forms format, so the data was collected directly on that platform.

Discussion

This study, which is in a continuum of previous study [27] aimed to propose a brief, inexpensive, noninvasive strategy for screening dementia from midlife to elderly, through a web-based app with a tailored multicomponent design. The goal was to design, develop, and implement a web-based app, called *Dementia,* which would be assessed from primary care professionals to multiple population (general, multicultural) and which would combine biomarkers and cognitive tests.

The basic screening strategy for dementia in the present is the assessment of Mini Mental State Examination, which is proved rather insufficient, for identifying Mild Cognitive Impairment [33]. Thus, MMSE may yield false positives in lower socioeconomic and limited health literacy populations, while exhibiting false negatives in highly educated groups [34,35]. According to Andrews et al. [36] established dementia risk tools have not been evaluated enough for assessment of risk of mild cognitive impairment (MCI). Although not all persons with MCI progress to dementia, they are at greater risk than those with no MCI individuals [37], so early detection of individuals at high risk of progressing to dementia provides a wider window of opportunity to initiate preventive measures.

We concluded that our basic research hypothesis, according to which, *if cognitive markers are combined with biomarkers and individual risk factors, then we will have the best results for identifying highly vulnerable dementia patients*, was confirmed, which agrees with the findings that screening cannot be done using just a single method, a "one size fit all" solution [7], as different delivery methods must be used to address patient needs [38]. Moreover, it is long before known that there exist several markers of a preclinical period of dementia, in which specific cognitive and biochemical changes precede the clinical manifestations [39]. Indeed, analysis from Mayo Clinic Study of Aging has long before identified several factors associated with the risk of MCI including age, education, sex, APOE genotype, parkinsonism, diabetes, depressive symptoms, cardiovascular disease, stroke, and slow gait [40]. According to statistical analysis, none of the participants with a diagnosis of dementia were successful on the overall outcomes. This absolute correlation (p=0.000), may be partly explained by the initial application grading term, according to which, a failure in just one of the tests was sufficient to be graded as an overall failure in the final result. It would also make a lot of sense to compare the performance to *Dementia* app with stabilized long-term cognitive test and not with dementia diagnosis, such as in our study, as then probably the correlations wouldn't be so absolute.

As far as our second research hypothesis concerned, that *If dementia screening can be done through an online application, then it could be easily and reliably administered by primary health care professionals at regular patient check-ups,* we also concluded that it is confirmed, following the results of System Usability Scale. Only recently general guidelines have been published in Greece in the context of the National Action Plan for Dementia and Alzheimer's Disease 2015–2020, stressing the importance of developing and using such tools and associated screening procedures in primary care [29]. Despite the challenges, primary health care professionals expressed a desire to continue using *Dementia* web-pp after the conclusion of the study. Literature shows positive correlation between usefulness and system acceptance, so however system acceptance [40] was not directly measured in the present study, we assume that users will have a positive attitude toward using an app for screening dementia.

As for the third research hypothesis that *if the appropriate psychometric tools and biomarker models are utilized, then it is possible to assess with the same online application different population groups, such as general and multicultural*, the findings were in agreement. According to the results (**Table 2**), no statistically significant differences emerge

between participants from different countries of origin ($p>0.05$ in all cases) and the distribution appears the same within the groups for all three tests, GPCOG, CAIDE and RUDAS. When it comes to Greek reality, the selection of GPCog agrees with the results of Iatraki's study [42] in Greek population, according to which, it is particularly useful tool in rural areas and can be administered by health personnel with minimal training and appear to be suitable for primary care settings serving elders with no or minimal formal education. All of the chosen instruments were validated in multiethnic population [43]. Comparing national dementia plans and strategies in Europe and European Free Trade Association countries (EFTA), resulted that twenty-three of the 35 EU and ETFA countries have a national dementia plan, ten of these documents refer to migration and one country (Austria) has a national dementia plan with a chapter on migration [16,44]. Literature indicates a lack of diagnosis within migrant communities in many European countries [44]. One reason for the underdiagnosis of dementia could be a lack of adequate diagnostic tools [45]. Using tools that have only been validated in a Western context obviously creates sources of error [46]. Many clinicians had limited experience with older immigrants with dementia, and specifically general practitioners (GPs) experience multiple challenges in assessing dementia due to language barriers and difficulties related to the involvement of the family, the culture or an interpreter [16]. However, GPCog and RUDAS are proposed by Greek Ministry of Health, as a guidance to assess dementia and mild cognitive impairment [29]. Also, although, CAIDE has various versions, incorporating APOE, the simple version was qualified as the most suitable, on the grounds that it is addressed to primary health care settings.

Further research is needed to investigate the implementation of a screening tool for dementia in a range of primary settings. New study should be conducted ensuring that the app is integrated within existing clinical software to minimize the additional work required by support staff and GPs to use this new technology. According to Elbert's et al. [9] review of systematic reviews and meta-analyses, most articles show eHealth is effective/cost-effective or at least suggest evidence is promising, which is consistent with previous findings and propose rather than strengthen current evidence, better to implement effective/cost-effective eHealth initiatives in daily practice. Given the findings that using apps could encourage individuals to take responsibility for their health and lead healthy lifestyles that prevent various deficits [47], a self-administration version of *Dementia*, would make sense to implement it in the coming years, only with the guidance and supervision of general practitioners, who will then through their clinical practice and examination be in charge of the referral procedure. Also, literature encourages the use of new technology, like smart phones, tablets, iPads for screening dementia, while patients and caregivers are in waiting rooms, waiting for medical examination and care provision [48].

Screening and referral of dementia may be improved, if primary care professionals had the chance to be supported by the progress and utilization of technology in the health field. Efficient dementia screening in primary health care settings depends on brief, accurate, reliable, psychometrically valid, acceptable to ailing patients, acknowledged as value-added by health care providers instruments, which could be assessed through web-based applications. More studies that investigate how general practitioners, other primary health specialties and practice support staff integrate screening technology into their routine work are needed.

Acknowledgments

This research is funded by the European Union and Greece (Partnership Agreement for the Development Framework 2014–2020) under the Regional Operational Program Ionian Islands 2014–2020, project title: "NEUROSYSTEM: Decision Support System for the analysis of multilevel data of non-genetic neurodegenerative diseases", project number: MIS 5016116.

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