Effect of a mobile application on the precision of the preliminary diagnosis of anxiety
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Abstract: There were not found studies about the impact of the use of a mobile application on the diagnostic precision of anxiety, which makes it difficult to make decisions to apply this technology to improve the sensitivity and specificity of this diagnosis, which is necessary due to millions of people around the world are affected by anxiety. The purpose of the research was to determine if a mobile application improved the process of preliminary diagnosis of the anxiety disorder of patients of the psychology service in a hospital with a convenience sample of 23 patients. The results of the study showed an improvement in sensitivity (from 33.3% to 83.3%) and a decrease in specificity (from 94.1% to 82.3%) of the preliminary diagnosis of this disorder. It was concluded that the use of the mobile application together with the color psychology allowed the increase of the sensitivity of the preliminary diagnosis and that the decrease of the specificity was a consequence of the better identification of patients with the diagnosis with this technological solution. For future researches, the recommendations included the use of the developed mobile application or other similar applications in other cities and countries, improving their functional and technical characteristics, as well as to study the results of the use of similar mobile applications for other psychological disorders.

Keywords: anxiety; mobile application; color psychology; sensitivity; specificity

ABOUT THE AUTHOR
Walter Junior Mayo Espinoza is a systems engineer of the Universidad César Valdejo. He developed diverse web and mobile applications and enjoyed with the research activities in his university jointly with his professors and specially with his thesis supervisor. He has been realized the following activities: maintenance of a hospital management information system, programming of diverse web and mobile applications in diverse programming languages, and diverse technical support activities such as: maintenance of computers, configuration of printers, database configurations, etc. His main interests are around the innovation in information technologies for improving the attention to patients in health entities and to learn new information technologies constantly.

PUBLIC INTEREST STATEMENT
This study shows the effect of a mobile application in the precision of the preliminary diagnosis of anxiety, which is a common disease that affects many people around the world and that could have a bad preliminary diagnosis considering the current procedures or techniques for its initial screening in diverse health organizations in diverse cities and countries. In comparison with the traditional procedures and techniques, the use of the mobile application demonstrated the increase of the sensitivity from 33.3% to 83.3% and a low decrease of the specificity from 94.1% to 82.3%, with a sample of 23 patients in a hospital. Color psychology applied jointly with the mobile application contributed to these results. The use of the developed mobile application in diverse health organizations of a city or a country and the improvement of the mobile application for other psychological disorders were recommended.
1. Introduction
The use of mobile applications for health improves the advance of the research, the prevention of
diseases, the diagnosis, the access to health services, and the communications with the patients
(Angarita & Castaña, 2017, p. 2). Moreover, Anxiety has been identified as a clinical diagnosis
(Céspedes, 2015, p. 34; Hernández, 2012, p. 14); however, there were not found studies in which
there is evidence of the use of mobile applications to support the diagnosis of anxiety, although
the use of mobile applications is widespread (Pacheco & Idrovo, 2014). In respect, Pacheco and
Idrovo (2014) explained that given “the expansion of the mobile phone market, more and more
mobile applications have been developed” (p. 17) and that “as far as medicine is concerned, the
development of applications oriented to health, nutrition, sports, etc. has grown enormously”. (p.
17). Therefore, it is very important to know the current states of the patients in the face of this
disorder, in order to orient them towards their emotional, psychic and social well-being.

After the literature review, there were not found studies about the impact of the use of a mobile
application on the diagnostic precision of anxiety. This lack of knowledge difficults the decision
making about the application of this type of technology for improving the sensitivity and specificity
of the diagnosis of the anxiety. In this context, a mobile application was developed for contributing
with psychology professionals in the preliminary diagnosis of anxiety disorder, which in the context
of the hospital in which the study was developed, allowed to increase the sensitivity of the
preliminary diagnosis of anxiety.

1.1 Background of the problem
About the construction of the mobile applications, Angarita and Castaña (2017) explained: “The
creation and use of mobile applications must respond to the specific conditions of each person”
(p. 3); in addition, “the possibility of evaluating the cost-benefit of using the application to enhance
care by all health professionals must be given” (p. 3). Moreover, Arévalo (2016) explained that the
U.S. National Institute of Mental Health stated: “Anxiety disorders affect approximately 40 million
American adults 18 years of age or older (approximately 18%) each year” (p. 3). According to
Cardona-Arias et al. (2015): “Anxiety disorders are more prevalent than other mental disorders;
19.3% of the population between 18 and 65 years of age has had them at some time in their lives
(in women, the prevalence increases to 21.8%)” (p. 81). According to Céspedes (2015), some
studies carried out in Peru on these types of mental illness mentioned:

The emotional and behavioral disorders in children in our country are 17,078 cases and there
are 4,441 cases in adolescence, being extracted from the mental health database of
hospitals in different departments of Peru. These departments are Amazonas, Ancash,
Apurímac, Arequipa, Ayacucho, Cajamarca, Callao, Cusco, Huancavelica, Huánuco, Ica, Junín,
La Libertad, Lambayeque, Lima, Loreto, Madre de Dios, Moquegua, Pasco, Piura, Puno, San
Martin, Tacna, Tumbes and Ucayali. (p. 18)

Romero (2015) indicated that mental illnesses affect more than 5 million people in Peru, according
to information from the Ministry of Health, and a large percentage do not receive adequate
treatment because state policies are not adequate to address these ills (para. 2). In addition,
Céspedes (2015) explained:

In Lima, 11,329 cases have been treated, being the department in which the major part of
the cases of emotional and behavioral disorders in children and adolescents are presented;
being 1317 cases of emotional disorders of the specific beginning in childhood under 11
years old and from 12 to 17 years old, 472 cases are presented; on the other hand, in other
emotional and behavioral disorders there are 3,905 cases corresponding to children under
11 years old and 2,297 cases ranging from 12 to 17 years old, data that alarm to our Lima
population. (p. 18)

Regarding anxiety, Mendieta et al. (2014) explained: (a) “Primary cognitive alterations, associated with
secondary somatic manifestations of anxiety, alter work capacity, interpersonal relationships, and
pleasurable activities” (p. 510), (b) “The global annual prevalence of TAD has been reported to be between 3 and 8%” (p. 510), and (c) “the prevalence of this disorder varies among different countries, perception believed to be due to the poor validity of the criteria” (p. 510). Additionally, Montoya and Suarez (2013) conducted a cross-sectional descriptive study with a non-probabilistic sample of 175 patients from a population of 319 patients at the Almánzar Aguinaga Asenjo National Hospital in the city of Lambayeque in Peru and three nephrological clinics with associated hospital services. Montoya and Suarez (2013) concluded that anxiety is present in 69.7% of the patients, of which 40.2% had a mild level, 26.2% had a moderate level, and 33.6% had a severe level and that the frequencies of depression and anxiety were higher than those reported in the literature.

In addition, Hernández (2012) conducted descriptive research using the screening questionnaire to diagnose anxiety, with a non-probabilistic sampling and inclusion and exclusion criteria applied to 65 people from the medical outpatient service of the Centro de Atención Primaria—Ucupe (center for primary attention in the city of Chiclayo in Peru) where they obtained as a result that women are more prone to suffer from anxiety, resulting in the presence of generalized anxiety disorder and depressive disorder, because they are the ones who suffer most from psychobiological factors. Additionally, Echeburua et al. (2014) explained:

In addition to the increase in mental disorders, the therapeutic demands of the population have changed considerably in recent years. Now there is a tendency to consult, in addition to the traditional clinical pictures (depression, anxiety disorders, schizophrenia, addictions, among others), for minor problems, derived from a greater intolerance to suffering on the part of patients. These problems, which do not properly constitute mental disorders, reflect a pathology of suffering or unhappiness, that is, a situation of personal dissatisfaction that in many cases has no clinical significance. (p. 66)

With the advancement of cellular technology and the massive increase in the use of smart phones, the proposal was born to implement and incorporate technology with mental health in a cellular application to support people suffering from this condition (Pacheco & Idrovo, 2014, p. 18). Likewise, Pacheco and Idrovo (2014) stated that with the passing of the years in the world “both science and technology have been evolving, for which various instruments of detection, diagnosis, new drugs and psychological treatments for the different disorders have been discovered” (p. 16) and that it has helped the progress and knowledge of this disorder, as well as the optimization of the results of its treatment (p. 16). In addition, Rodríguez et al. (2013) explained that mobile phones are used for those treatments of various ills in the field of health and that their use is growing, as they offer various advantages such as rapid availability which provides to the patient with the desired information for treatment, among many other tasks that improve their condition (p. 2).

Arias and Gonzales (2015) stated that the construction of an information system favors the reduction of time, both for the qualification and interpretation of evaluations, as well as the process of patient care by making the information of consultations and medical history stored in a safe place and be able to make respectful reports (p. 15), due to that “Mental health problems, in general, are usually attended initially in primary care consultations, and at this level of care a significant number of the demands generated by these are resolved” (Navas & Vargas, 2012, p. 497). In this regard, Niño and Fernández (2015) explained:

In the evolution of our society, the presence of the doctor and the medicines constitute a necessity of first order assumed and demanded by all. Prompt intervention, correct diagnosis and prevention are the answers that the health sciences have always given to these social demands, and to achieve this they have relied on communication and technological innovations. (p. 146)

As can be seen, anxiety is a frequent disorder and given the lack of population and health services, its diagnosis requires technological support to increase its speed. Mobile applications could help greatly to speed up this diagnosis.
1.2. Theoretical framework
The sensitivity and specificity of the disease diagnosis, the use of mobile applications for health diagnosis, the technology and methodology used for the development of the mobile application, the anxiety disorder, the Zung questionnaire, and the colour psychology are explained in this section. All these themes constituted the theoretical framework for the mobile application used in this study.

1.2.1. Sensitivity and specificity of disease diagnosis
The sensitivity and the specificity of the disease diagnosis are the measures of the validity of a test (Stojanovic et al., 2014, p. 1062). Stojanovic et al. (2014) also explained:

For a test to be accurate, both sensitivity and specificity should be high. When measuring sensitivity, we only calculate those people with disease. High sensitive test detects a high percentage of positive cases while missing few. Also, a negative result would suggest the absence of disease according to test with high sensitivity. On the contrary, specificity highlights negative test results. A highly specific test is good for detection of a disease if a person tests positive, likewise it does not falsely diagnose disease when none is present. (p. 1064)

Sensitivity is a proportion of people with true positive disease diagnosis expressed in percentages (Stojanovic et al., 2014, p. 1063). Additionally, about sensitivity, Trevethan (2017) indicated:

The sensitivity of a screening test can be described in variety of ways, typically such as sensitivity being the ability of a screening test to detect a true positive, being based on the true positive rate, reflecting a test’s ability to correctly identify all people who have a condition, or, if 100%, identifying all people with a condition of interest by those people testing positive on the test. (p. 3)

Specificity of the disease diagnosis is the proportion of people with true negative disease diagnosis expressed in percentages (Stojanovic et al., 2014, p. 1064). Additionally, Trevethan (2017) defined specificity as follows:

the ability of a screening test to detect a true negative, being based on the true negative rate, correctly identifying people who do not have a condition, or, if 100%, identifying all patients who do not have the condition of interest by those people testing negative on the test. (p. 3)

1.2.2. Use of mobile applications for health diagnosis
Sathya et al. (2019) defined to the mobile application as follows: “software program designed to use in mobile phones or tablets for various purposes” (p. 135). Similarly, about the mobile application, Dorrer et al. (2019) precised: “is a modern software which intended for working on tablets, smartphones and other mobile devices” (p. 1). About the use of mobile applications and sensors, Hranovska (2020) precised that it “will allow pupils to immerse themselves in research activities to learn how to use measuring devices and to develop research skills that will be necessary for them in future study and own needs realization.” (p. 15).

With respect to the use of mobile applications for health, Angarita and Castañeda (2017) explained: “It has been pointed out that these technologies make it possible to advance research, prevent diseases, improve diagnosis, treatment and education, reduce inequalities, increase access to health services, and even reduce their costs.” (p. 2). In addition, Angarita and Castañeda (2017) stated: “Moreover, mobile applications facilitate communication with the user/patient, and have shown promising and more economical results in the clinical field, because they shorten distances and avoid unnecessary efforts in the vulnerable population.” (p. 2).

Niño and Fernández (2015) explained: “the new technologies associated with health are causing both the patient and the professional to change their treatment in the consultation” (p. 149). In addition, Niño and Fernández (2015) said that making it easier and more comprehensible by means of a technological tool, easy to use and usable, is something that makes up an open communication
space (p. 149) and “allows not only understanding but also sharing experiences in the environment that most human beings concerns about their own health.” (p. 149). In this regard, Santamaria and Hernández (2015) explained: “Apps have potential benefits, such as improving the quality of care and avoiding medical errors through clinical algorithms, reducing costs, avoiding unnecessary medical consultations, and improving access to health services” (p. 602).

Darvariu et al. (2020) developed MyMood, which was “a smartphone application that allows users to periodically log their emotional state together with pictures from their everyday lives, while passively gathering sensor measurements” (p. 1). Darvariu et al. (2020) conducted an in-the-wild study with 22 participants and collected 3,305 mood reports with photos and found “context-dependent associations between objects surrounding individuals and self-reported emotional state intensities” (p. 1). Finally, as applications of their study, Darvariu et al. (2020) recommended the following: “The applications of this work are potentially many, from the design of interior and outdoor spaces to the development of intelligent applications for positive behavioral intervention, and more generally for supporting computational psychology studies.” (p. 1).

Munoz et al. (2018) developed mPsych, which “is a web-based or browser-based application that can be accessed and is adaptive to mobile devices” and “It uses gamification and contains glossaries and tests for each of the four Philippine psychometrician board exam subjects (Abnormal Psychology, Theories of Personality, Psychological Assessment and Industrial/Organizational Psychology).” (p. 99). Additionally, about mPsych, Munoz et al. (2018) précised:

In Offline Mode, reviewees are presented with a set of randomized test items and choices and receive prompts for scheduled tests. Online Mode lets registered reviewees login, manage their settings and select subjects/exams based on their priority. In addition, online mode allows them to compete with one another. It includes a Reports Section (Leaderboard) highlighting top exam performers. Its mLearning Portal lets them take exams, review glossary terms, check or track scores, and manage Account Settings. (p. 94)

Torous et al. (2014) conducted a study with 100 health patients at the Beth Israel Deaconess Medical Center (mental health clinic in Boston, Massachusetts, USA); as a result, more than 50% of patients in different age groups expressed interest in the daily use of mobile applications to monitor their mental health. Regarding the use of information and communication technologies for the care of mental disorders, Malhotra et al. (2014) indicated:

Mental disorders are highly prevalent and equally disabling in India as in the rest of the world, and as in other low-income countries, most people with mental disorders continue to receive inadequate treatment. Discrepancies exist between resources and need, urban and rural services, and primary, secondary and tertiary care. Telepsychiatry, the use of information and communication technologies to provide or support clinical psychiatric care from a distance, has been proposed as an alternative strategy. (p. 1)

Likewise, Quispe (2015) carried out an experimental research in which he applied a test to assess the patient’s memory with a sample of 18 patients from the Yrpa Tayka old people’s home in the city of La Paz in Bolivia and used the hypermedia object-oriented design method for the development of the HTML 5 web application. Through the application, the participants were able to improve their cognitive capacity and it was recommended to apply Responsive Design so that it can be executed in any device, as well as to design more web applications that help in the detection of cognitive disorder (Quispe, 2015). Regarding the use of smartphone applications for health, Bindhim et al. (2014) explained:

Using smartphone applications as a new way to manage depression screening offers instant feedback and access to screening tools without Internet connectivity, gives users the ability to store and access their data locally, saves time and money, and provides more privacy. In
addition, the proximity of a smartphone to its user makes health-related applications available anytime, anywhere. (p. 29)

Arias and Gonzales (2015) developed a desktop application for evaluations of neuropsychology disciplines in patients between the ages of five and 16, which helped diagnose cognitive and learning problems and concluded that the construction of the system made it possible to manage the clinical data of patients participating in consultations and neuropsychological evaluations in an orderly manner, allowing the visualization of personal and clinical information stored in the database, facilitating the creation of graphic reports that manually take a long time to make. In addition, F. J. Arias and Ruiz (2014) conducted research supported by a web and mobile application to monitor and control the treatment of patients at the Archbishop Loayza National Hospital in the city of Lima, Peru, which contributed to improved treatments and diets and prevented the loss of medical information for patients.

Cortez and Padilla (2015) developed a rule-based web-based expert system containing a set of psychological tests to support the selection process of professional and occupational interests of the fifth grade students of the private educational institution Eliel School. After applying their system to a sample of 25 students, Cortez and Padilla (2015) concluded: (a) the reliability of the expert web system developed was 97.51%; (b) the use of the expert system reduced the level of anxiety generated by the interview with the psychologist, measured through criteria such as: sweat, tremor, and worry; (c) the use of the application reduced “the time of delivery of the clinical diagnosis from 1400 minutes to 25 minutes per revision of the Psychological Test Battery” and in addition, “the expert will be able to know the results of the evaluations immediately and will be able to consult them when the expert deems it convenient”; and (d) the error rate of the clinical diagnosis was reduced from 18% to 0%, due to that before there were errors due to the fatigue of the psychologist when reviewing 25 batteries of continuous tests (p. 92). In addition, Oromendia et al. (2015) mentioned:

Anxiety disorders are among the most common disorders. Panic disorder (PD) is one of the most common anxiety disorders. It affects the quality of life of those who suffer from it and has an important economic cost. Having tools that allow early and rapid detection of PD, referring patients to specialized health services, and preventing the development of the disorder in subclinical populations is crucial. Web-based screening tools can be very advantageous for physicians and researchers because they allow broad geographic coverage, provide access to a large number of users, have very low cost, reduce errors, and save time. They are also advantageous for patients: flexible schedules, less travel, more confidentiality, and less stigmatization. (p. 138)

1.2.3. Used technologies and methodology for the development of the mobile application
The technologies for the development of the mobile application for preliminary diagnosis of anxiety were the following: Android Studio, Java, and SQL Server. The methodology for the development of the mobile application of this study was Mobile-D. About Android, Fuentes et al. (2016) explained: “Android is a software package whose main purpose is to create an open platform available to equipment manufacturers and developers” (p. 85) and “it is primarily designed for touch screen devices, although versions have recently been released for televisions, cars, and smart dressing devices” (p. 85). In this regard, Arias and Ruiz (2014) indicated:

Android allows programming in a working environment (Java framework, applications on a Dalvik virtual machine [a variation of the Java machine with compilation at runtime]). In addition, what differentiates it from other operating systems is that anyone who knows how to program can create new applications, widgets or even modify the operating system itself, due to that Android is open source, so knowing how to program in Java language, it will be very easy to start programming on this platform. (p. 51)

Android is one of the most competitive operating systems on the market and has been accepted not only by the telephone industry but also by the population. Benbourahala (2015) explained: “Android is an OS (Operating System) Open Source designed for mobile phones and developed by
the Open Handset Alliance (OHA) under Google authorization” (p. 13). Android works under Linux and Apache which makes it a free system (Tomas, 2013, p. 21). In addition, the use of agile methods of software development has received both support and opposing arguments. The main argument against it is the lack of validation. Regarding Mobile-D, methodology for the development of mobile applications, Amaya (2013) explained:

This new methodology, proposed by Pekka Abrahamsson and his team VTT (Technical Research Center in Finland) is specifically oriented to mobile applications and is in evolution, in its current stage is called Mobile Development Process Spiral, which is based on Extreme Programming and Crystal. They include test-based development, pair programming, continuous integration and refactoring, as well as software process improvement tasks. Mobile-D must be used by a team of no more than ten developers, working together to deliver a ready product within a maximum of ten weeks. (p. 118)

1.2.4. Anxiety disorder and the Zung questionnaire
With respect to the Zung questionnaire, Benítez and Caballero (2017) explained: “The psychometric instruments used for levels of anxiety and depression were originally designed in English (1965) by Zung and subsequently translated (1971) and applied in studies in Latin America” (p. 222). Among the various pathologies suffered by the mind, Maganto and Maganto (2013) defined anxiety as: “non-specific cognitive response that is more relative to vigilance and that we can define as facilitating or preparing a confrontation response” (p. 155). In addition, Álvarez et al. (2012) explained that anxiety is a type of emotion that all people suffer at some time in front of some situation of great importance showing physical and mental reactions and that it is presented through a combination of feelings, behaviors and/or reactions (p. 338). In this regard, Arévalo (2016) indicated:

Anxiety occurs in any person temporarily or chronically, can produce aggressive reactions that result in increased stress experienced by the patient. Because there are effective therapies for anxiety disorders and several researches are discovering new treatments, these can help the majority of people suffering from anxiety disorders to live productive and full lives. (p. 5)

With respect to anxiety, Céspedes (2015) explained: “Anxiety is a normal emotional reaction necessary for the survival of individuals” (p. 34) and that “anxiety reactions may reach excessively high levels or may be unadaptive in certain situations” (p. 34), which evidences that “in this case the reaction ceases to be normal and becomes pathological” (p. 34). Likewise, Rodríguez and Mesa (2011) considered anxiety as: “a specific or concrete emotion” (p. 35) and explained that “it encompasses basic negative emotions intermingled with fear, anger, disgust, shame, sadness, and guilt” (p. 35).

There are procedures for the treatment of this type of disorder (AD: Anxiety Disorder), as Torres and Chávez (2013) mentioned: “The treatment for these AD can be psychological or pharmacological, because it alters in a neurological and subjective way (fear, diarrhea, insecurity, etc.). It can lead to alterations in the family, work and/or social environment”. (p. 1789). As a result of an evaluation conducted in Chile, Krebs et al. (2012) stated: “Anxiety disorders are one of most prominent reasons for psychological consultations, as a third of the population manifest some type of psychiatric disorder, among the most common are agoraphobia, social phobia, simple phobia, major depressive disorder, and alcohol dependence.” (p. 134).

With respect to the Zung questionnaire, Castellanos et al. (2011) stated: “it is an instrument consisting of twenty points that quantifies anxious, 15 somatic, and 5 cognitive symptoms” (p. 52) and that “this scale presents a Likert type response pattern that is answered” (p. 53). With respect to the Zung test, Hernández-Pozo et al. (2008) explained: “15 reagents are phrased in such a way that if the subject chooses the options that denote greater frequency, the anxiety score will be higher, while five of the reagents, 5, 9, 13, 17, and 19 have an opposite directionality (p. 23). In this regard, Cardona-Arias et al. (2015) explained: “Of the questions, 15 are related to negative aspects
such as: nervousness, fear, headache, nightmares, dizziness and 5 with positive aspects such as: well-being, tranquility, ease of sleeping, and normal breathing” (p. 82).

1.2.5. Color psychology
Vazifehdust et al. (2018) defined color psychology as follows: “Color psychology is a branch of behavior psychology science that studies how the colors affect human behavior.” (p. 31).
Additionally, Casas and Chinoperekwéyi (2019) precised: “Color perception and color psychology affects people's behavior in such a way that the symbolism of the colors resonates with people's perceptions, hence linking it with information from their cultures.” (p. 441).

Cante (2017) mentioned: “Color is loaded with information and is one of the most penetrating visual experiences that we all have in common and therefore it is a valuable source of visual communicators” (p. 52). In addition, Cante (2017) indicated: “the color of both light and pigment behaves uniquely, but our knowledge of color in visual communication goes a little beyond our observations” (p. 52). Additionally, Cante (2017) explained the virtues of colors, as follows: (a) red: courage, perseverance, kindness, and love; (b) orange: purity and holiness; (c) yellow: wisdom, discernment, and good judgment; (d) green: compassion, understanding, benevolence, generosity, and humility; (e) blue: faith and trust; (f) indigo: loyalty and integrity; (g) violet: sacrifice and detachment (p. 52).

According to Quan (2017), colors are one of the aspects that should be considered due to that they influence the mood in proportion. In addition, Quan (2017) indicated that colors are a great influence not only on emotions but also on the state of mind, due to that everyone perceives a physical reaction to a given color, not by its symbolism, which comes from tradition and culture, but by associated psychological reactions, such as: (a) red: stimulating, thus increasing energy, which facilitates blood circulation; (b) yellow: provides vitality and optimism (indicated to improve emotional health, communication and creativity); and (c) blue: is refreshing and relaxing, so it brings peace and tranquility. Regarding colors, N. Arias and Cifuentes (2015) mentioned:

- When speaking of each color it is said that blue is the preferred color by excellence, is a cold and reassuring color, is the most named for sympathy, harmony, friendship, and trust. It is also related to distance and infinity, fidelity, fantasy and divinity. It is associated with the masculine, intelligence, and science. (p. 31)
- Red is the color of passion, it is pleasant for a considerable majority of men and women. The symbolism of red is associated with experience, such as fire and blood. It is a color associated with love as well as hate, joy, closeness, nobility, luxury, and also aggressiveness along with black. Red evokes danger, the forbidden, and immoral. It is quite used in advertising, which overloads the vision of observers and makes this color lose favoritism. (p. 31)
- Yellow is considered a contradictory color because although it is the color of optimism, it is also the color of anger and envy, it is associated with fun, betrayal, sunshine, and light. It is considered the color of envy, jealousy, and lie, is a flashy color and even squeaky, also refers to something old and dirty. Due to that the color is contradictory, this color is also associated with the creative, warning, understanding, and sensual love. (p. 31)

About the sensations and stimuli generated by the colours, Arenas et al. (2015) explained:

- Blue—Truth, freedom, calms emotions, produces peace and sleep, so it is a relaxant for the nervous system. Encourages awareness and reduces irritability. (p. 7)
- Red—Determination, impulsivity, courage, strength, determination, stimulates action. Not recommended when reading. (p. 7)
- Orange—Warmth, enthusiasm, creativity, success, courage. Stimulates communication which helps teamwork and socialization. (p. 7)
2. Method

The problem of the research was that there were not found studies about the impact of the use of a mobile application on the diagnostic precision of anxiety, which makes it difficult to make decisions to apply this technology to improve the sensitivity and specificity of this diagnosis. The overall purpose of the research was to determine the effect of the use of a mobile application in the precision of the diagnosis of anxiety disorder in psychology patients in a hospital. The specific purposes were the following: (a) to determine whether the use of a mobile application improved the sensitivity of the anxiety disorder diagnosis of psychology service patients in a hospital and (b) to determine whether the use of a mobile application improved the specificity of the anxiety disorder diagnosis of psychology service patients in a hospital.

The research was developed in the area of psychology of a hospital in the city of Lima in Peru, which treats hundreds of patients with various mental illnesses. The colors of the application were combined with a blue background to provide the patient with the sensation of calm and freedom (Arenas et al., 2015), as well as relaxation (N. Arias & Cifuentes, 2015). In the hospital where the study was developed, there is a great demand for attention to the patients and little professional staff to attend them. In addition to the wear and tear not only physical but also mental by the daily work of personal interviews, these patients are at risk and/or prone to suffer the effects of a pathology which was not diagnosed in a timely manner.

The patients who participated in this research were selected by the psychologists, due to that they were considered suitable for the application of the test because they had traits that showed some sign of suffering with this disorder. The sampling was carried out for convenience due to that “it allows to select those accessible cases that accept to be included” (Otzen & Manterola, 2017, p. 230) and that “It was based on the convenient accessibility and proximity of the subjects” (Otzen & Manterola, 2017, p. 230). Based on the foregoing, only 23 patients were considered with the following inclusion criteria: (a) elderly patients LOTEP (Lucid, Time, Space and Person Oriented), (b) psychology patients, and (c) patients of both sexes; in addition, the following exclusion criteria were considered: (a) patients with schizophrenia, (b) patients with organic problems (neurological problems), (c) psychotic patients, and (d) illiterate patients.

The instrument used was Zung’s anxiety rating scale, in which multiple responses were used for the questionnaire to obtain a score and measure the patient’s level of anxiety. Zung’s test has been used to evaluate anxiety in Colombia and Peru, as shown in several studies (Arequipeno & Lastra, 2016; Cardona-Arias et al., 2015; Perales et al., 2011). Cardona-Arias et al. (2015) studied the prevalence of anxiety in 200 university students of a university in Colombia with a reliability of 80%, showing 58% with high presence of anxiety and proposed strategies for the health care of people at greatest risk.

Arequipeno and Lastra (2016) studied optimism as a protective factor of anxiety in psychology students at a private university in Tarapoto in Peru, applying the Zung anxiety scale to 137 students with a reliability level of 72% for Cronbach’s Alpha coefficient. In addition, Perales et al. (2011) conducted research aimed at determining the levels of general and occupational stress, depression and anxiety in magistrates (judges and prosecutors) in the judicial district of Lima, capital of Peru, applying a cross-sectional and descriptive study with 287 magistrates who developed a questionnaire composed of four instruments to measure stress, depression and anxiety, with a reliability of 96% through Chi Cuadrado and use of SPSS. Based on the literature reviewed, the hypotheses were the following:
• General Hypothesis:
GH: The implementation of a mobile application increased the sensitivity and specificity of the preliminary diagnosis of the patients’ anxiety disorder.

Bindhim et al. (2014) explained that Smartphone applications have the potential to be valuable self-help interventions and to play a significant role in disease screening, self-management, control and health (p. 29). Bindhim et al. (2014) also indicated that sensitivity and specificity improved both indicators to 0.89. (p. 30)

• Specific hypotheses:
SH1: The implementation of a mobile application increased the sensitivity of the preliminary diagnosis of anxiety disorder.

Oromendia et al. (2015) explained that web-based detection tools for early detection of panic disorder are useful for clinical and research purposes and that the accuracy of WSQ-Panic is acceptable as an Internet detection tool (p. 138), showing a sensitivity of 0.83 and a specificity of 0.74 (p. 138); therefore, it may be useful for physicians to detect people suffering from this disorder. (p. 140)

SH2: The implementation of a mobile application increased the specificity of the preliminary diagnosis of anxiety disorder.

Malhotra et al. (2014) explained that specificity was high for all disorders, positive predictive values were acceptable to high for most disorders, and negative predictive values were consistently high (p. 1). Preliminary results suggested that despite some limitations, the diagnoses generated by the tool had an acceptable level of accuracy and the tool appeared to be feasible to use; therefore, it seemed appropriate to use the online telepsychiatric application, intended for diagnosis, and psychiatric management of childhood disorders. (Malhotra et al., 2014, p. 10)

3. Results
The results of the research have been presented in this section. Table 1 shows the records obtained. The first column shows the number that identifies a patient who participated in the research, the second column shows patients with anxiety traits as indicated by psychologists before the use of the mobile application, and the third column shows patients diagnosed before the mobile application (patients with or without anxiety are shown according to the routine tests used by psychologists); The fourth and last column shows patients diagnosed after the mobile application (those patients who may or may not show traits and coincide with the results obtained before the system or in some cases were patients with anxiety but who were not considered in the studies prior to the mobile application).

Table 2 shows the results of the tests performed by psychologists on 23 people, of which six showed anxiety traits and only two patients were diagnosed positive before the use of the mobile application. There were four patients who despite showing traits, did not have anxiety. Of the 17 that did not show anxiety traits, only one person with a positive diagnosis is shown because the person has it and 16 that agree with a negative diagnosis because they did not show traits nor did they have anxiety. The data obtained showed a sensitivity of 33.3% of people who had anxiety at some of the various levels that can be diagnosed and 94.1% (specificity) for people who did not have anxiety at any level. The calculation of sensitivity and specificity before the use of the mobile application is shown in Table 3.

Table 4 shows the results of the tests performed by psychologists using the mobile application on 23 people; of which six showed anxiety traits, five were patients diagnosed positive with the use of
the mobile application and one patient who despite showing traits had no anxiety. Of the 17 patients who did not show anxiety traits, three people were shown to be positive because they had and 14 people who agreed to be negative because they did not show anxiety traits through the use of the mobile application. In addition, the calculation of sensitivity and specificity after the use of the mobile application is shown in Table 5.

Table 1. Patients diagnosed with anxiety before and after mobile application

| N°  | Patients with anxiety traits | Patients diagnosed prior to mobile application | Patients diagnosed after mobile application |
|-----|------------------------------|-----------------------------------------------|---------------------------------------------|
| 1   | Yes/No (1/0)                 | Yes/No (1/0)                                  | Yes/No (1/0)                                |
| 2   | 1                            | 1                                             | 1                                           |
| 3   | 1                            | 0                                             | 1                                           |
| 4   | 0                            | 0                                             | 0                                           |
| 5   | 1                            | 0                                             | 1                                           |
| 6   | 0                            | 0                                             | 0                                           |
| 7   | 0                            | 0                                             | 0                                           |
| 8   | 0                            | 0                                             | 0                                           |
| 9   | 0                            | 0                                             | 0                                           |
| 10  | 0                            | 0                                             | 0                                           |
| 11  | 0                            | 0                                             | 0                                           |
| 12  | 0                            | 0                                             | 0                                           |
| 13  | 0                            | 0                                             | 0                                           |
| 14  | 0                            | 0                                             | 0                                           |
| 15  | 0                            | 0                                             | 0                                           |
| 16  | 0                            | 0                                             | 0                                           |
| 17  | 0                            | 0                                             | 0                                           |
| 18  | 0                            | 0                                             | 0                                           |
| 19  | 1                            | 0                                             | 0                                           |
| 20  | 0                            | 0                                             | 0                                           |
| 21  | 0                            | 0                                             | 1                                           |
| 22  | 1                            | 0                                             | 1                                           |
| 23  | 0                            | 1                                             | 1                                           |

Table 2. Patients with anxiety before the use of the mobile application

|          | With Anxiety | Without Anxiety | Total |
|----------|--------------|-----------------|-------|
| Positive | 2            | 1               | 3     |
| Negative | 4            | 16              | 20    |
| Total    | 6            | 17              | 23    |

Table 3. Calculation of sensitivity and specificity before the use of the mobile application

Sensitivity: \( \frac{2}{2 + 4} = 33.3\% \)

Specificity: \( \frac{16}{1 + 16} = 94.1\% \)
A sensitivity of 83.3% of people who had anxiety in some of the various levels that can be diagnosed was achieved and a specificity of 82.3% was achieved in the diagnosis of people who did not have anxiety in any level, after the use of the mobile application. Therefore, the results accepted the H1 alternative hypothesis, but rejected the H2 alternative hypothesis and the general hypothesis.

4. Discussion

The results of the evaluation of the first hypothesis revealed a sensitivity after use of the application corresponding to 83.3% being greater than the sensitivity before the use of the application (33.3%), resulting in an improvement of 150.15% over the previous situation. These results are similar to the results found by Oromendia et al. (2015) who obtained a sensitivity of 83% with their web system for the detection of panic disorder. With the mobile application, the patient gives more accurate answers compared to the answers in a printed questionnaire, because in the interface of the application was considered the psychology of color, showing colors that cause peace and tranquility (blue) in the emotional mood of the patient (Quan, 2017). As Cante (2017) mentioned, colors are a powerful source of psychological triggers that help users learn better by changing their perception and evoking feelings.

From the results obtained for the specificity, the use of the mobile application showed a specificity of 82.3%, being lower than the value obtained before the use of the application (94.1%) which shows a decrease of 12.54% in the specificity compared to the initial result. This result is not in line with the previous study by Malhotra et al. (2014), who found greater specificity in their research for all psychiatric disorders with their Telepsychiatry system (p. 1). In their research, Malhotra et al. (2014) used an Internet level application with a random sample to be evaluated by general practitioners; if not, the mobile Intranet level application that was used in this research, as a convenience sampling was used where inclusion and exclusion criteria were considered for the patients who participated; however, Malhotra et al. (2014) included people suffering from schizophrenia, organic disorders, psychosis, substance use, etc. The application used in this study was designed to be manipulated by psychologists and not by non-specialized personnel who do not have the experience and knowledge necessary to diagnose psychiatric illnesses (Malhotra et al., 2014, p. 2).

Van Ballegooijen et al. (2012) carried out an investigation with a web application and a higher sensitivity (81%) and a lower specificity (66%) were obtained for the detection of agoraphobia after its use (p. 1). Van Ballegooijen et al. (2012) proposed criteria for participants to perform the test, excluding people who suffered from panic and risk of suicide (p. 2), showing a lower percentage than the present research, because being web presented problems as incomplete records by the failures at the time of saving them (p. 5), problems that did not occur in this research; among the inclusion criteria, the participants in the detection of agoraphobia went through interviews, had to have an Internet connection and/or have mild panic disorder (p. 2), criteria that were not considered in the present research, due to that this research was carried out at intranet level and

| With Anxiety | Without Anxiety | Total |
|--------------|-----------------|-------|
| Positive     | 5               | 3     | 8    |
| Negative     | 1               | 14    | 15   |
| Total        | 6               | 17    | 23   |

### Table 4. Patients with anxiety after the use of the mobile application

|          | With Anxiety | Without Anxiety | Total |
|----------|--------------|-----------------|-------|
| Sensitivity: \( \frac{5}{1+5} = 83.3\% \)  |
| Specificity: \( \frac{14}{3+14} = 82.3\% \)  |
the patients were not interviewed to be selected and the most important thing was that they did not already have a diagnosed disorder. These circumstances could have caused a greater sensitivity.

Similarly, Gibbons et al. (2012) indicated an increased sensitivity of 92% for the diagnosis of depression disorder by means of an adaptive computerized test and a specificity of 88% (p. 1105), showing greater sensitivity to the research conducted; they applied inclusion and exclusion criteria for the selection of people who took the test, excluding patients diagnosed with psychosis and/or schizophrenia (p. 1106), characteristics that were not considered in the selection of patients for the use of the mobile application of anxiety disorder. Its application was distributed through the Internet in some cases without medical assistance, for later discussion with the treating physician (Gibbons et al., 2012, p. 1110), which would cover a greater number of participants for their specificity, as opposed to the present research due to that it was applied in a hospital through an intranet.

Diamond et al. (2010) obtained a greater specificity of 85% versus 75% sensitivity in their Internet-based behavioral health screen research; through this tool, the various psychiatric behaviors and symptoms were evaluated; similar considerations regarding the traits patients had before the use of the mobile application in the present research, as opposed to the age range, due to that in this research only adults were considered. The Internet-based behavioral health screen was applied to people between the ages of 12 and 21, where patients with symptoms of depression, suicide risk, anxiety, and stress disorder were diagnosed (Diamond et al., 2010).

In the results obtained after the use of the mobile application, the levels of sensitivity and specificity were 83.3% and 82.3% respectively, which were lower than the results shown by Bindhim et al. (2014) who in their investigation of depression over a smartphone obtained 89% for sensitivity and specificity (p. 30). It should be noted that among people who used this application were some people who already had a preliminary diagnosis of the disorder and other people who were prone but undiagnosed (Bindhim et al., 2014, p. 31), similarly to people who participated in this research. They included adolescents, minors (Bindhim et al., 2014, p. 30) which could lead to a greater number in both specificity and sensitivity, due to that the current research was applied to older people. While patients with high scores about depression measurement were advised to go to a physician for treatment (Bindhim et al., 2014, p. 30), the present application of the research was taken by the same psychology professional to receive appropriate treatment.

5. Conclusions
The diagnosis of anxiety through a system on a mobile phone improved the process of preliminary diagnosis of anxiety disorder of patients in the psychology service compared to the previous diagnosis process, showing that there are factors that do not allow a specific preliminary diagnosis in the care given to the patient. Additionally, the mobile application increased the sensitivity, showing a significant increase in the number of patients with a preliminary diagnosis of some type of anxiety disorder, because of the three patients who had initially, the total was raised to eight and the indicated treatments should be given, because being a mental disorder they could bring not only physical, mental, personal problems but also at social level, showing in some way the improvement of the instruments of work that are used in the nosocomial. The mobile application also decreased the specificity, which would demonstrate that there are healthy patients who do not suffer from this mental state (anxiety) and would be taking some inadequate treatment for their state, because they do not have a defined preliminary diagnosis, which usually happens in some cases.

Some recommendations for future researches are the following: (a) to study the results of the mobile application used in this study in other hospitals in various cities and countries and for other diagnoses of psychological disorders; (b) to develop this application in Apple’s mobile operating system iOS, as well as the Android operating system to expand the market and then study the
results of its use; (c) to expand the functionalities of the mobile application used in this study to include the various needs requested by psychologists of health institutions, such as: (i) registration of patients attended; (ii) report system according to CIE-10 attended in each quarter, (iii) manual CIE-10 only for psychology diagnoses, and (iv) digital medical history; and (d) to evaluate the results of the mobile application used in this previous development study with a different mobile programming technology (Rubi, HTML5, IIU, C#, among others) so that they can improve its ease of use and functionality. Finally, it is necessary to study the results of the use of mobile applications not only in the various tests that are taken by psychologists for diagnoses, but also in the treatments that are provided, because there are studies and projects that validate this new instrument with good results for both the psychologist and the patient and would bring a benefit to the great demand for patients that exists and the few staff who attend them.

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