Technology in Psychology: A bibliometric analysis of technology-based interventions in clinical and health psychology.

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Abstract

This study aimed to identify, synthesize, and evaluate the current state of research on the use of technology-based interventions in clinical psychology through 2017 as a recent innovative area of study. It was intended to provide a critical overview of trends in different tools and populations and identify future areas of interest. This paper focuses on studies published in psychological interventions in childhood, adolescents, adults, and geriatric populations using new technologies, including web-based intervention, virtual reality, augmented reality, mobile applications, and robotics, with particular attention to methodology. To achieve this aim, a systematic search was made in the ISI Web of Science for intervention, psychology, and the technological tools previously mentioned. The results of the study show that the use of information and communication technologies in psychology has been an innovative and growing field of study for the last ten years. 743 were included in this study. A growing trend has been observed in publications related to psychology and the use of technologies since 2007. Research topics were focused mainly on interventions on specific problems or disorders such as depression. The largest number of publications were found for the web-based intervention, in randomized clinical trials and applied to adults

Keywords: bibliometric; clinical psychology; health psychology; information and communication technologies; scientometric

Introduction

The use of technologies has caused a change in perspective in many scientific disciplines, among them clinical and health psychology. Indeed, this was suggested by Holmes et al. (1) in *The Lancet Psychiatry Commission*, in which the use of the Information and Communications Technologies (ICT) was presented as an opportunity for progress in psychology. Specifically, in clinical and health psychology ICT can provide innovations to strengthen treatments, allowing the adaptation of psychological therapies in brief, flexible, and worldwide accessible formats (1).

The use of ICT offers psychological interventions some advantages. For example, the use of Virtual Reality (VR) or Augmented Reality (AR) adds value to exposure therapy (2) providing the development of virtual scenarios that safely produce emotional reactions similar to real contexts (3). The use of web-based interventions allows access to treatment for a larger number of patients without having to be in the same place and at any time of the day (4–6). The low accessibility to evidence-based treatments is an important limitation in the field of clinical psychology (7). ICT can also provide new resources or tools to improve assessment and treatment procedures, for example, it can provide information and assessment at the moment and in the real context, that is *Ecological Momentary Assessmen*t (EMA) (8), which is an opportunity to improve the psychometric and ecological validity of psychological instruments of assessment. Besides, because of new mobile devices, ICT make it possible to conduct the intervention in natural contexts, which is *Ecological Momentary Interventions* (EMI) (9), which can facilitate the generalization of the learned skills. However, several disadvantages are found in applying ICT to clinical psychology, for example, it is difficult to certify that the patient is carrying out the intervention, while it is necessary to improve the confidentiality of the data. Likewise, the initial costs for the development of the technology are high, require technical skills and specific devices. It can have different types of dependencies on the patient, and it is easy to find prejudices and rejection by the therapists (10).

The objective of this study is to review and make a bibliometric analysis of the use of ICT in clinical and health psychology, that is, to perform a quantitative analysis of scientific production in this field. To this end, a systematic search of the literature of the main ICT used in psychology was carried out, following the classification of behavioral intervention technologies in a review by Mohr et al. (4): including VR, web-based, serious games, mobile devices, and also robotics (11).

Review of technologies applied to clinical and health psychology

Virtual Reality and Augmented Reality

Virtual Reality (VR) is defined as the use of virtual scenarios in which the participant has the feeling of being immersed in it and interacting with stimuli from the scenario to implement the intervention (5). Regarding psychological interventions, VR in combination with the traditional evidence-based intervention was found to be an effective tool for treating phobias (12), anxiety and depression symptoms (2,13), in patients with schizophrenia (13,14), eating disorders (13,15), among others. Despite this promising data it is important to highlight the importance of the therapeutic content and the technology backing up its efficacy, more than the technology *per se*, that is, the use of ICT for clinical intervention is not the answer to the psychological problem or diagnosis, but it is important to validate the therapeutic content. Augmented Reality (AR), one of the ICTs on the Milgram and Kishino (16) reality-virtual continuum, consists of including virtual elements in a "real world" which can be viewed through a device. Similar to VR, RA has shown positive effects in reducing phobias in a similar way to exposure in vivo (17,18) and with similar effects than VR with anxiety (19). Also, augmented reality can increase the level of motivation and attention in children with autism, improving the perception of emotions (20).

Web-based interventions

Telepsychology or web-based interventions are defined as the administration of health from a distance, whether over the Internet, through a self-applied web page, videoconferencing, etc. (21,22). Online treatments or those applied over the internet for prevention may be effective in reducing risk (23) as well as the prevention and treatment of mental health (24). Specifically, web-based interventions have shown positive effects in the reduction of affective symptoms of anxiety and depression disorders (25), stress symptoms (26), chronic pain (27), or eating disorders (24). As in anxiety, a reduction in symptoms is observed, but they are not maintained in the long term (23,24).

Serious games

An ICT employed in clinical psychology which is especially attractive for children and youth is serious games, educational, preventive, or intervention software, but with specific objectives for psychological treatment or health (28,29). The use of serious games has been related to an improvement in cognitive skills such as memory, problem-solving, and attention tasks. Besides motivational level encourages learning and understanding of content (30,31). For example, the use of serious games has shown benefits in children with Attention Deficit Hyperactivity Disorder (ADHD) (32,33), in anxiety symptoms (34), and symptoms derived from post-traumatic stress disorder (33). Besides, there is a reduction in depressive symptoms in adolescents and promotes social skills in children diagnosed with autism (33).

Mobile's devices

Additionally, the software for psychology has also been developed as cell phone applications (Apps) for implementing psychological interventions, or mHealth. The use of cell phones for health and psychology provides important benefits as mentioned above, such as EMA and EMI (8,9). Mobile devices have some features that can be very useful for clinical practice such as gyroscope, Global Positioning System (GPS), camera, etc. Also, it is easy to connect the smartphone with other devices and senses of biofeedback that allow the

monitoring of psychophysiological aspects such as heart rate (35). A review by Menon, Rajan, and Sarkar (36) found positive effects using Apps to reduce depressive symptoms, improve monitoring in bipolar disorder, reduce anxiety symptomatology, stress and improve coping strategies in anxiety disorders, reduce psychotic symptoms and reduce substance use. Although these positive effects on mental health are found, the support of the mental health professional is a moderator of the effects of the intervention (37).

Robotics

The use of social robots is another of the ICT employed in clinical and health psychology. A social robot is an automated system provided with artificial intelligence with the ability to interact in a social setting (38) which has as its purpose an affective relationship for rehabilitation, learning (39) through these interactions to create a supportive context for general positive skills for a living (40). The intervention supported by a robot can be useful for example, for children with autism spectrum disorder (41). However, human involvement is necessary. Similarly, social robots show improvements in well-being in older adults. This technology can improve the levels of stress, anxiety, quality of life, and loneliness in people with dementia or cognitive impairment (42).

Purpose of the study and research questions

Bibliometrics is commonly used to measure scientific output to understand the development of an area of knowledge and the evolution of publications (43). To our knowledge, no publications are covering this objective and the benefits and advantages of the use of ICT in clinical and health psychology have been pointed out (1). This paper aims to study the body of ITC and interventions in clinical and health psychology literature employing bibliometric procedures, following a similar methodology as previous studies (44,45). For this purpose, the studies found are analyzed based on different research questions. To analyze the evolution of publications from the beginning to the present (RQ1: *How many articles on psychological intervention through ICT have been published in JCR (Journal Citation Reports)*

journals?), to check what type of technology is used according to the age and diagnosis of the

participants (RQ2*: Which technologies are employed the most for psychological intervention?*

Are technologies different depending on the type of population?), the research methods used

(RQ3: *Which journals publish studies about psychological intervention through ICT most*

frequently?), and the areas of knowledge that make use of this tool and which countries

publish on this topic (RQ4: *What research methods are used in studies of psychological*

intervention through ICT? What journals publish these studies by research method? and RQ5:

What are the main countries that publish studies of psychological intervention through ICT?

What other areas of knowledge publish studies using ICT for treatments or interventions?).

Given these objectives, the present study can be useful to update knowledge and observe the

progress of the use of technology in psychology. It can also be a tool for decision-making in the

design of research and publication strategies.

This paper includes journals indexed in the Journal Citation Reports (JCR) as a widely

used indicator of quality. It can be assumed that journals with higher impact factors are the

most prestigious. The quality of papers published has been considered as having high-quality

peer-reviewed publications (46).

Method

Data Sources and search strategy

ISI Web of Science electronic database was searched systematically. There was no time

limit (up to December 2017) in the search strategy, that is, there was no specified start date

for the search. The following search terms were used: "psychol*" AND "intervention" in

combination with "web", "robot", "virtual reality", "app" y "augmented reality", the searching

terms were selected following the classification of Mohr et al. (4). See Appendix A for the

search strategy.

Sample selection

Once obtained the results of the systematic search articles, the PICOS strategy

(Participants, Intervention, Comparison, Outcome, Study design) was used to define the

research question with clear inclusion criteria. This bibliometric paper included studies applied (P) to all types of population (children, adolescents, adults, geriatric population) in the field of clinical and health psychology, including studies for a non-specific population (that is, systematic reviews); (I) who receive an intervention that used technology in at least one of the components, among which is included in the classification of Mohr et al. (4): mobile devices, web-based intervention, virtual reality (including augmented reality), serious games and also robotics, (C) in all comparison conditions (including no comparison), (O) to promote psychological problems, Physical or specific concerns psychological disorder in (S) all design studies. Articles were excluded if the studies are letters to the editor, abstracts of communications, symposia, and book reviews.

The initial search was made by the first author, who identified the studies that met the inclusion criteria of titles and abstracts. Duplicated were eliminated. The studies were analyzed by reviewing the full text, and decisions on the inclusion of the article were made through a discussion.

Data extraction and analysis

The following variables were extracted from the articles including (See Appendix B for more details):

(a) Kind of technology used; based on the procedure section of articles we classified in mobile devices (including cell phones, tablets, etc.), robots, serious games, virtual reality, and web-based interventions. We also included general technologies for studies that are not technology-specific or combine ICT solutions.

(b) Topic or diagnosis to which the publication is directed.

(c) Kind of population: children, youth, young adults (for university students), adults, geriatric, and non-specified.

(d) Research method: studies of validation or development of assessment instruments (assessment); correlational studies, case studies (including case series studies), studies of

software design or development, protocol studies, pilot studies, theory studies, quasi-experimental design, qualitative design, systematic review, and meta-analysis, randomized controlled trials (RCT) and studies of usability or ergonomics.

(e) Year of publication.

(f) Journal of publication.

(g) Country of study, for this, the country of the first author was taken as reference.

(h) Knowledge area in which the study is framed. For this, the department or place of work of the first author was taken as a reference.

As to data analysis, firstly, a descriptive analysis of the frequency and percentage of each variable was done. To analyze statistical differences to the expected frequencies the Chi-square nonparametric test (x^2) was done and adjusted standardized residuals were used for highlighting contribution to chi-square. To explore the power effect of association the Cramer's V was used. A Cramer's V of .1 is considered a small effect, .3 a medium effect, and .5 or larger a large effect (47).SPSS Statistics 21 statistical software was employed.

Results

The first search identified a total of 5173 studies from all the search topics. Specifically, 1342 studies were identified in the search on cell phones, 124 studies on robotics, 237 studies on applications (Apps), 3039 Web studies, 426 studies on virtual reality, and 5 on augmented reality. Of these studies, 773 which met the criteria for inclusion for analysis were finally selected for the study. Two hundred and thirty-six were on mobile devices, 48 on robotics, 116 on Apps, 218 related to the internet (or Web), 153 on virtual reality, and two on augmented reality. After eliminating duplicates, the 743 studies remaining were finally analyzed (Figure 1).
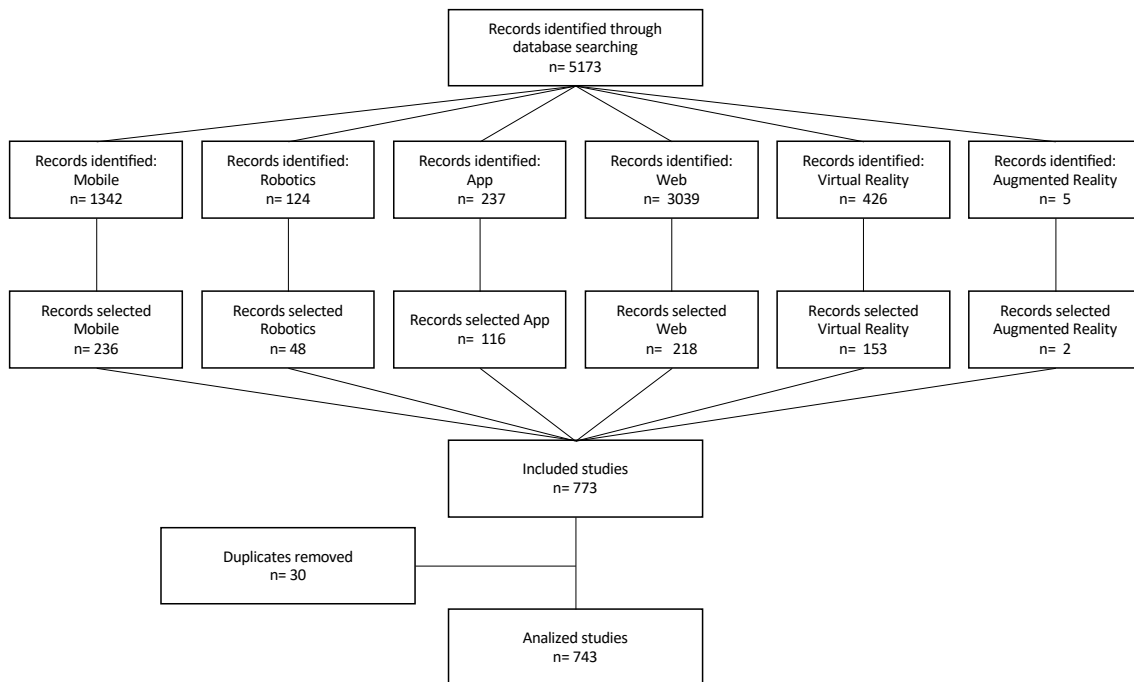
Figure 1. PRISMA Flow Diagram of identified and included studies.

RQ1: How many articles on psychological intervention through ITCs have been published in JCR journals*?*

  The increase in publications on the use of ICT in psychology may be observed in Figure 2. The first study was published in 1988 (48) in a theoretical review of the implications of robotics in occupational psychology. From 2007 on, an upward trend in publications (n=11) is observed. In 2013 (n=91) the greatest increase in publications on this subject matter from previous years is observed. The year with the most publications was 2017 (n=120).

  The first publications on cell phones (n=2) appeared in 2005. One of them was a theoretical review of interventions for obesity using cell phones (49). The other publication, the same year, was a quasi-experimental study in the field of health on parent-child interaction for monitoring glucose in Type 1 Diabetes (50). In 2008, the first article on serious games was published, it was a review of strategies for children and adolescents (51). In 1997, the first study on VR, a review of opportunities for using VR in psychology, was published (52).

Finally, at the end of 2000, an evaluation for professionals on the use of the internet for

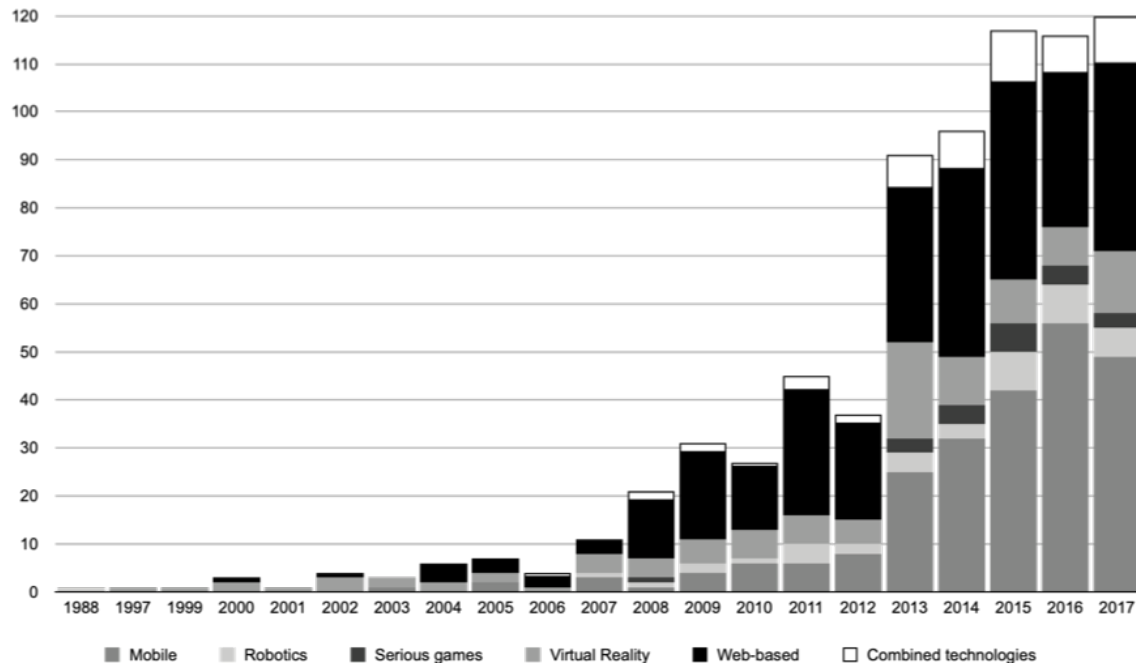psychological consultation was published (53).

Figure 2. Trend of publications on technology-based treatments and psychology.

Table 1 shows the relative frequencies of publications in the last five years.

Publications on the use of cell phones have increased in recent years and have been more

frequent since 2015. In 2017, it was the area with the most scientific production (40.83%).

Publications on the use of web-based or interventions administered over the internet made up

another 32.5% in 2017. The ICT with the fewest publications is serious games with only 2.5%.

The topics of research have also changed over the years. In the beginning, the research

was focused mainly on interventions in phobias or non-clinical samples, while currently, it

focuses on specific problems or disorders such as depression, mental health, or substance

abuse. Similarly, research methods have varied, initially consisting of theoretical articles or

case studies, while currently being systematic reviews, meta-analyses, or RCT.

Table 1. Overview of included studies (N=743)

	MOBILE (n=235)	ROBOT (n=41)	SG (n=21)	TECH (n=55)	VR (n=105)	WEB (n=286)	N (N=743)	%
YEAR (LAST 5 YEARS, n=540) – n (%)								
2013	25 (27.4)	4 (4.4)	3 (3.3)	7 (7.6)	20 (21.9)	32 (35.1)	91	12.2
2014	32 (33.3)	3 (3.1)	4 (4.1)	8 (8.3)	10 (10.4)	39 (40.6)	96	12.9
2015	42 (35.9)	8 (6.8)	6 (5.1)	11 (9.4)	9 (7.6)	41 (35)	117	15.7
2016	56 (48.28)	8 (6.9)	4 (3.4)	8 (6.9)	8 (6.9)	32 (27.5)	116	15.6
2017	49 (40.83)	6 (5)	3 (2.5)	10 (8.3)	13 (10.8)	39 (32.5)	120	16.2
POPULATION								
Children	14	19	6	4	21	12	76	10.22
Young	19	2	0	5	9	32	67	9.01
Young adults	5	0	0	1	1	1	8	1.07
Adult	145	7	8	18	55	187	420	56.5
Geriatric	3	10	3	2	6	10	34	4.6
Non-specified	49	3	4	25	13	44	138	18.57
DISORDER*								
Depression	38	5	5	5	3	72	128	17.2
Substance abuse	39	0	2	3	3	23	70	9.4
Mental health	26	1	0	8	2	21	58	7.8
Eating disorders	25	0	1	4	7	14	51	6.9
TEA	5	16	3	5	10	1	40	5.4
Non-clinical	11	2	3	6	3	14	39	5.2
Pain	5	0	1	2	16	10	34	4.6
PTSD	7	0	0	1	9	17	34	4.6
Cancer	6	1	0	0	6	14	27	3.6
Affective disorders	11	0	0	6	2	6	25	3.4
STUDY DESIGN								
Assessment	15	0	0	2	3	5	25	3.4
Correlational	7	0	0	2	4	5	18	2.4
Case study	7	6	2	2	9	3	29	3.9
Design	18	5	3	2	7	18	53	7.1
Protocol	21	0	0	2	2	30	55	7.4
Pilot study	26	7	1	3	10	23	70	9.4
Theory	15	2	1	4	2	11	35	4.7
Quasi-experimental	29	9	3	1	21	22	85	11.4
Qualitative	7	0	0	1	2	9	19	2.6
Systematic Review /Meta-analysis	35	5	7	32	18	44	141	19
RCT	34	6	2	3	18	99	162	21.8
Usability	21	1	2	1	9	17	51	6.9
COUNTRY*								
USA	64	9	6	15	33	121	248	33.4
UK	26	3	4	15	9	22	79	10.6
Australia	24	6	0	3	13	21	67	9
The Netherlands	23	3	3	2	12	19	62	8.3
Spain	13	1	1	4	6	17	42	5.7
Germany	13	0	0	2	3	19	37	5
Canada	7	4	3	4	5	6	29	3.9
Italy	7	3	0	1	1	8	20	2.7
Sweden	2	1	2	1	4	8	18	2.4
Switzerland	4	0	0	3	0	7	14	1.9
AREA OF KNOWLEDGE								
Psychology	86	11	10	15	35	94	251	33.8
Others	35	9	4	11	17	39	115	15.5
Medicine	31	1	2	9	15	52	110	14.8
Non-specified	29	6	0	3	3	23	64	8.6
Engineering	12	8	0	5	12	21	58	7.8
Psychiatry	11	1	1	8	7	26	54	7.3
Nursing	10	2	3	1	7	11	34	4.6
Rehab / Physiotherapy	16	1	0	1	8	6	32	4.3
Neuroscience	4	1	1	0	1	7	14	1.9
Pediatrics	1	1	0	2	0	7	11	1.5

RQ2. Which technologies are most used for psychological intervention? Are technologies different depending on the type of population?

The ICT employed the most in studies, and therefore, with the largest number of publications, was found to be the use of internet and websites (n=286; 38.5%), followed by the use of cell phones (n=235; 31.6%), virtual reality (n=105; 14.1%), robotics (n=41, 5.5%), and lastly, serious games (n=21; 2.8%). Also, 7.4% of studies were not aimed at a specific technology or were combined ITC (n=55), that is, these were theoretical studies, reviews, or with more than one type of ICT (Figure 3).
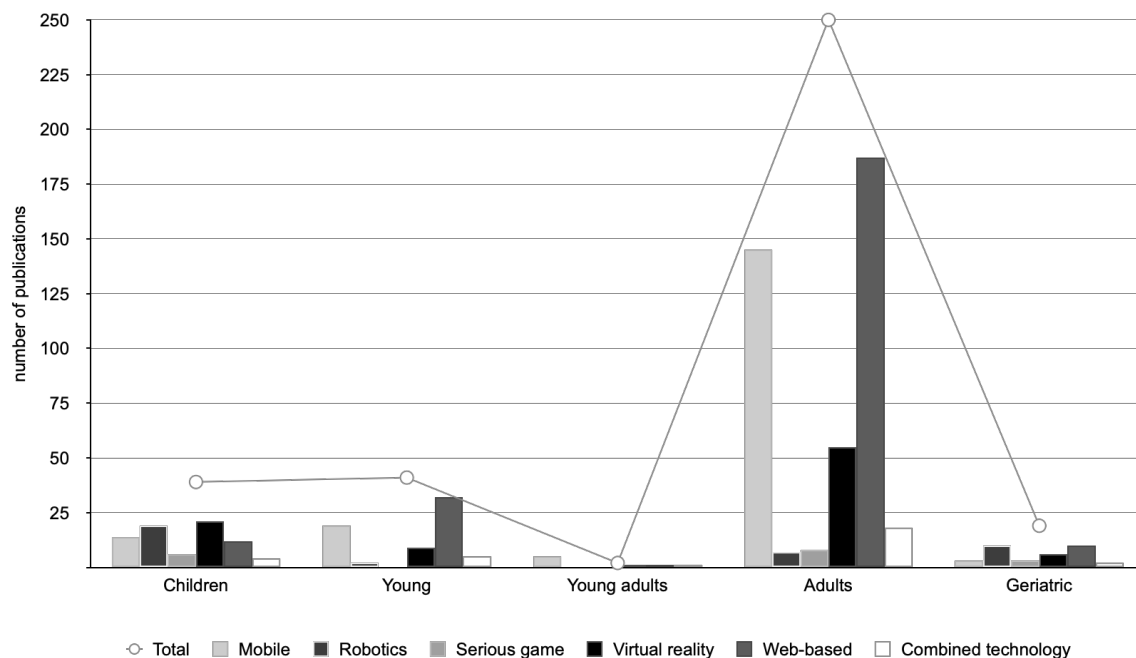

Figure 3. Number of publications by kind of technology.

Concerning the type of population, it was found that the publications have been mainly on adults (n=420; 56.6%), followed by children (n=76; 10.22%), youth (n=67; 9.01%), geriatric (n=34; 4.6%) and youth adults (n=8; 1.07%). There are also many publications that are not directed at any specific type of population (n=138; 18.57%).

Furthermore, most of the publications devoted to the adult population employed web-based strategies to carry out interventions (n=197) followed using cell phones (n=148). For children, most of the publications reported on the use of virtual reality (n=21). For adolescents, web-based interventions (n=32) and mobile devices (n=19) are used the most. For geriatric population, robotics (n=10) and web-based (n=10) intervention are more frequent (see Table 1)

Pearson's x^2 analyses indicated that there was a significant interaction between type of technology and population, (x^2 (30) = 204.25, *p*<.001) in which the power of association was small (*V*=.23). Specifically, studies on mobile devices were more likely for youth adults; studies on robots were more likely for children; studies on serious games were more likely for children; studies on virtual reality were more likely for children, and studies on web-based intervention were more likely for adults.

Concerning the topic of studies, we found 42 topics among the studies, in most of the studies, the objective was intervention in depression (n=128; 17.2%), performed to a greater extent employing the internet (n=72). Substance use (n=70; 9.4%) in which the cell phone was employed most often (39). Finally, for mental health (n=58; 7.8%) the cell phone was used the most (n=26) (See Table 1 the most frequent topics and Figure 4)
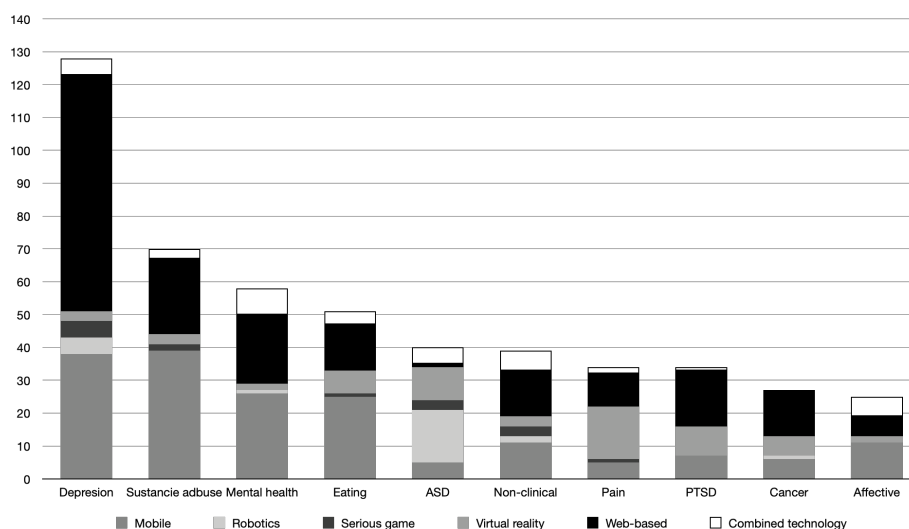

Figure 4. Number of publications by psychological disorder and kind of technology.

Dividing the sample by population type, adults with depression (n=97; 21.4%), substance use (n=48;10.6%), and posttraumatic stress disorder (PTSD) (n=29; 6.4%) were more frequents. In childhood, ICT are used more often in Specific Learning Disorder (SLD) (n=28; 38.4%), depression (n=8; 11%) and Acquired Brain Damage (ABD) (n=6; 8.2%). In adolescents, technologies are more frequent used for promoting mental health (n=12; 17.9%), Substance Abuse (n=12; 17.9%), eating disorders (n=8; 11.9%) and Autism Spectrum Disorder (ASD) (n=8; 11.9%). In geriatric population is used more frequent for dementia (n=15; 44.1%).

Pearson's x^2 analyses indicated that there was a significant interaction between type of technology and topic of study, (x^2 (205) =551.91, *p*<.001) in which the power of association was moderate (*V*=.34). Specifically, studies on mobile devices were more likely for substance abuse, studies on robots were more likely for ASD, studies on serious games were more likely for non-clinical studies; studies on virtual reality were more likely for fear, and studies on web-based interventions were more likely for depression.

RQ3: Which journals publish studies about psychological intervention through ICT most frequently?

There was also variability in the journals which publish studies related to the application of the ICT in psychology. We found 325 different journals that show a certain acceptance in their editorial lines of general journals, that is, most of the publications were not concentrated in only a few specialized journals. It should be emphasized that the *Journal of Medical Internet Research* published 11% (n=82) of the articles in this field, followed by the *BMC Psychiatry* (3.6%; n=27) and *Trials* (2.7%; n=20). Most of the publications in these three journals dealt with web-based treatments (*Journal of Medical Internet Research* (n=54), *BMC Psychiatry* (n=18), and *Trials* (n=9)) (Table 2). These journals are within two first quartiles in JCR.

Table 2. Number of publications by journal (N=325)

	Impact factor 2016	5 year impact factor	MOB	ROB	SG	TEC	VR	WEB	N	%
J Med Internet Res	5.175	5.835	22	0	0	5	1	54	82	11
BMC Psychiatry	2.613	3.119	7	0	0	2	0	18	27	3.6
Trials	1.969	2.203	8	0	0	2	0	9	20	2.7
JMIR Research Protocols	5.175	5.835	4	0	1	1	1	6	13	1.7
J Autism Dev Disord	3.321	4.099	1	5	1	3	2	0	12	1.6
PLOS One	2.806	3.394	3	1	0	1	3	4	12	1.6
BMC Public health	2.265	2.814	4	0	0	0	0	5	9	1.2
Cyberpsychol Behav Soc Netw	2.571	3.866	1	0	2	0	6	0	9	1.2
JMIR Mhealth and Uhealth	4.636	4.463	9	0	0	0	0	0	9	1.2
JMIR Mental Health	5.175	5.835	3	0	0	1	0	4	8	1.1

According to the type of ICT employed in the studies (see in Table 3 the most frequent journals), we found that the *Journal of Medical Internet Research* had the most publications on cell phone technology with 9.4% (n=22), use of technology in general (9.1%; n=5) and use of websites or internet for psychological intervention (18.9%; n=54). Studies using robots were published mostly in the *Journal of Autism and Developmental Disorders* (12.2%; n=5). Publications on serious games (9.5%; n=2) and virtual reality (5.7%; n=6) were published most often in *Cyberpsychology, Behavior, and Social Networking.* Similarly, these journals are also located within the first quartile in JCR.

Table 3. Journals and number of publications by kind of technology

	Impact factor 2016	5 year impact factor	n	%
MOBILE (N=235)				
J Med Internet Res	5.175	5.835	22	9.4
JMIR Mhealth And Uhealth	4.636	4.463	9	3.8
Trials	1.969	2.203	9	3.8
Bmc Psychiatry	2.613	3.119	7	3
ROBOT (N=41)				
J Autism Dev Disord	3.321	4.099	5	12.2
Journal of The American Medical Informatics Association	3.698	3.971	4	9.8
International Journal of Social Robotics	2.559	2.507	3	7.3
IEEE Transactions on Neural Systems and Rehabilitation Engineering	3.410	3.749	2	4.9
SERIOUS GAME (N=21)				
Cyberpsychol Behav Soc Netw	2.571	3.866	2	9.5
Games for Health Journal	2.019	2.242	2	9.5
JMIR Serious Games	5.175	5.835	2	9.5

GENERAL TECHNOLOGIES (N=55)				
J Med Internet Res	5.175	5.835	5	9.1
Behaviour Research and Therapy	4.064	4.750	4	7.3
J Autism Dev Disord	3.321	4.099	3	5.5
Bmc Psychiatry	2.613	3.119	2	3.6
VIRTUAL REALITY (N=105)				
Cyberpsychol Behav Soc Netw	2.571	3.866	6	5.7
Cyberpsychology & Behavior	2.71	2,732	5	4.8
IEEE Transactions on Neural Systems and Rehabilitation Engineering	3.410	3.749	5	4.8
WEB (N=286)				
J Med Internet Res	5.175	5.835	54	18.9
BMC Psychiatry	2.613	3.119	18	6.3
Trials	1.969	2.203	9	3.1
JMIR Research Protocols	5.175	5.835	6	2.1

Note: * 4 more frequent journals are presented

RQ4: What research methods are used in studies of psychological interventions through ICT? What journals publish these studies by research method?

The type of experimental design employed most frequently in the studies was RCT (n=162, 21.8%), systematic reviews and meta-analysis (n=141; 19%) and quasi-experimental studies (n=85; 11.4%).

The type of ICT most employed in the studies was the cell phone in systematic reviews or meta-analysis (n=35;14.9%) and RCT (n=34; 14.5%). The studies employing robots employed quasi-experimental designs (n=9; 22%), pilot tests (n=7; 17.1%) and case studies (n=6; 14.6%) most often. In the use of serious games, systematic reviews and meta-analyses were the most frequent (n=7; 33.3%), followed by design studies (n=3; 14.3%) and quasi-experimental studies (n=3; 14.3%). In virtual reality-based studies, the most frequently used were the quasi-experimental design (n=21; 20%), systematic reviews and meta-analysis (n=18; 17.1%) and RCT (n=18; 17.1%). Finally, RCT (n=99;34.5%), systematic reviews and meta-analysis (n=44; 15.4%) and protocol studies (n=30,10.5%) were used most frequently for study designs that employed the internet and web intervention.

Pearson's x^2 analyses indicated that there was a significant interaction between type of technology and research method, (x^2 (55) =185.325, $p<.001$) in which the power of association was small ($V=.22$). Specifically, studies on mobile devices were significantly more likely for

assessment studies. Studies on robots were significantly more likely for case studies. Studies

on serious games were significantly more likely for systematic reviews and meta-analyses.

Studies on virtual reality were significantly more likely for quasi-experimental design. Studies

on web-based intervention were significantly more likely for RCT.

Figure 5 shows the chronological progress of experimental design, finding that

qualitative and quasi-experimental designs have been used since 2007 onward more than

experimental studies (RCT). In any case, the trend of experimental tests was upward until 2016

when they started to fall off and experimental and quasi-experimental studies and qualitative
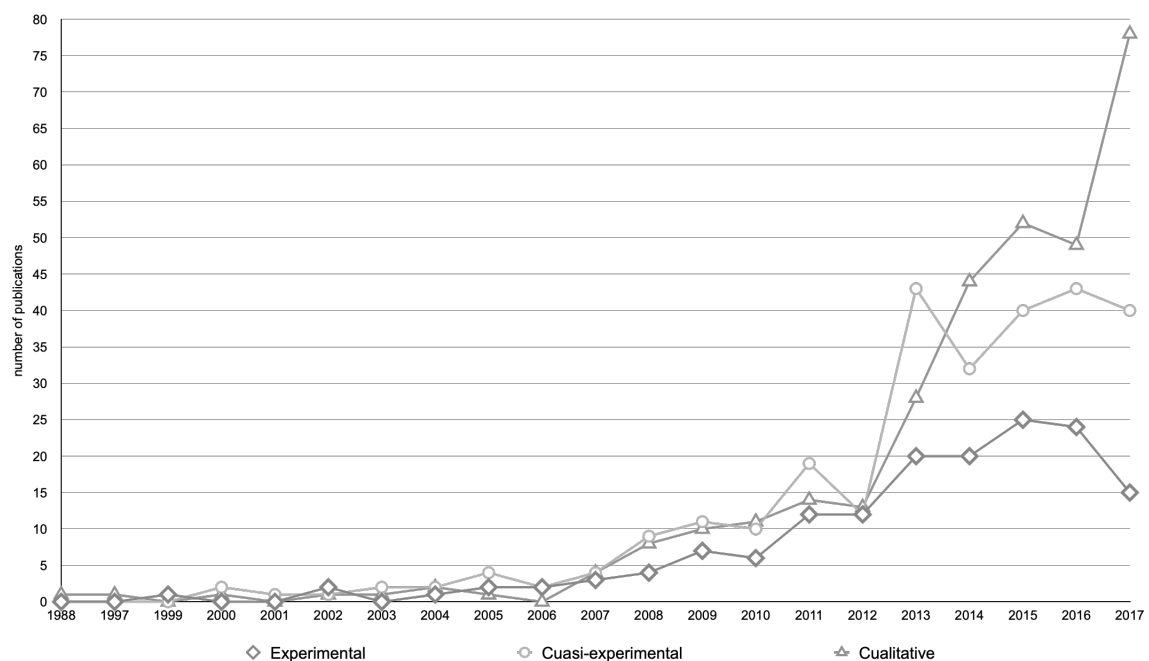
studies rose.

Figure 5. Curve of publications on technology-based treatments based on experimental design.

The experimental designs published most frequently were, by journal, experimental

protocol studies in *Trials* (n=15; 27.3%), ICT design in *IEEE Transactions in Neural Systems and

Rehabilitation Engineering* (n=6; 11.3%), descriptive or correlational designs in *Studies in

Health Technology and Informatics* (n=4; 22.2%), case studies in *Journal of Autism and*

Developmental Disorders (n=3; 10.3%), and theoretical studies in *Annals of Behavioral*

Medicine (n=2; 5.7%). The *Journal of Medical Internet Research* published RCT the most

frequently (n=31; 19.1%), systematic reviews and meta-analyses (n=20; 14.2%), quasi-

experimental studies (n=6; 7.1%), evaluation-related studies (n=5; 20%), qualitative studies

(n=5; 26,3%), usability or accessibility studies (n=5; 9.8%) and pilot tests (n=3; 4.3%).

RQ5: What are the main countries that publish studies of psychological intervention through ICTs? What other areas of knowledge publish studies using ICT for treatments or interventions?

The countries with the most scientific production in the field of clinical psychology and

the ICTs were the USA (n=284; 33.4%), the UK (n=79; 10.6%), Australia (n=67; 9%), the

Netherlands (n=62; 8.3%) and Spain (n=42; 5.7%). The USA was the country with the most

scientific production in all the ICT. We found production in 36 different countries.

The main area of knowledge that this type of publication deals with is psychology

(n=251; 33.8%) followed by medicine (n=110; 14.8%) and engineering (n=58; 7.8%). The types

of ICT employed in psychology to the greatest extent in publications were web-based

interventions (n=94; 37.5%) and cell phones (n=84; 34.3%). Medicine used web-based

interventions (n=52; 47.3%) and cell phones (n=31; 28.2%) the most. In engineering, studies

published used web-based interventions (n=21; 36.2%), cell phones (n=12; 20.7%) and VR

(n=12; 20.7%).

Regarding research method by area of knowledge, the main production in psychology

(N=251) seem to be mainly systematic reviews or meta-analysis (n=56; 22.3%), quasi-

experimental designs (n=47; 18.7%) and RCT (n=32; 12.7%). Medicine (N=110) made most

frequent use of RCT (n=35; 31.8%), systematic reviews or meta-analysis (n=31; 28.2%) and

usability studies (n=14; 12.7%). In engineering (N=58) RCT (n=18; 31%), pilot studies (n=9;

15.5%) and quasi-experimental studies (n=7; 12.1%) were the most frequent.

Pearson's x^2 analyses indicated that there was a significant interaction between type

of technology and area of knowledge, (x^2 (45) =75.749, *p*<.005) in which the power of

association was small (*V*=.14). Specifically, studies on mobile devices were significantly more

likely for physiotherapy; studies on robots were significantly more likely for engineering;

studies on serious games were significantly more likely for nursing; studies on virtual reality

were significantly more likely for physiotherapy and studies on web-based intervention were

significantly more likely for medicine.

Furthermore, by area of knowledge, the journals that published psychology most

frequently were the *Journal of Medical Internet Research* (n=26; 10.4%), *BMC Psychiatry* (n=12;

4.8%) and *Trials* (n=7; 2.8%). The journals that published medicine most frequently were the

Journal of Medical Internet Research (n=20; 18.2%), *BMC Psychiatry* (n=4; 3.6%), *JMIR mHealth*

and uHealth (n=3; 2.7%) and *PLOS One* (n=3; 2.7%). In engineering, they were *Journal of*

Medical Internet Research (n=6; 10.3%) and *BMC Psychiatry* (n=3; 5.2%).

Discussion

This study is a contribution to bibliometric literature in the area of psychology. Its

purpose was to find out exactly what chronological progress has been made in the application

of the ICTs to psychology, the characteristics of the populations, and the impact journals which

are covering publications. The discussions of the results have been structured according to the

research questions outlined in the introduction.

RQ1. Evolution of publications on psychological intervention through ICT.

For the last years, since 2007 a growing trend has been observed in publications

related to psychology and the use of the ICTs, showing the greatest increase in these

publications in 2013 and tending to stabilize in the last three years. Similarly, these changes

are observed in studies on social media in psychology, in which the increase occurs in

2011(54). While publications in psychology in all fields have increased since 2003 (55). It is

therefore a recent area of research in a stage of expansion of knowledge. This is also

observable in the chronological trend of publications by type of research, in which qualitative

studies, that is, theoretical, protocols, or systematic reviews, exceed the number of

experimental (RCT) and quasi-experimental studies (correlational, case studies, usability

studies, or pilot studies). The progressive increase in quantitative and experimental research is

a trend observed in the discipline (56). However, there is also an increase in the publications of

systematic reviews and meta-analysis in psychology (57).

Similarly, changes in the trend of the objectives or topics of the publications are also

observable, at the beginning these are aimed at theoretical revisions directed to non-clinical

population or intervention in phobias (i.e., improving exposure therapy). Currently,

interventions are aimed at specific disorders or problems, for example, depression or

substance abuse. These changes have been generated while technical advances, now ICT is

more affordable, offer greater versatility and the development of software and hardware is

greater. If this trend continues, it may be expected for publications in the coming years to

focus on the use of mobile devices which provide more versatility for implementing

psychological interventions (8,9).

When comparing initial and current publications we found several differences. For

example, the first intervention study using VR consisted of a brief intervention for traumatic

brain injury with non-immerse VR techniques (58). A short time after, immersive VR

techniques began to be used for fear (59) or eating disorders (60). However, technological

development in both hardware and software today is remarkable. Regarding hardware, the

first VR glasses used LCD (Liquid Crystal Display) screens, while nowadays glasses include high-

resolution color micro-displays with sensors (61). In the beginning, studies with mobile devices

made use of mobile phones as a tool to play therapeutic content (video, audio, etc.) (62), but

currently, specific software is being developed for smartphones (Apps) (63). Likewise, the web-

based intervention has also improved; at the beginning, the resources and tools were based on

interactive diagrams or texts (64,65) but nowadays they also include multimedia content and

exercises (66). As for the use of robots and serious games, the changes are mainly focused on

the functionalities that are being developed at the same time as the technical developments.

Nevertheless, one point already mentioned by Freeman et al. (13), is that the efficacy of the

intervention will depend more on the validity of the contents and strategies of the

intervention than on the type of ICT employed.

RQ2. Research by type of technology and sample population.

This bibliometric study has enabled us to find out which ICTs are employed the most

often and what type of population they are mainly used for. The results show that websites,

online, and/or self-applied interventions are used the most. However, publications making use

of mobile devices were published more frequently in the last three years. These results are

consistent with the global production in mHealth publications that shows the largest increase

in 2012 and remains thereafter (67). We hypothesize that in the coming years, mobile devices

will be employed for psychological and health intervention more frequently. Most of the

publications were on intervention in adult populations, and less frequently for children and

adolescents and geriatric, a point which has already been mentioned in previous studies

finding that the use of ICTs in children and youth psychology to be a potential niche for

research (24,68), more so considering how the use of ICTs can motivate this population (31).

The results of this study show significantly different types of technology employed depending

on the population. For adults and youth, the ICTs most used were Web-based interventions

and mobile devices, while for children virtual reality and robotics were used more often.

Of the psychological disorders or illnesses subject to intervention, depression was the

most prevalent disorder, followed by substance abuse and general mental health. Intervention

for depression was mainly implemented on websites. However, for intervention in substance

use, mental health, and eating disorders, mobile devices were used more frequently. VR was used more often for intervention in ASD and pain. The application of robots was concentrated mainly on intervention for ASD.

RQ3. Bibliometric analysis of journals.

Finally, we found many JCR journals publishing studies related to the objective of this study, showing that publications are not concentrated in a series of specialized thematic journals, but are accepted by the editorial lines of journals in general. Although some journals specialize in this scientific area, they make up less than 15% of the total. This result is consistent with the number of journals that publish meta-analysis in psychology. Although there is some variability in the journals that publish studies on this topic, the journals that they publish most frequently are high-impact journals that are located within the first two quartiles.

RQ4. Research methods.

This study has a series of methodological limitations. In the first place, only those studies published in JCR journals were collected, which leaves out all the rest of the published resources. However, this was considered an indication of quality (69,70).
 Nevertheless, future research on this topic should be considered. The importance of evidence-based treatments in psychology is evident (71,72), it is necessary to investigate the processes and therapeutic effectiveness. The use of technologies has not yet been explored as an evidence-based intervention, although guides are beginning to be carried out exploring the value of health care (73).

RQ5. Countries and area of knowledge.

Most of the studies were done in the USA and the UK, which coincides with the number of publications on general psychology (74) and social media studies (54). The areas of

knowledge published most frequently concerning the use of the ICTs was, psychology, followed by medicine and engineering.

This study has a series of methodological limitations. In the first place, only those studies published in JCR journals were collected, which leaves out all the rest of the published resources. However, this was considered an indication of quality (69,70). Nevertheless, future research on this topic should be considered. The importance of evidence-based treatments in psychology is evident (71,72), it is necessary to investigate the processes and therapeutic effectiveness. The use of technologies has not yet been explored as an evidence-based intervention, although guides are beginning to be carried out exploring the value of health care (73).

Conclusions

Most of the initial hypotheses have been confirmed, except in the case of research designs. This study shows that the publications related to the use of ICT and psychology are an innovative field of study which has been growing for the last ten years, is in evolution, and changes with technological advances. This research is being increasingly specific to clinical diagnosis and mainly with adults. Although there is some specific journal to the research topic, we found a wide variety of journals that publish with this topic, all of them are impact journals within the first two quartiles. Most of the studies are RCT, although we find a greater number of qualitative or quasi-experimental studies, so it is necessary to increase the number of studies with experimental design. Finally, the USA was the country with the most scientific production in all the ICTs.

References

1.   Holmes EA, Ghaderi A, Harmer CJ, Ramchandani PG, Cuijpers P, Morrison AP, et al. The

     Lancet Psychiatry Commission on psychological treatments research in tomorrow's

     science. The Lancet Psychiatry [Internet]. 2018 [cited 2018 May 10];5(3):237–86.

     Available from:

     https://www.sciencedirect.com/science/article/pii/S2215036617305138

2.   Carl E, Stein AT, Levihn-Coon A, Pogue JR, Rothbaum B, Emmelkamp P, et al. Virtual

     reality exposure therapy for anxiety and related disorders: A meta-analysis of

     randomized controlled trials. J Anxiety Disord [Internet]. 2019 Jan 1 [cited 2019 Apr

     8];61:27–36. Available from:

     https://www.sciencedirect.com/science/article/pii/S0887618518302469#fig0010

3.   Baños RM, Etchemendy E, Castilla D, García-Palacios A, Quero S, Botella C. Positive

     mood induction procedures for virtual environments designed for elderly people.

     Interact Comput [Internet]. 2012 May 1 [cited 2018 May 14];24(3):131–8. Available

     from: https://academic.oup.com/iwc/article-lookup/doi/10.1016/j.intcom.2012.04.002

4.   Mohr DC, Burns MN, Schueller SM, Clarke G, Klinkman M. Behavioral Intervention

     Technologies: Evidence review and recommendations for future research in mental

     health. Gen Hosp Psychiatry [Internet]. 2013 [cited 2018 May 10];35(4):332–8.

     Available from:

     https://www.sciencedirect.com/science/article/pii/S0163834313000698

5.   Riva G. Virtual reality: an experiential tool for clinical psychology. Br J Guid Counc. 2009

     Aug;37(3):337–45.

6.   Vilardaga R, Bricker J, McDonell M. The promise of mobile technologies and single case

     designs for the study of individuals in their natural environment,. J Context Behav.

     2014;3:148–53.

7.   Kazdin A. Evidence-based treatment research: Advances, limitations, and next steps.

Am Psychol [Internet]. 2011 [cited 2019 Apr 8];66(8):685. Available from:

https://psycnet.apa.org/fulltext/2011-25622-011.html

8.   Shiffman S, Stone A, Hufford M. Ecological momentary assessment. Annu Rev Clin

Psychol. 2008;

9.   Heron KE, Smyth JM. Ecological Momentary Interventions: Incorporating Mobile

Technology Into Psychosocial and Health Behavior Treatments. Br J Health Psychol

[Internet]. 2010;15(Pt 1):1–39. Available from:

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2800172/

10.   Soto-Pérez F, Franco M, Monardes C, Jiménez F. Internet y psicología clínica: revisión de

las ciber-terapias. Rev Psicopatología y Psicol Clínica [Internet]. 2010 Apr 1 [cited 2018

Dec 23];15(1):19–37. Available from:

http://revistas.uned.es/index.php/RPPC/article/view/4082/3936

11.   Rabbitt SM, Kazdin AE, Scassellati B. Integrating socially assistive robotics into mental

healthcare interventions: Applications and recommendations for expanded use. Clin

Psychol Rev [Internet]. 2015 Feb 1 [cited 2019 Apr 8];35:35–46. Available from:

https://www.sciencedirect.com/science/article/pii/S0272735814000993

12.   Botella C, Fernández-Álvarez J, Guillén V, García-Palacios A, Baños R. Recent Progress in

Virtual Reality Exposure Therapy for Phobias: A Systematic Review. Curr Psychiatry Rep

[Internet]. 2017 Jul 24 [cited 2018 May 14];19(7):42. Available from:

http://link.springer.com/10.1007/s11920-017-0788-4

13.   Freeman D, Reeve S, Robinson A, Ehlers A, Clark D, Spanlang B, et al. Virtual reality in

the assessment, understanding, and treatment of mental health disorders. Psychol Med

[Internet]. 2017 Oct 22 [cited 2018 May 14];47(14):2393–400. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/28325167

14.   Rus-Calafell M, Garety P, Sason E, Craig TJK, Valmaggia LR. Virtual reality in the

assessment and treatment of psychosis: a systematic review of its utility, acceptability

and effectiveness. Psychol Med [Internet]. 2018 Feb 24 [cited 2019 Apr 8];48(03):362–91. Available from:

https://www.cambridge.org/core/product/identifier/S0033291717001945/type/journal_article

15.   Clus D, Larsen ME, Lemey C, Berrouiguet S. The Use of Virtual Reality in Patients with Eating Disorders: Systematic Review. J Med Internet Res [Internet]. 2018 Apr 27 [cited 2019 Apr 8];20(4):e157. Available from: http://www.jmir.org/2018/4/e157/

16.   Milgram P, Kishino F. A taxonomy of mixed reality visual displays. IEICE Trans Inf Syst [Internet]. 1994 [cited 2018 May 14];77(12):1321–9. Available from: https://search.ieice.org/bin/summary.php?id=e77-d_12_1321

17.   Suso-Ribera C, Fernández-Álvarez J, García-Palacios A, Hoffman HG, Bretón-López J, Baños RM, et al. Virtual Reality, Augmented Reality, and In Vivo Exposure Therapy: A Preliminary Comparison of Treatment Efficacy in Small Animal Phobia. Cyberpsychology, Behav Soc Netw [Internet]. 2019 Jan 16 [cited 2019 Apr 8];22(1):31–8. Available from: https://www.liebertpub.com/doi/10.1089/cyber.2017.0672

18.   Chicchi Giglioli IA, Pallavicini F, Pedroli E, Serino S, Riva G. Augmented Reality: A Brand New Challenge for the Assessment and Treatment of Psychological Disorders. Comput Math Methods Med [Internet]. 2015 Aug 3 [cited 2019 Apr 8];2015:1–12. Available from: http://www.hindawi.com/journals/cmmm/2015/862942/

19.   Tsai C-F, Yeh S-C, Huang Y, Wu Z, Cui J, Zheng L. The Effect of Augmented Reality and Virtual Reality on Inducing Anxiety for Exposure Therapy: A Comparison Using Heart Rate Variability. J Healthc Eng [Internet]. 2018 Nov 25 [cited 2019 Apr 8];2018:1–8. Available from: https://www.hindawi.com/journals/jhe/2018/6357351/

20.   Chen C-H, Lee I-J, Lin L-Y. Augmented reality-based video-modeling storybook of nonverbal facial cues for children with autism spectrum disorder to improve their perceptions and judgments of facial expressions and emotions. Comput Human Behav

[Internet]. 2016 Feb 1 [cited 2019 Apr 8];55:477–85. Available from:

https://www.sciencedirect.com/science/article/pii/S0747563215301643

21.   Barak A, Klein B, Proudfoot JG. Defining Internet-Supported Therapeutic Interventions.

        Ann Behav Med. 2009 Aug;38(1):4–17.

22.   Hardey M. "E-health": the internet and the transformation of patients into consumers

        and producers of health knowledge. Information, Commun Soc [Internet]. 2001 Oct

        [cited 2018 Jul 26];4(3):388–405. Available from:

        http://www.tandfonline.com/doi/abs/10.1080/713768551

23.   Sánchez-Gutiérrez T, Barbeito S, Calvo A. A Revision of Preventive Web-based

        Psychotherapies in Subjects at Risk of Mental Disorders. Int J Interact Multimed Artif

        Intell [Internet]. 2017 [cited 2018 May 14];4(5):50–4. Available from:

        http://www.ijimai.org/journal/sites/default/files/files/2016/12/ijimai20174_5_9_pdf_1

        4588.pdf

24.   Sander L, Rausch L, Baumeister H. Effectiveness of Internet-Based Interventions for the

        Prevention of Mental Disorders: A Systematic Review and Meta-Analysis. JMIR Ment

        Heal [Internet]. 2016 [cited 2018 May 14];3(3):e38. Available from:

        https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5007382/

25.   Andrews G, Basu A, Cuijpers P, Craske MG, McEvoy P, English CL, et al. Computer

        therapy for the anxiety and depression disorders is effective, acceptable and practical

        health care: An updated meta-analysis. J Anxiety Disord [Internet]. 2018 Apr 1 [cited

        2019 Apr 14];55:70–8. Available from:

        https://www.sciencedirect.com/science/article/pii/S0887618517304474

26.   Heber E, David ;, Ebert D, Lehr D, Cuijpers P, Berking M, et al. The Benefit of Web-and

        Computer-Based Interventions for Stress: A Systematic Review and Meta-Analysis.

        [cited 2019 Apr 14]; Available from: http://www.jmir.org/2017/2/e32/

27.   Vugts MAP, Joosen MCW, van der Geer JE, Zedlitz AMEE, Vrijhoef HJM. The

effectiveness of various computer-based interventions for patients with chronic pain or functional somatic syndromes: A systematic review and meta-analysis. Yang J, editor. PLoS One [Internet]. 2018 May 16 [cited 2019 Apr 14];13(5):e0196467. Available from: https://dx.plos.org/10.1371/journal.pone.0196467

28.   Greitzer FL, Kuchar OA, Huston K. Cognitive Science Implications for Enhancing Training Effectiveness in a Serious Gaming Context. ACM J Educ Resour Comput . 2007;7(10).

29.   Bellotti F, Kapralos B, Lee K, Moreno-Ger P, Berta R. Assessment in and of Serious Games: An Overview. Adv Human-Computer Interact. 2013;2013:1–11.

30.   Connolly TM, Boyle EA, MacArthur E, Hainey T, Boyle JM. A systematic literature review of empirical evidence on computer games and serious games. Comput Educ [Internet]. 2012 Sep 1 [cited 2018 May 17];59(2):661–86. Available from: https://www.sciencedirect.com/science/article/pii/S0360131512000619

31.   Wouters P, van Nimwegen C, van Oostendorp H, van Der Spek ED. A meta-analysis of the cognitive and motivational effects of serious games. J Educ Psychol [Internet]. 2013 [cited 2018 May 24];105(2):249–65. Available from: http://doi.apa.org/getdoi.cfm?doi=10.1037/a0031311

32.   Bul KCM, Doove LL, Franken IHA, Oord S Van der, Kato PM, Maras A. A serious game for children with Attention Deficit Hyperactivity Disorder: Who benefits the most? van Wouwe JP, editor. PLoS One [Internet]. 2018 Mar 15 [cited 2019 Apr 8];13(3):e0193681. Available from: https://dx.plos.org/10.1371/journal.pone.0193681

33.   Lau HM, Smit JH, Fleming TM, Riper H. Serious Games for Mental Health: Are They Accessible, Feasible, and Effective? A Systematic Review and Meta-analysis. Front Psychiatry [Internet]. 2017 Jan 18 [cited 2019 Apr 8];7:209. Available from: http://journal.frontiersin.org/article/10.3389/fpsyt.2016.00209/full

34.   Barnes S, Prescott J. Empirical Evidence for the Outcomes of Therapeutic Video Games for Adolescents With Anxiety Disorders: Systematic Review. JMIR serious games

[Internet]. 2018 Feb 28 [cited 2019 Apr 8];6(1):e3. Available from:

http://games.jmir.org/2018/1/e3/

35.   Luxton DD, McCann RA, Bush NE, Mishkind MC, Reger GM. mHealth for mental health:

Integrating smartphone technology in behavioral healthcare. Prof Psychol Res Pract

[Internet]. 2011 Dec [cited 2019 Apr 8];42(6):505–12. Available from:

http://doi.apa.org/getdoi.cfm?doi=10.1037/a0024485

36.   Menon V, Rajan T, Sarkar S. Psychotherapeutic applications of mobile phone-based

technologies: A systematic review of current research and trends. Indian J Psychol Med

[Internet]. 2017 [cited 2018 May 17];39(1):4. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/28250552

37.   Versluis A, Verkuil B, Spinhoven P, van der Ploeg MM, Brosschot JF. Changing Mental

Health and Positive Psychological Well-Being Using Ecological Momentary

Interventions: A Systematic Review and Meta-analysis. J Med Internet Res [Internet].

2016 Jun 27 [cited 2019 Apr 8];18(6):e152. Available from:

http://www.jmir.org/2016/6/e152/

38.   Bartneck C, Forlizzi J. A design-centred framework for social human-robot interaction.

In: 13th IEEE International Workshop on Robot and Human Interactive Communication

[Internet]. 2004 [cited 2018 May 17]. p. 591–4. Available from:

http://ieeexplore.ieee.org/abstract/document/1374827/

39.   Feil-Seifer DJ, Matarić MJ. Defining Socially Assistive Robotics. In: Conference on

Rehabilitation Robotics [Internet]. 2005 [cited 2018 May 17]. p. 465–8. Available from:

http://ieeexplore.ieee.org/abstract/document/1501143/

40.   Libin A V., Libin E V. Person-robot interactions from the robopsychologists' point of

view: The robotic psychology and robotherapy approach. In: Proceedings of the IEEE

[Internet]. 2004 [cited 2018 May 17]. p. 1789–803. Available from:

http://ieeexplore.ieee.org/document/1347459/

41. Costescu CA, Vanderborght B, David DO. The effects of robot-enhanced psychotherapy: A meta-analysis. Rev Gen Psychol [Internet]. 2014 [cited 2018 May 17];18(2):127–36. Available from: https://asknao.aldebaran.com/sites/default/files/publications/review_of_general_psychology_costescu_1.pdf

42. Pu L, Moyle W, Jones C, Todorovic M. The Effectiveness of Social Robots for Older Adults: A Systematic Review and Meta-Analysis of Randomized Controlled Studies. Gerontologist [Internet]. 2019 Jan 9 [cited 2019 Apr 9];59(1):e37–51. Available from: https://academic.oup.com/gerontologist/article/59/1/e37/5036100

43. Raban DR, Gordon A, Geifman D. THE INFORMATION SOCIETY. Information, Commun Soc [Internet]. 2011 Apr [cited 2018 Jul 26];14(3):375–99. Available from: http://www.tandfonline.com/doi/abs/10.1080/1369118X.2010.542824

44. Sáez-Martín A, López-Hernandez AM, Caba-Perez C. Access to public information: a scientometric study of legal versus voluntary transparency in the public sector. Scientometrics [Internet]. 2017 [cited 2018 Jul 16];113(3):1697–720. Available from: https://link--springer--com.ual.debiblio.com/content/pdf/10.1007%2Fs11192-017-2541-5.pdf

45. Whipple EC, Dixon BE, McGowan JJ. Linking health information technology to patient safety and quality outcomes: A bibliometric analysis and review [Internet]. Vol. 38, Informatics for Health and Social Care. 2013 [cited 2018 Sep 20]. p. 1–14. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22657387

46. Bordons M, Fernández MT, Gómez I. Advantages and limitations in the use of impact factor measures for the assessment of research performance in a peripheral country. Scientometrics [Internet]. 2002 [cited 2018 Dec 20];53(2):195–206. Available from: https://link.springer.com/content/pdf/10.1023%2FA%3A1014800407876.pdf

47. Cohen J. Statistical power analysis for the behavioral sciences [Internet]. 1988.

Available from: https://content.taylorfrancis.com/books/download?dac=C2010-0-30830-5&isbn=9781134742707&format=googlePreviewPdf

48.   Shenkar O. Robotics: A challenge for occupational psychology*. J Occup Psychol [Internet]. 1988 Mar 1 [cited 2018 Apr 20];61(1):103–12. Available from: http://doi.wiley.com/10.1111/j.2044-8325.1988.tb00275.x

49.   Tufano JT, Karras BT. Mobile eHealth Interventions for Obesity: A Timely Opportunity to Leverage Convergence Trends. J Med Internet Res [Internet]. 2005 Dec 20 [cited 2018 Apr 20];7(5):e58. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16403722

50.   Gammon D, Årsand E, Walseth OA, Andersson N, Jenssen M, Taylor T. Parent-Child Interaction Using a Mobile and Wireless System for Blood Glucose Monitoring. J Med Internet Res [Internet]. 2005 Nov 21 [cited 2018 Apr 20];7(5):e57. Available from: http://www.ncbi.nlm.nih.gov/pubmed/16403721

51.   Goh DH, Ang RP, Chern Tan H. Strategies for designing effective psychotherapeutic gaming interventions for children and adolescents Computers in Human Behavior. Comput Human Behav [Internet]. 2008 [cited 2018 Apr 20];24:2217–35. Available from: www.sciencedirect.com

52.   Glantz K, Durlach NI, Barnett RC, Aviles WA. Virtual Reality (VR) and Psychotherapy: Opportunities and Challenges. Presence Teleoperators Virtual Environ [Internet]. 1997 Feb 13 [cited 2018 Apr 20];6(1):87–105. Available from: http://www.mitpressjournals.org/doi/10.1162/pres.1997.6.1.87

53.   Maheu MM, Gordon BL. Counseling and therapy on the Internet. Prof Psychol Res Pract [Internet]. 2000 [cited 2018 Apr 20];31(5):484–9. Available from: http://doi.apa.org/getdoi.cfm?doi=10.1037/0735-7028.31.5.484

54.   Zyoud SH, Sweileh WM, Awang R, Al-Jabi SW. Global trends in research related to social media in psychology: mapping and bibliometric analysis. Int J Ment Health Syst [Internet]. 2018 Dec 19 [cited 2019 Apr 9];12(1):4. Available from:

https://ijmhs.biomedcentral.com/articles/10.1186/s13033-018-0182-6

55.   van Leeuwen T. Publication trends in social psychology journals: A long-term

       bibliometric analysis. Eur J Soc Psychol [Internet]. 2013 Feb 1 [cited 2019 Apr

       9];43(1):9–11. Available from: http://doi.wiley.com/10.1002/ejsp.1933

56.   Kliegl R, Bates D. International collaboration in psychology is on the rise. Scientometrics

       [Internet]. 2011 [cited 2019 Apr 9];87(1):149–58. Available from:

       https://link.springer.com/content/pdf/10.1007%2Fs11192-010-0299-0.pdf

57.   Guilera G, Barrios M, Gómez-Benito J. Meta-analysis in psychology: a bibliometric

       study. Scientometrics [Internet]. 2013 Mar 8 [cited 2019 Apr 9];94(3):943–54. Available

       from: http://link.springer.com/10.1007/s11192-012-0761-2

58.   Grealy M, Johnson D, and SR-A of physical medicine, 1999 undefined. Improving

       cognitive function after brain injury: the use of exercise and virtual reality. Elsevier

       [Internet]. [cited 2018 Dec 23]; Available from:

       https://www.sciencedirect.com/science/article/pii/S0003999399901697

59.   Botella C, Baños R, Villa H, … CP-B, 2000 undefined. Virtual reality in the treatment of

       claustrophobic fear: A controlled, multiple-baseline design. academia.edu [Internet].

       [cited 2018 Dec 23]; Available from:

       http://www.academia.edu/download/45675865/Virtual_reality_in_the_treatment_of_

       clau20160516-2604-gjpiy1.pdf

60.   Riva G, Bacchetta M, Baruffi M, Cirillo G, Molinari E. Virtual Reality Environment for

       Body Image Modification: A Multidimensional Therapy for the Treatment of Body

       Image in Obesity and Related Pathologies. CyberPsychology Behav [Internet]. 2000 Jun

       [cited 2018 Dec 23];3(3):421–31. Available from:

       http://www.liebertpub.com/doi/10.1089/10949310050078887

61.   Kampmann IL, Emmelkamp PMG, Hartanto D, Brinkman W-P, Zijlstra JH, Morina N.

       Exposure to virtual social interactions in the treatment of social anxiety disorder: A

randomized controlled trial. 2015 [cited 2018 Dec 23]; Available from:

http://dx.doi.org/10.1016/j.brat.2015.12.016

62.   Grassi A, Gaggioli A, Riva G. The Green Valley: The Use of Mobile Narratives for

Reducing Stress in Commuters. CyberPsychology Behav [Internet]. 2009 Apr [cited 2018

Dec 23];12(2):155–61. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/19275475

63.   Kuhn E, Kanuri N, Hoffman JE, Garvert DW, Ruzek JI, Taylor CB. A randomized controlled

trial of a smartphone app for posttraumatic stress disorder symptoms. J Consult Clin

Psychol [Internet]. 2017 Mar [cited 2018 Dec 23];85(3):267–73. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/28221061

64.   Griffiths KM, Christensen H, Jorm AF, Evans K, Groves C. Effect of web-based depression

literacy and cognitive–behavioural therapy interventions on stigmatising attitudes to

depression. Br J Psychiatry [Internet]. 2004 Oct 2 [cited 2018 Dec 23];185(04):342–9.

Available from: http://www.ncbi.nlm.nih.gov/pubmed/15458995

65.   Christensen H, Griffiths KM, Korten A. Web-based Cognitive Behavior Therapy: Analysis

of Site Usage and Changes in Depression and Anxiety Scores. J Med Internet Res

[Internet]. 2002 Feb 15 [cited 2018 Dec 23];4(1):e3. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/11956035

66.   Beiwinkel T, Eißing T, Telle N-T, Siegmund-Schultze E, Rössler W. Effectiveness of a

Web-Based Intervention in Reducing Depression and Sickness Absence: Randomized

Controlled Trial. J Med Internet Res [Internet]. 2017 [cited 2018 Dec 23];19(6):e213.

Available from: http://www.ncbi.nlm.nih.gov/pubmed/28619701

67.   Sweileh WM, Al-Jabi SW, AbuTaha AS, Zyoud SH, Anayah FMA, Sawalha AF. Bibliometric

analysis of worldwide scientific literature in mobile - health: 2006-2016. BMC Med

Inform Decis Mak [Internet]. 2017 [cited 2019 Apr 9];17(1):72. Available from:

http://www.ncbi.nlm.nih.gov/pubmed/28558687

68. Ebert DD, Cuijpers P, Muñoz RF, Baumeister H. Prevention of Mental Health Disorders Using Internet- and Mobile-Based Interventions: A Narrative Review and Recommendations for Future Research. Front Psychiatry [Internet]. 2017 Aug 10 [cited 2018 May 17];8:116. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28848454

69. Bordons M, Fernández MT, Gómez I. Advantages and limitations in the use of impact factor measures for the assessment of research performance. Scientometrics [Internet]. 2002 [cited 2018 May 22];53(2):195–206. Available from: http://link.springer.com/10.1023/A:1014800407876

70. Lluch JO. Some considerations on the use of the impact factor of scientific journals as a tool to evaluate research in psychology. Scientometrics [Internet]. 2005 [cited 2018 Jul 16];65(2):189–97. Available from: https://link--springer--com.ual.debiblio.com/content/pdf/10.1007%2Fs11192-005-0267-2.pdf

71. Moriana JA, Gálvez-Lara M, Corpas J. Psychological treatments for mental disorders in adults: A review of the evidence of leading international organizations. Clin Psychol Rev [Internet]. 2017 Jun [cited 2019 Apr 9];54:29–43. Available from: http://www.ncbi.nlm.nih.gov/pubmed/28384513

72. Moriana J, Martínez V. La psicología basada en la evidencia y el diseño y evaluación de tratamientos psicológicos eficaces. Rev psicopatología y Psicol [Internet]. 2011 [cited 2019 Apr 9];16(2):81–100. Available from: http://e-spacio.uned.es/revistasuned/index.php/RPPC/article/view/10353

73. NICE. Evidence standards framework for digital health technologies [Internet]. The Grants Register 2019. 2019 [cited 2019 Apr 9]. Available from: https://www.nice.org.uk/Media/Default/About/what-we-do/our-programmes/evidence-standards-framework/functional-classification-case-studies.pdf

74. Navarrete-Cortes, Fernández-López, López-Baena, Quevedo-Blasco, Buela-Casal. La psicología a nivel mundial: Un análisis bibliométrico de las publicaciones en la Web of

Science. Univ Psychol [Internet]. 2010 [cited 2018 May 22];9(2):553–67. Available from:

http://www.scielo.org.co/pdf/rups/v9n2/v9n2a21.pdf

Conflict of Interest

All authors declare that they have no conflicts of interest.

Appendix A. Search string

Theme: (psychol*) AND Theme: (intervention) AND Theme: (app)

Theme: (psychol*) AND Theme: (intervention) AND Theme: (augmented reality) Theme:

(psychol*) AND Theme: (intervention) AND Theme: (robot*)

Theme: (psychol*) AND Theme: (intervention) AND Theme: (virtual reality) Theme: (psychol*)

AND Theme: (intervention) AND Theme: (mobile)

Theme: (psychol*) AND Theme: (intervention) AND Theme: (web)

APPENDIX B. Data extraction

VARIABLE	CATEGORIES	DESCRIPTION	CODE
Kind of technology	Mobile	If the article used procedures that involved the use of mobile phones, tablets or other mobile devices in at least one of its components.	M
	Robots	If the intervention or treatment includes the use of social robots in at least one of its components.	R
	Serious games	If the intervention or treatment is done through software in a serious game format, that is, games with specific objectives for psychological treatment or health in at least one of its components.	SG
	Virtual reality	If the intervention includes the use of virtual reality/augmented reality in at least one of its components in at least one of its components.	VR
	Web-based interventions	Interventions applied through the internet in at least one of its components in at least one of its components.	W
	Technology	Studies that are not one technology specific or combine ITC solutions.	T
Topic	Topic/Diagnosis	The topic of the study was indicated. In case of being oriented to a specific psychological disorder or illness, it was codified. The topic of the study was also codified if he objective was improving well-being, assessment, aspects of work or neuropsychological, etc., that is, without psychological disorder or illness. In case of not being oriented to a specific problem or to a non-clinical sample, it was specified. This data was extracted from the participant section or the study objective.	-
Population	Children	If in the participants section an average age =<16 was indicated	C
	Youth	If in the participants section an average age between 17 and 20 was indicated	Y
	Young adults	If in the participants section an average age between 21 and 30 was indicated	YA
	Adults	If in the participants section an average age >30 was indicated	A
	Geriatric	If in the participants section an average age >65 was indicated	GER
	Non-specified	It was classified in this code if the participants' section does not indicate the average age or are studies in which they do not employ participants (for example, theoretical articles or systematic reviews)	NO/GEN
Research method	Assessment	It was classified in this code if the objective of the study was to validate an evaluation procedure through ICT	ASSESS

	Correlational studies	It was classified in this code if the objective of the study is to explore the relationships between two or more variables, or in which the independent variable cannot be manipulated, that is, ex post facto studies	CORR
	Studies of software design or development	It was classified in this code if the objective of the study is to describe the development of the shoftware	D
	Protocol studies	It was classified in this code if the objective of the study is to describe the study design or protocol	P
	Pilot studies	It was classified in this code if the objective of the study is to assess the reliability of the intervention in a pilot study. It was classified in this category if indicated in the title of the article or in experimental design section	PI
	Theory studies	It was classified in this code if the study does not present quantitative data, that is, if a theoretical contribution or critical analysis is made	T
	Quasi-experimental design	It was classified in this code if the objective of the study is to assess an intervention using a pre-post design but it is not possible to randomize the sample or have a control group	Q
	Qualitative desig	It was classified in this code if the study does not present quantitative data, if it is an observational study or in the title of the study either in the design section has been classified as a qualitative design.	QUA
	Systematic review and meta-analysis	It was classified in this code if the objective of the study is to perform a systematic review of the literature or a meta-analysis.	R
	Randomized controlled trials (RCT)	It was classified in this code if the objective of the study is to assess an intervention using a pre-post design with randomization.	RCT
	Studies of usability or ergonomics	It was classified in this code if the objective of the study was to analyze the usability or accessibility of the technology.	U
Year	Year of publication	It was extracted from the year of study publication	-
Journal	journal of publication	It was extracted from the journal in which the study was published	-
Country	County	It was extracted from the county of the first author	-
Area of Knowledge	Area of Knowledge	It was extractor from the department or place of work of the first author	-