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Review

Use of digital technologies in public health: a narrative review

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Abstract. *Background and aim:* Websites, social media networks and mobile applications constitute important communication tools, while simultaneously enabling the population to increase their knowledge of health issues. This study aims to describe digital health experiences in Public Health to examine the different possible uses of digital technologies by Public Health Operators (PHOs) and Health Care Workers (HCWs) and the role these tools play in the efficiency of the health interventions undertaken. *Methods:* A narrative literature survey was conducted by consulting the PubMed and Scopus databases to find articles relevant to the topic of interest. The selection criteria adopted for manuscript screening involved including the survey studies dealing with the use of digital means such as new media in Public Health, published between 1 January 2012 and 31 May 2021. *Results:* Based on the keywords, 2,019 manuscripts were identified, of which 45 were included. The articles were grouped according to the digital tool (social media network, mobile application and websites) employed by PHOs and/or HCWs in health promotion initiatives. Specifically, this was broken down into: i) the use of social media in public health: 24 articles, ii) the use of mobile applications: 10 articles, iii) the use of websites: 8 articles and iv) the use of the three digital tools combined: 3 articles. *Conclusions:* The results of this study indicate that digital technologies may play a useful role in Public Health to improve communication between health professionals and patients, provide quality care even remotely and facilitate the achievement of health outcomes for the population from a Health Literacy perspective. (www.actabiomedica.it)

Key words: Digital Technologies, digital health, health literacy, self-management education

1. Introduction

Digital health (e-health) applies digital technologies to implement the healthcare system, improving the efficiency of service delivery, streamlining communication between healthcare institutions and citizens, simplifying booking systems and ensuring the quality of healthcare (1-5).

The current COVID-19 pandemic has greatly accelerated the digital transformation of the healthcare sector. Examples include advanced technologies related to artificial intelligence, telemedicine, electronic referral and online consultation systems, cloud computing or IoT (Internet of Things), and systems for monitoring and measuring lifestyle behavior (e.g. remote monitoring of physical activity and proper nutrition, digital education) (6-10).

The availability of communication media also increased significantly in recent years and the proliferation social networks, online content-sharing platforms, forums and blogs modified the way how people express themselves, and share information (11-14).

Nowadays, 5.44 billions of people own a mobile phone and 5.16 billion are regularly connected to Internet, and so, social media are common used by half of the world's population (4.76 billion users) (15). The easy access to the web allowed the mankind to participate in debates on several key topics (i.e. health issues), that in the past, were reserved only to experts and institutions (16-18). In particular, digital technologies addressed the increasing information needs of the population, that tried to manage its own health, using online information.

Starting from these premises, several Public Health workers planned to investigate the potential use of digital tools, evaluating their capabilities to health education and health promotion initiatives (19-24).

Several digital tools are able to assure an interaction between general population and the health system; thus, constituting a valid ally (14,25-68). In this regard, literature evidences describe how the use of the web and the social web is a successful strategy in the analysis of the different behaviors of the population (1,5-11,14,17,24).

Moreover, an increased interest raised in the use of mobile health applications that may support the decision-making and clinical processes of health professional workers (1). According to the latest "mHealth Economics of Research 2 Guidance" report, over 300,000 apps have been developed worldwide in the last decade, of which those related to exercise and weight loss are the most commonly used (2,3).

Based on these premises, this narrative review was designed and carried out with the aim to describe the comprehensive evidence in the literature about digital health tools. As ancillary aim the in order to examine the different option uses of social media, apps and websites by Health Care Workers (HCWs) and Public Health operators will be assessed and evaluated.

2. Materials and methods

2.1. Search strategy

The study was designed as a narrative non-systematic review of the literature, which was carried out to retrieve scientific evidence regarding e-health experiences using digital tools in Public Health. The review was carried out consistently with the methodological process proposed by Arksey and O'Malley (69). The methodological procedure adopted included the following steps: defining the research question, identifying relevant studies, selecting studies, collecting data, and summarising and reporting results.

A preliminary search was performed on PubMed and Scopus. Each database was searched according to its specific syntax rules. In particular, the review adopted a search strategy based on a set of keywords consistent to the main topic investigated and the research question. Therefore, studies were selected using the following keywords alone or in combination: "new media", "health care", "health communication"and "public health".

2.2. Selection process

For the purpose of identifying articles relevant to the research question, the following inclusion criteria were applied: i) studies aimed at or performed by PHOs and/or HCWs and addressed to the general population/patients, ii) implementation of health-related websites and mobile applications, iii) use of social media PHOs and/or institutions for health communication experiences and remote support. Additionally, the following exclusion criteria were applied during the selection process: i) only open-access; ii) articles written in English; iii) articles published prior to May 2022.

Thereafter, duplicates were removed, and the titles and abstracts of search results were independently examined by two reviewers (AA and MD) to establish their relevance and determine whether they met the planned inclusion criteria.

The same two authors proceeded to examine the full texts of the selected studies, establishing which ones actually met the inclusion criteria and should be included in the review. Disagreements regarding inclusion/exclusion of a study were discussed at each stage of selection until consensus was reached. In case of permanent disagreement, the decision was made by a third reviewer (PC).

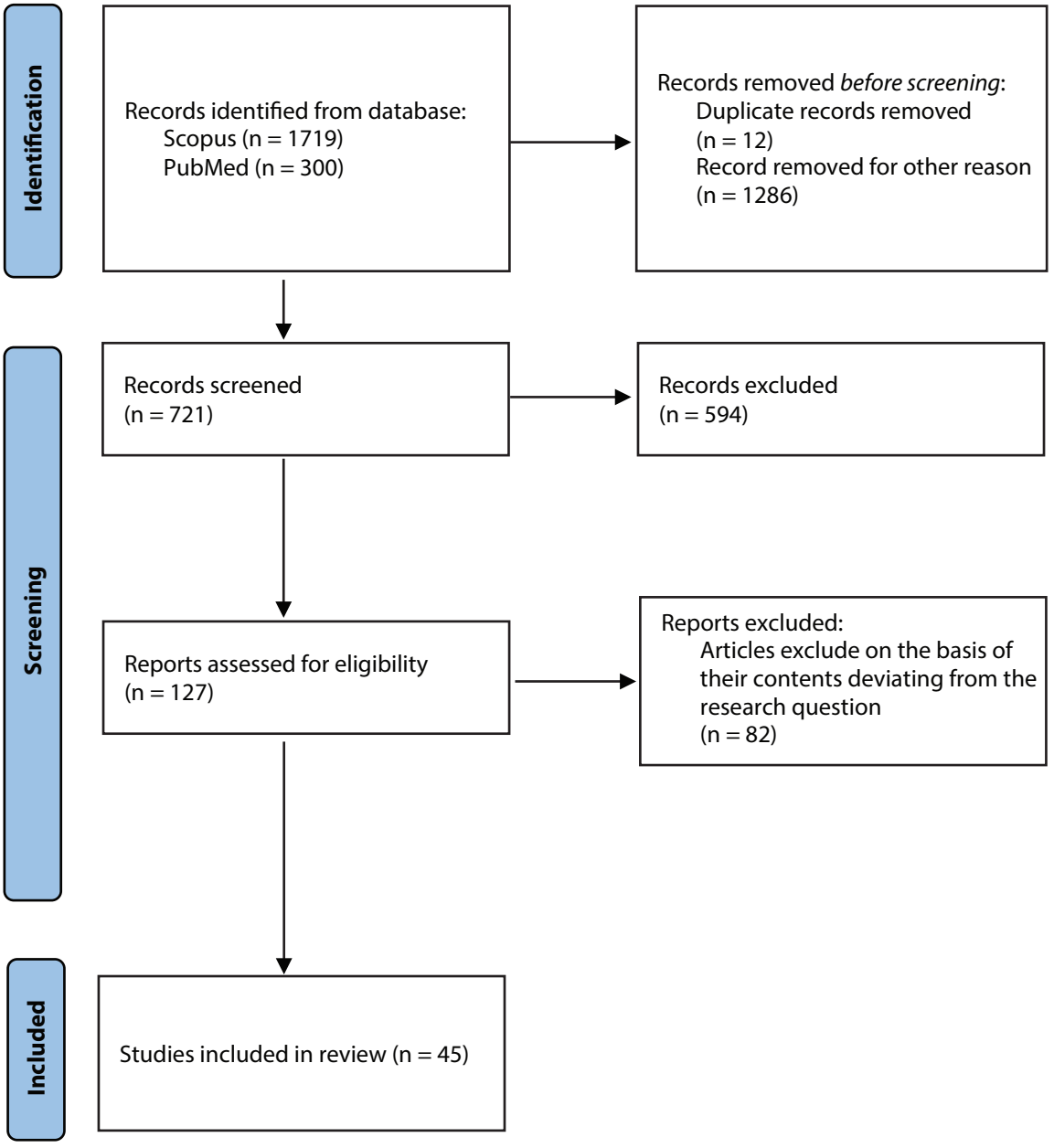

Figure 1. PRISMA 2020 flow diagram (70).

2.3. Data collection

The search results and the relative selection process are shown in the following flowchart (Figure 1).

In particular, from the combination of keywords, the Scopus and PubMed databases yielded a total of 2,019 manuscripts of which 1,719 were retrieved from Scopus and 300 from PubMed.

In accordance with the selection criteria decided before the survey, 1,298 manuscripts were excluded, 12 of which excluded as duplicates and 1,286 as not compliant with the research criteria. Overall, 721 articles were selected for elegibility, and 594 manuscripts were excluded after screening title and/or abstract. One hundred and twenty-seven potentially appropriate articles were found to be eligible, of which 82 were

excluded on the basis of their content deviating from the research question being investigated by the authors. In total, therefore, 45 articles dealing with the deployment of digital tools such as social media, mobile applications and websites in Public Health were selected.

The details of the publications reviewed and included in the survey are described in Table 1 (supplementary material); they are grouped according to "Investigation tools" under the following entries: authorship (first author, title of manuscript, journal and year of publication), research topic, target, methodology and main results of the study.

Based on the topics that emerged from the research, the selected articles were grouped into four areas of investigation: 1) Public Health interventions carried out using social media networks (alone or in conjunction with traditional dissemination methods such as front-office); 2) implementation of health-related websites and their use for health education interventions; 3) creation of health-related apps by health institutions and/or health professionals and aimed at the general population; 4) Public Health initiatives involving the integrated and combined use of social media, apps and websites.

In particular, the selected articles were distributed as follows: i) 24 articles presented the use of social media in Public Health, ii) 10 described only the use of mobile applications, iii) 8 reported on the use of websites and iv) 3 discussed the use of multiple associated variables, of which 1 article dealt with the combined use of social media and websites for Public Health purposes, 1 article described the use of mobile applications and websites and 1 article discussed the use of the three tools in combination applied to e-health.

3. Results

3.1. Use of social media in public health

Based on the research question underpinning the survey, 24 manuscripts describing the use of social media as an application of Digital Health in Public Health were included.

The most frequently recurring of these were: (i) studies that argued for the effectiveness of an integrated approach based on the traditional front-office information method in conjunction with the sharing of social media posts (25,29,30,38,39), (ii) studies that referred to the recruitment of users through social media posts in order to facilitate community adherence to online surveys and interviews (27,28,34,35,41), iii) implementation of health education and information initiatives on health behaviours through instant messaging on social media by Health Care Workers in order to provide appropriate and personalised support to selected cohorts of patients (31,33,40,42,43,45-48).

In addition, studies dealing with: (i) patient recruitment through the publication of posts dedicated to a particular health topic (36,37), (ii) the possibility of transmitting ad-hoc audio and video content via social media for health promotion activities (44), (iii) the development of automatic detection systems for anti-scientific posts and content (such as anti-vaccination) in order to implement specifically tailored health education interventions (26) and the monitoring of social media posts for tracking activities with an infodemiological approach (32) were analysed.

3.2. Use of mobile application in public health

The use of mobile applications in Public Health was described in 10 of the manuscripts included in our survey. The main themes that emerged from the analysis described: (i) use of mobile applications to educate specialist health care figures in the use of these digital tools for remote observation and support of patients (49) and for the digitalisation of medical records with electronic reporting (57), (ii) use of mobile applications for appointment bookings and vaccination record management (50), (iii) use of applications aimed at sexual (51,52) and nutritional education initiatives (53) and for patient involvement in the optimisation of drug and interventional therapy (54-56,58).

3.3. Use of web site in public health

A total of eight manuscripts described the use of websites for Public Health purposes. Among them, three articles described the importance of a dedicated website to implement awareness-raising, training and

support measures on important health topics such as: nutritional education in diabetic patients (59), sexual health and awareness of screening for sexually transmitted diseases in selected population cohorts (prisoners) (60), and medical-scientific communication on vaccinations to make users aware of adherence to vaccination programmes (66). In addition, analyses of websites through an infodemiological approach (61), implementation of evaluation tools of vaccination-related websites (64) and analyses of patient satisfaction with the Public Health information on found institutional websites (62,63,65) were described.

3.4. Integrate use of tools with social media, mobile application and web sites in Public health

Based on our selection criteria, only one study among those included in the survey regards digital Health applications in Public Health reports using social media together with health communication websites. The paper describes how by circulating data and news to increase attention to typhoid disease (through a website and a newsletter) while also amplifying the information conveyed via social media and a blog, it was possible to reach a diverse audience, sharing data with decision makers and raising awareness among the general population (67).

Regarding the integrated use of mobile applications and websites, a single study was identified. This was conducted in 2018 in order to evaluate the effectiveness of an online training program integrating principles of communication and science in order to positively influence sexual and reproductive health choices (14).

Finally, a study conducted in Italy and published in 2021 (68), described health education interventions through the integrated use of digital technologies such as social media, mobile applications and a website which recorded more than 220,000 website visits, 4,000 followers on the Facebook page and more than 5,000 downloads of the mobile application.

4. Discussion

The last two decades have been shaped by digital innovation and the consequent application and use of digital technologies in daily life. (20,71,72). Today, in fact, all users are an integral and active part of the Web 4.0 era, characterised by web sites, mobile applications and social networks. In this context, the average user has an extreme awareness of IT tools and interaction with the web has become much more active and participative (72-77).

In a daily life now driven by the Internet, its networks and mobile technology, in which the circularity of online information blossoms in its many forms of chats, forums and virtual communities, Public Health too has chosen to make use of Information and Communication Technologies (ICTs) to connect with diverse population groups and achieve better health conditions for all.

This new discipline, known as Digital Health or e-health, has been the key driver in making healthcare systems around the world more modern and sustainable (72,78-80)]. It employs technological innovation to improve the prevention, diagnosis and treatment of many diseases, and to adapt health systems' responses to changing health demands by providing health care through the use of digital tools (e.g., websites and social media networks and mobile applications) using easy-to-understand language (2,20,71,72).

According to the literature, Digital Health application is described in a wide range of public health activities that also use digital technologies to implement remote care system effectiveness and personalised care in a precise and reliable manner.

The analysis of the national and international literature on the topic of digital transformation has allowed us to focus on the broad spectrum of digital technologies, including mobile apps, social media platforms, wearable devices, artificial intelligence and big data, which are increasingly being used with the promise of increased speed, efficiency and cost-effectiveness of public health services and remotely administered care (20,71-73).

From the results of this narrative investigation, it was possible to infer that the benefits gained from an accurate use of digital in healthcare go beyond a traditional care model. In this regard, there is evidence that healthcare institutions commonly use digital technologies and the social web for health communication activities on health topics such as (i) the prevention of

infectious and chronic-degenerative diseases, (ii) the relationship between environment and health, (iii) risk and crisis communication etc. (81-87).

In particular, from clinical health to public health campaigns, in order to support, promote and increase the distribution of information and to improve personal and community health practices, the medical industry is increasingly turning to social media, making the transition to Web 4.0 an extraordinary resource available to Public Health.

In this regard, the studies included in our survey described an integrated approach based on the traditional front office information method together with the sharing of social media posts (25,29,30,36-39) as a winning strategy also in terms of user engagement and community participation in online surveys and interviews (27,28,34,35,41).

Moreover, these digital tools are well suited for the dissemination of ad-hoc audio and video content for health promotion activities (44) and thanks to the use of keywords and hashtags that refer to a collection of single-topic content, they prove to be valuable allies for infodemiological tracking activities (32) of the most widespread anti-scientific content (such as anti-vaccination content) that can be monitored and countered with the development of automatic post detection systems (26).

Numerous evidences included in our survey also demonstrated how social media can be used for the implementation of health education and information interventions on proper health behaviours promoted by HCWs in order to provide adequate and personalised support to selected cohorts of patients via instant messaging systems (31,33,40,42,43,45-48).

The use of mobile applications has also proven successful in remotely conducted healthcare practices. Indeed, as mobile devices have advanced in everyday life, applications have also found their way into healthcare in what is now called mobile health (m-Health), defined by WHO as "medical and public health practice supported by mobile devices such as smartphones, patient monitoring devices and other wireless devices" (2,4,20,72). There are currently there are more than 325,000 apps dedicated to health, nutrition, wellness, lifestyle and exercise on the main app stores, and the interest shown by the virtual community in health topics indicates that they are to become even more frequently used. In terms of utility, apps promote greater patient involvement, better compliance with therapy, healthier lifestyles, improved doctor-patient communication, more immediate delivery of healthcare services (alleviating the appointment system and reducing costs) and increased data available for research (1-3,72,88). The digitalisation of medical reports and medical records through innovative and advanced mobile applications alsot aims to create a flow of digital documents with full legal value. This process has proven successful in many circumstances and in the near future it is hoped that it will lead to the replacement of paper equivalents and the improvement of the services provided to citizens (89).

Numerous representations of the aforementioned have emerged from this narrative investigation. According to Ciani, et al. (58) for example, for susceptible cohorts of the population such as lung cancer patients, having a mobile app dedicated to self-reporting lung cancer symptoms and side effects of therapies is a potentially useful tool not only in terms of infodemiology but also with regard to the positive impact on the lives of those remotely assisted and on the delivery of care.

The same effectiveness in terms of intervention has been demonstrated by Korecha, et al. (53) who, describing the creation of two health apps aimed at monitoring patients suffering from atrial fibrillation, showed how the development of smartphone and tablet apps for patients and caregivers is an exciting opportunity to increase patients' active involvement in disease management, optimise adherence to drug therapy, provide timely education to patients and share experiences with caregivers, as well as potentially improving clinical outcomes through the pursuit of guideline-compliant care.

Similarly, according to Borgen, et al. (56) although the development of an app offering women with gestational diabetes mellitus the possibility to automatically transfer and record blood glucose levels from a glucose meter to their mobile phone, did not demonstrate any effects on clinical outcomes, a dedicated app could be a useful tool to support traditional disease management even if only in terms of personalised information on diet, physical activity and breastfeeding.

Indeed, mobile health apps support patient-healthcare provider interaction, enhance patient self-management, positively impact health literacy and improve health management (through the integration of electronic health records) thus offering an important benefit not only to the patients but also to the providers (49,51-53). In this regard, several studies have described how mobile health apps prove to be useful tools for HCWs as well, both in terms of data management and computerisation and electronic reporting through electronic health records that can be easily consulted online (55,57), and in terms of training and expanding digital literacy in order to support traditional care delivery practices (50).

However, in spite of the certain positive results resulting from the use of digital technology in Public Health, it is important to consider that, the Internet user has gone from being a passive receptor with few opportunities for interaction to an active consumer capable of creating and disseminating online content of various types and in various formats, sometimes conveying information lacking in scientific evidence characterised by entirely personal considerations and opinions (e.g. articles, comments, videos) (84,91).

This, together with the potential for information dissemination provided by the Internet, has increased the problem of misinformation on many health-related topics. In fact, while the possibilities offered by the Internet in the process of searching for health information have given individuals greater access to online content, they have also exposed the user to countless pieces of information of dubious veracity (17,19,24,66).

Indeed, the quality of information on the web varies considerably and the considerable amount of inaccurate or misleading messages seems to generate a negative attitude (e.g. reluctance to vaccinate) to a greater extent than institutional information channels promoting good health behaviour (e.g. adherence to vaccinations) generate a positive attitude (24 ,66). It is precisely in this context that the increased power of information sharing and the spread of important Public Health issues such as the known phenomenon of Vaccine Hesitancy have forced Public Health to revolutionise the way it communicates with users/patients. In such a scenario, a possible intervention strategy for health promotion or disease prevention in the field of health communication could exploit the multiplier effect of the use of information spread on the Internet and thus respond more effectively to the public's health information needs (17,19,24,66,93-96)].

Institutional medical and scientific information websites would appear to lend themselves well to this task.

Our survey showed that the transfer of shared knowledge and expertise through evidence-based websites with dedicated sections, regular news and scientific publications can be a valuable ally for Public Health in information and education interventions. In particular, numerous studies have described the importance of a dedicated website for awareness-raising, training and support actions regarding key health topics such as nutritional education in diabetic patients (59), sexual health, awareness of screening for sexually transmitted diseases (60) and medical-scientific communication on vaccinations aimed at raising awareness of adherence to vaccination programmes (66).

Greater effectiveness of public health interventions is observed when digital health applications in Public Health use health communication websites in conjunction with social media. In particular, Lindsay et al. (67) show how divulging health information (through a website and a newsletter) and amplifying this information through social media and a blog can reach a diversified audience while sharing data with decision-makers and raising awareness in the general population. Similarly, with regard to the combined use of mobile applications and web sites, Levitz et al. (14) report reaching more than 65,000 US residents recruited through virtual conversations and instant messaging with expert educators.

However, as shown in previous studies, choosing an approach that combines the use of digital tools with traditional assistance could be the most successful strategy. In fact, our research identified a single study conducted in Italy and published in 2021 (68), in which the authors describe new Digital Health tools in Public Health such as Health Communication conveyed through the integrated use of social media, mobile applications and websites. In this study, the aim was to counter fake nutritional news concerning pregnancy and the first 1,000 days of life. To this

end, the 'Nutripedia' website was developed as a tool to deliver evidence-based content counteracting fake news, integrating messages about the importance of proper nutrition for early childhood also through a page hosted on the social media site Facebook and an innovative app (chatbot) used to provide personalised information and interventions with over 220,000 visits on the website, 4,000 followers on the Facebook page and over 5,000 downloads of the mobile application.

In addition, the studies selected in our survey showed that although the combination of disciplines such as health education and digital communication may be the best strategy to support citizens, digital health today is also to be considered an evolution from a social and cultural point of view, which goes beyond technological innovation proper. Were it not for this, its expansion would not have been slowed down by phenomena such as the digital divide, organisational resistance or distrust on the part of users (18,93). This further observation leads to the assertion that the value of e-Health is especially corroborated when technological innovation is combined with a social methodological approach that is also and above all to be considered from an equity perspective.

In this sense, the predictive capabilities enabled by data-driven healthcare must steer healthcare towards a more effective and efficient allocation of resources, starting with the population cohorts that are most disadvantaged by deprivation and precarious health status. With this in mind, it is necessary to plan a more precise control of the technologies used and the therapies implemented, as well as a higher quality and effectiveness of the services provided for the benefit of both patients, who see their waits reduced and treatment improved, as well as the healthcare personnel who obtain appropriate support throughout all phases of patient management with services that are increasingly personalised and better able to meet specific needs (72). Only in this way can digital health increasingly become the cornerstone of a strategic relationship between caregiver and patient, in full awareness of the healthcare objectives to integrate patient care, healing, treatment and support at all levels of prevention and assistance.

4.1. Study limits

One of the limitations of this review is that some information may have been missed due to the electronic search procedure, the various studies included/excluded by the reviewers, the time limitation of the search, the decision to select only publication in English and open-access and the fact that, despite the wide use of new technologies, the scientific literature does not sufficiently analyse their value (e.g. out of more than 300,000 apps used in the field, only 120 articles were found dealing with this topic).

In spite of these limitations, this review briefly describes the current background in the field, helps the reader to orientate himself/herself on the existing knowledge, the new information needs in Public Health, the potential that new technologies make available to us, and thus can orientate public health practitioners to engage with new technologies in order to keep up with the real needs of the population and to plan future health care interventions.

5. Conclusions

One of the main challenges that public health will have to face in the coming decades is the fight against misinformation, hence the importance of acquiring and reinforcing health communication skills by using those digital tools most commonly used by the population such as social networks. In this regard, the current health emergency has further highlighted that, although patient empowerment and users' self-management skills in seeking health information may be beneficial in terms of Health Literacy and proper management of one's own health, the presence of the health professional as a communicator is essential to guide users towards accurate and scientifically proven information. However, if on the one hand the health emergency has thrown the health organisations into crisis by highlighting gaps and delays in care, on the other hand it has confirmed the need to bolster the measures aimed at improving the capacity of the health system to respond to a possible further crisis situation. This has accelerated the digital and organisational transformation towards a model of Connected

Care built on the needs and requirements of the patient and emphasised the urgent need for a connected, territory-oriented system based on precision and continuity of care.

Strong multidisciplinary alliances between health professionals, the development of communication and health education activities through the use of all available information methods (including current information technologies) and opportunities for two-way dialogue between health professionals and patients are just some of the possible strategies that should be considered by international and national health authorities and agencies in order to strengthen health messages to promote self-care and encourage the adoption of correct health behaviors.

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