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INFLUENCE OF DIGITAL HEALTH ON PUBLIC HEALTH PROTECTION AGAINST THE COVID-19 PANDEMIC IN ALGERIA

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Abstract

Covid-19, many challenges were faced by the people. Lacking of medical health facilities were top listed among these challenges. As a result of these issues, the medical system is paying more attention to digital Health. The purpose of this study was to examine the influence of digital health on public health protection against the COVID-19 pandemic via public health awareness and public health behavioural changes as mediating factors in Algeria. Population of the study was comprised of Algerian doctors and nurses. Five hundred and twenty two (522) respondents were selected as sample by using available sampling technique. For the collection of data a self-made questionnaire was developed and used for the collection of data. The collected data were analysed by using PLS-Smart program. Based on analysis, the researcher concluded that adoption of digital health can have a positive impact on public health behavioural changes and COVID-19 protection.

Key words: Digital Health, Public Health Protection, Awareness, Behavioural Changes, COVID-19, Doctors, Nurses, Algeria

1. INTRODUCTION

The majority of patients were traced to a single seafood market in Wuhan, China, which apparently sold seafood and some live animals, including poultry, bats, marmots, and other wild animals, suggesting that the disease may be spread from animal to human. The infection was quickly identified as a novel coronavirus, designated 2019-nCoV by the World Health Organization.^[1]

On January 9, 2020, Chinese state media announced that a team of experts led by Xu Jianguo had identified a novel coronavirus as the pathogen behind a strange pneumonia outbreak in Wuhan. Since then, the disease has quickly spread throughout China and the rest of the world. The virus that caused this coronavirus pandemic is known as SARS-CoV-2. ^[2]

With documented instances in practically every country around the world, the Covid-19 epidemic has quickly spread and has become a new global public health catastrophe. ^[3]. Policy makers and hospitals did not have enough time to alter their responses to the unexpected change, causing unparalleled disruption in the global healthcare system. The outbreak was labeled a pandemic by the World Health Organization (WHO) on March 11, 2020, due to the significant public health dangers it posed to world health ^[4] .

By the spring of 2020, more than half of the world's population had been subjected to a rigorous containment lockdown. Beyond the coronavirus's health and human tragedy, it is now widely acknowledged that the pandemic triggered the world's most significant health catastrophe ^[5].

Many countries around the world, however, have had various degrees of success in handling COVID-19's burden [6]. As a result, a favorable trend in the deployment of digital health technology was noted during the COVID-19 outbreak, which increased the efficiency and efficacy of health care operations and service delivery. During the outbreak, a transition from traditional health care operations to digital health operations was noticed in a few countries, as well as a significant growth in the adoption of digital health in certain nations that had already implemented digital health [7].

Digital technologies can be classified depending on the patient requirements they meet in health care, according to Hermann et al [8]; diagnosis, prevention, treatment, adherence, lifestyle, and patient engagement. We suggest that it's critical to understand which digital technologies were used to deal with the COVID-19 problem, as well as if and how they can be useful once the crisis has passed. In order to accomplish this, it is critical to address as many facets of digital technology use in health care as possible in response to the COVID-19 pandemic.

Many countries around the world, however, have had various degrees of success in handling COVID-19's burden [9]. Given the apparent inferiority of these countries' health-care systems, public awareness of infectious diseases leads to behavioural adjustments among the general populace, resulting in partial treatment; in particular, this awareness lessens the strain and financial burden on medical institutions. To make the public aware. [10] According [Sam Ajadi] Data-driven disease surveillance, prevention and health promotion, diagnosis, treatment, and social control can all benefit from digital health at different stages of a disease epidemic. These digital solutions have the potential to limit healthcare workers' exposure to extremely dangerous diseases like COVID-19 [11].

During the COVID-19 pandemic, digital health technology are playing a significant role in public health authority. The internet and social media have become key sources of COVID-19 and protective behaviour-related information [12].

Evidence of digital health's impact on the digitalization of health services and behaviour is extensive, and it is anticipated to become much more extensive in the future. Like other services, it's critical to assess the impact of digital health services at various levels of the health-care system, ideally using data on their success in relation to health-care goals [13].

Many studies have found a scarcity of research on the impact of digital health on public health knowledge of pandemic diseases like COVID-19, notably in Algeria. As a result, the following hypotheses and research questions are developed and tested

RESEARCH QUESTIONS

- Q.1 Does public knowledge of COVID-19 as a pandemic disease improve as a result of the usage of digital health?
- Q.2 Do people's attitudes toward COVID-19 as a pandemic disease change as a result of their use of digital health?
- Q.3 Does the use of digital health platforms improve public protection against the pandemic disease COVID-19?
- Q.4 Do public health awareness and behavioural changes have a significant role in improving the link between digital health (interventions) and public health protection against COVID-19 as a pandemic disease?

HYPOTHESES

- H_{A1} The use of Digital Health is significantly increasing behaviour change.
- H_{A2} The use of Digital Health is significantly increasing behaviour change.
- H_{A3} Public health awareness is significantly contributing to public health Protection.
- H_{A4} Public health behavioural change is significantly increasing public health protection.
- H_{A5} Public health awareness is significantly mediating the relationship between Digital Health and public health awareness.
- H_{A6} Public health behavioural change is significantly mediating the relationship between the use of Digital Health and public health awareness.
- H_{A7} Public health awareness is significantly contributing to public health protection.
- H_{A8} Public health behavioural change is significantly increasing public health protection.
- H_{A9} Public health awareness is significantly mediating the relationship between digital health and public health awareness.
- H_{A10} Public health behavioural change is significantly mediating the relationship between the use of digital health and public health awareness.

Significance of the Study

This study's findings are expected to be useful and important for public health authorities and governments in determining who receives the intervention (message), the impact of Digital Health, and the

extent to which changes in public health behaviour and health outcomes can be attributed to the intervention, as well as determining how the disseminated information is perceived.

2. METHODOLOGY

The below procedures were adopted by the researcher for reaching at certain findings and conclusions;

Nature of the study

This research uses quantitative research with descriptive analysis approach.

Population and Sampling Procedures

Population of the study was comprised of Algerian doctors and nurses. Five hundred and twenty two (522) respondents were selected as sample by using available sampling technique

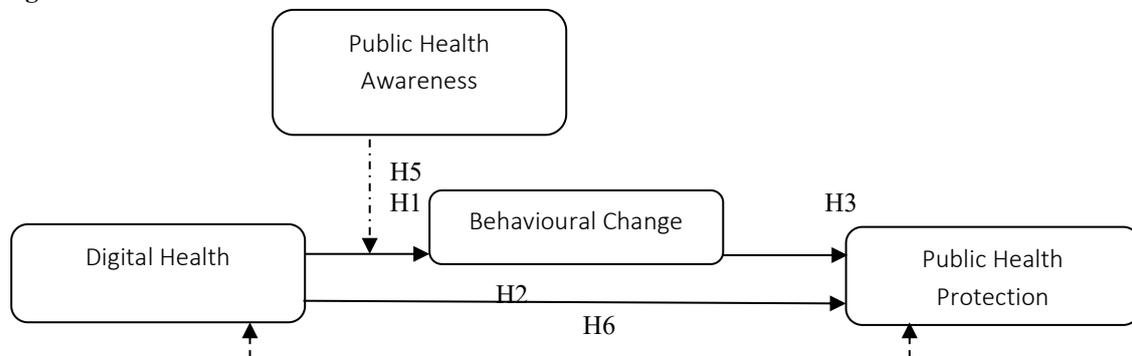
Instruments and Instrumentation

For the collection of data a self-made online questionnaire comprised of relevant questions was developed by the researcher and it was available online from November 26 until December 28, 2021.

Conceptual Framework

The below figure no.1 shows the research model detailing the relationship between the study variables. The model includes Digital Health, Public Protection Health, and Public Health Awareness and Behaviour Changes. The circles represent each variable of the study, and the rectangular boxes indicate items for each variable.

Figure 1. Research model.



Based upon the above model, the following hypotheses were formulated concerning the role of Digital Health in increasing public awareness of COVID-19 as a pandemic disease in Algeria.

Data Analysis

The collected data were analysed by using PLS-Smart program.

3. RESEULT AND DISCUSSION

Algerian doctors and nurses took part in the research. There are 532 people in the sample, with 199 males (37.3%) and 323 women (62.6%) ranging in age from 18 to 29. The average age was 22.6 years, with a 2.9-year standard deviation.

3.1 Evaluation of the measurement model:

Where the field study was divided into:

- **Convergent validity** which measures the degree of convergence and compatibility of questions from each other, and according to Hair et al, the most important criteria for convergent validity:

- **Loading coefficient:** To assess the validity of the convergence of reflective buildings, by looking at the external loading of the building indicators, so that the elements that are indicators of a specific reflective building must converge and share a high percentage of variance. High external loading indicators associated with a building indicate that they have a lot in common, which are picked up by the builder. Well the external load volume is also commonly called the reliability of the indicator.

It is noted from the table below that in most cases 0.70 is considered close enough to 0.708 to be acceptable as a minimum (J.Hulland, 1999). Accordingly, through the results of the above table, we note that the indicators (measurements): E-H1, PAW3, PAW4, PAW5, PBC2 PPR6, PPR5, PPR4, PBC4, their external load factor is less than 0.7, and therefore we must delete these expressions, because the covariance between the latent variable and its index is smaller than the variance of measurement errors.

- **Cronbachs Alpha (CA):** internal consistency criterion, which provides an estimate of reliability based on the inter-correlations of observed indicator variables if the coefficients of this criterion are greater than 0.7. (J.Hulland, 1999) From the table, it is noted that all latent variables are significant and statistically acceptable because they are greater than 0.7, and this corresponds to the composite reliability index.

• **Composite Reliability (CR):** The composite reliability values ranging from 0.6 to 0.7 can be considered acceptable in the exploratory research, (Hair & all, 2014, p. 136) as through Table No. 03, we note that all CR coefficients are significant and acceptable Statistically speaking, because it is greater than 0.7, and this indicates the existence of interdependence of the study paragraphs in measuring the latent variables, and thus the existence of reliability of the measurement model used.

• **Average Variance Extracted (AVE):** An AVE value of 0.5 or more indicates that the construct explains, on average, more than half of the variance in its indicators. Accordingly, through the above table and figure, we note that all the values of the AVE coefficients are significant and statistically acceptable because their values are greater than 0.5 according to (Fornell & Lacker's, 1981), which indicates that each latent variable explains more than half of the variances of its indicators, and therefore the validity of the convergence You may check in this form, that is, there are compatibility of questions with each other.

Table 1. Construct validity of the items of the scales using Structural Equations of Variance using Partial Least Squares.

Scales Items	Factorial Weight	CA	CR	AVE
Digital Health				
E-H1	0,315			
E-H2	0,916			
E-H3	0,887	0,781	0,904	0,795
E-H4	0,865			
Public Health Protection				
PPR1	0,847			
PPR2	0,864			
PPR3	0,749	0,819	0,908	0,767
PPR4	0,651			
PPR5	0,685			
PPR6	0,589			
Public Health Awareness				
PAW1	0,888			
PAW2	0,843			
PAW3	0,304	0,756	0,919	0,850
PAW4	0,046			
PAW5	0,591			
Beavioral Changes				
PBC1	0,886			
PBC2	0,682	0,789	0,869	0,769
PBC3	0,822			
PBC4	0,233			

Sample: 532 Doctors & Nurses

3.2. Discriminant Validity Using SEM-PLS

The discriminant validity is tested according to their commendations from Chin (2010). To assess said validity, we compare the square root of the mean variance extracted (AVE), for each factor (Latent Variable), with the correlation between the factors two by two. If the square root of the AVE is superior to the correlations between the factors, the discriminant validity is ensured. This validity is acquired if manifest variables share more variances with their Latent Variables than with others. In other words, the items measuring a phenomenon must be weakly correlated items measuring other constructs (Latent Variables). The results of table n°3 clearly show that the square root of the AVE of each factor exceeds the correlations between the factors two by two, which confirms the validity discriminating.

Table 2. Discriminant validity of sub-scales using the Fornell-Larcker criterion.

Scales	E-H	PAW	PBC	PHP
E-H	(0,892)			
PHA	0,720	(0,922)		
BC	0,595	0,404	(0,877)	
PHP	0,505	0,505	0,623	(0,876)

Sample: 532 Doctors & Nurses

Digital Health: DH; **Public Protection Health:** PPH; **Public Health Awareness:** PHA; **Behaviour Changes:** BC.

It is clear from the above table that all latent variables have a relationship value with themselves greater than the value of the relationship with another latent variable, and therefore we say that these latent variables are independent.

- According to the criteria of the Heterotrait-Monotrait Ratio, the condition of validity of the differentiation is achieved according to this test if the HTMT values do not exceed 0.9, and the results are summarized in the following table3

. **Table 3. Test Heterotrait-Monotrait Ratio**

latent variables	digital Health	Public Awareness	Behavioural change
Public Awareness	0.827		
Behavioural change	0.734	0.521	
Public Health protection	0.566	0.369	0.795

Sample: 532 Doctors & Nurses

It is clear from the above table that all the values of the latent variables do not exceed 0.9, and accordingly we say that the condition of validity of the differentiation is fulfilled.

- Variance inflation factor (VIF) test: to evaluate the problem of multiple collinearity in the data. (West & Aiken, 1991) suggested that the values of VIF should be less than 10, and this study found the values of VIF within the proposed range, and therefore there is no problem in the multi-linear relationship in the data (see Table 04).

3.3 Assessment of Structural Model

Once we confirm that the construction measures are reliable and valid, the next step is to assess the results of the structural model. This involves studying the predictive capabilities of the model and the relationships between constructs. We will present a set of measures that should be used to evaluate the structural model

Table 4: coefficient of determination R2

Relations	R ²	R ² Adjusted	VIF	Q ²	f ²
Behavioural change	0.362	0.336	2.079	0.238	0.270
Public Health protection	0.415	0.391	1.565	0.292	

Sample: 532 Doctors & Nurses

- **The coefficient of determination (R2)**

The coefficient of determination (R2) is an indicator which makes it possible to judge the quality of a structural model, and measures the quality of the internal model. It is calculated for each variable endogenous according to the latent explanatory variables.

From the results of the above table, we notice that all coefficients of R2 are greater than 0.1. So that the highest percentage was recorded in the protection of public health when it recorded a coefficient of determination of 0.415, which means that the behavioural change explains an amount of 41.5% of the change in the protection of public health, which is a medium relationship, while the variable of behavioural change recorded a determination coefficient of 0.362 and this means that health The numeric explains an amount of 36.2% of the change in behavioural change, which is a medium relationship. As for a variable, we also note that the modified determination values are close and do not differ much from the determination values, and this indicates the quality and morality of the model.

- **Effect size f2:**

(f2) is the degree of impact of each exogenous latent construct on the endogenous latent construct. When an independent construct is deleted from the pathway model, it changes the value of the coefficient of determination (R2) and defines whether the deleted latent exogenous construct has a significant influence on the value of the latent endogenous construct .If the values of f2>0.35 (strong effect), if 0.15< f2≤0.35 (medium effect), if 0.02< f2≤0.15 (weak effect), and if f2< 0.02 (no effect).

It is evident from the results of the above table that the size of the impact of behavioural change on public health protection is 0.270, which is a medium effect, which shows us the importance of these variables inherent in the model. It is clear that the application of digital health leads to behavioural change and raise public awareness, which in turn affects the protection of public health

- **Predictive relevance (Q²):**

It was posed by Stone-Geisser (1974-1975) (Vincenzo and others, 2010), in addition to the coefficient (R²), we can use the predictive relevance indicator (Q²) effectively as a criterion forecast. (Q²) demonstrates how well the collected data has been empirically collected using the model.

If Q² > 0 the model has predictive relevance, and vice versa if

Q² ≤ 0, The model has no predictive significance) (vincenzo et al., 2010).

It is clear from the table that all Q² coefficients are significant and acceptable from a statistical point of view because they are greater than zero. This indicates that the latent variables present in the study model have the ability to predict, as their maximum value was at the level of the public health protection variable by 29.2%, followed by the behavioral change variable by 23.8%.

3.4 Hypothesis testing:

In the second part, we will use the structural equations in order to test the hypotheses of our study. The significance of structural links, i.e. links between the latent variables of the model, as well as the level of these links corresponds to our research hypotheses. The test of our conceptual model was done at using Smart PLS software (version 3) (Ringle et al., 2015).

The global adjustment indices, as well as that the significance of the structural links that connect the constructs will confirm or to reject our hypotheses. In order to validate the hypotheses, we need to examine the direction, value and level of significance of the causality coefficients (beta β – Original Sample) significance of the coefficients, using SEM calculated by the method PLS. The values of the regression will be presented by the values of the Path table coefficient (beta β). The validation of the results will also go through the examination of the coefficients of determination R² and by the significance of the regression coefficients in using the T-Student test. According to Urbach and Ahlemann (2010), T-Student values test the significance of causal relationships. In the PLS approach, they are calculated using the bootstrap procedure.

The results of the hypothesis tests will be detailed (direct and the mediating effects) In the Direct effects we examined and tested the first three hypotheses, in the mediating effect were examined by testing both the following last hypotheses:

Table 5: Significance testing of path coefficients using Bootstrapping

Hypothesis		Beta	Mean (M)	(STDEV)	T	P
H1	E-H->PBC	0.000	4.155	0.154	0.630	0.633
H2	E-H->PPR	0.120	1.559	0.172	0.266	0.269
H3	PBC->PPR	0.002	3.189	0.155	0.493	0.495
The direct and the mediating effects						
H4	EH->PBC->PPR	0.014	2.461	0.130	0.320	0.321
H5	EH->PAW->PBC	0.169	1.376	0.120	-0.163	-0.165

Bootstrapping technique (5000 times) using Smart PLS. *p*-value < 0.01. Sample: 532 business students.

The path that links digital health with behavioural change, which recorded a good path with a value of 0.633 with a significant level of $p=0.000<5\%$, which means acceptance of H1, that is, there is a positive, statistically significant relation between digital health and behavioural change. These are all results that confirm that digital health has worked to spread awareness-raising campaigns about the dangers of this virus and preventive measures, by relying on television programs and social networking sites, and thus it was credited with changing the behaviour of its users, through this premise we can say that digital health has undoubtedly contributed to behavioural changes for individuals.

The path that links digital health and public health protection, which recorded a path with a value of 0.269 with a significant level $p = 0.120 > 5\%$, which means the rejection of H2, that is, there is no direct positive relationship with statistical significance between digital health and public health protection. These results confirm that digital health does not directly contribute to the protection of public health; This is because digital health, in addition to needing applications and technologies, requires individuals to improve their use through which awareness and behaviours are formed among its users about preventive measures that contribute significantly to maintaining public health, and therefore it can be said that this hypothesis is wrong.

The path that links behavioural change and the protection of public health, which recorded a good path with a value of 0.495, with a significant level of $p=0.002<5\%$, which means acceptance of H3, that is, there is a positive, statistically significant relationship between behavioural change and public health protection. This is what was observed in the positive results achieved by the world, including Algeria, by relying on general and partial quarantine procedures, especially by relying on the liberation of violations and strictness in implementing preventive measures, and accordingly it can be said that the imposed behavioural change contributed significantly to maintaining public health, and this What made the results of recording infection with this disease stable in many times, and therefore it can be said that this hypothesis is also correct.

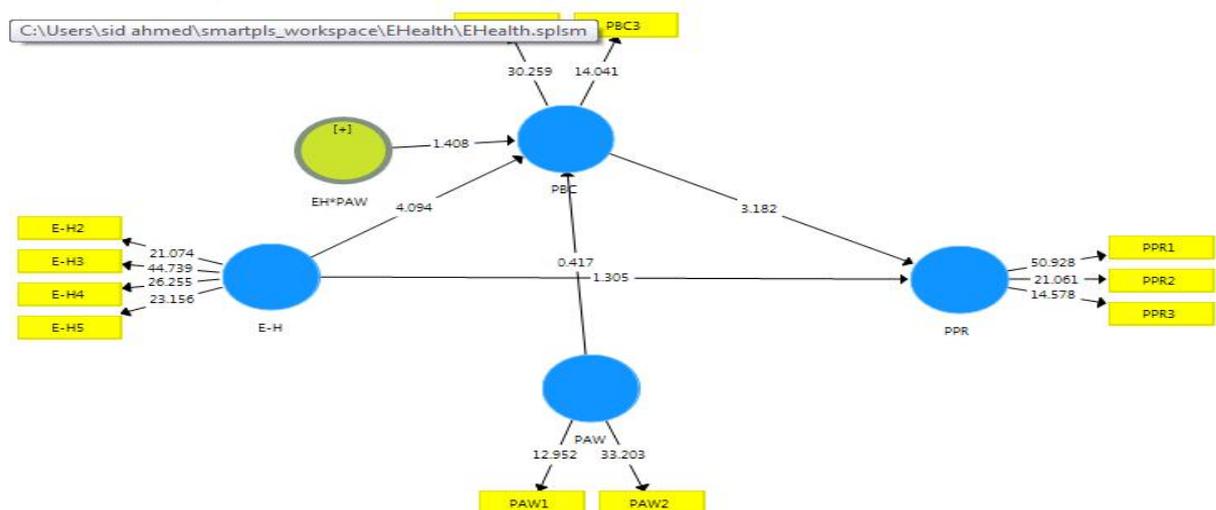
The results showed that the direct effects between digital health and public health protection were not significant $B=0.321$ $t=2.461$ $p=0.002<5\%$, while the indirect effects were positive and significant, $B=0.321$ $t=2.461$ $p=0.014<5\%$ Therefore, we conclude that the behavioural change is an indirect effect mediation only, meaning that it indicates that our mediator conforms to the assumed theoretical framework and thus accepts H4. Through the second hypothesis, which confirmed that digital health does not directly contribute to the protection

of public health, only after it contributes to the behavioural change of individuals, and this is through the programs and applications that it presents on mobile phones and social networking sites that work to sensitize individuals to the seriousness of this disease, as well as Explanation of the preventive measures that undoubtedly contribute to maintaining public health, supported by the measures imposed by the state from general and partial quarantine. Hence, it is a valid hypothesis.

Moreover, the results of the study show that public awareness works insignificantly in modifying the relationship between digital health and behavioural change. $B = -0.165, t = 1.376, p = 0.169 > 5\%$ Therefore, the interaction of public awareness and digital health (EH * PAW) on behavioural change is not significant, and therefore hypothesis H5 is rejected.

This indicates that the digital health in force is based mainly on self-isolation and quarantine in achieving behavioural change to confront Covid-19, and this is what makes Algeria follow strict procedures and not on digital applications that are used in mobile phones and social media, or rely on x-ray cameras Alhambra to quickly detect infection, or rely on GPS data such as GPS, which indicates that digital health in Algeria is weak, which may affect the maintenance of public health in it, making it suffer from frequent health crises and setbacks. Therefore, this hypothesis is wrong.

Figure 2. Research model tested.



4. CONCLUSION

On the basis of data analysis, the researcher concluded that the use of digital health can positively influence awareness of public health behavioural changes and public protection against COVID-19. Public health authorities may use digital health as useful tools to increase public health awareness through the dissemination of brief messages to targeted populations. More research is needed to validate how social media channels can be used to improve health knowledge and adopt healthy behaviours in a cross-cultural context.

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