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In Search for Health Social Determinants in Algeria: How Social Vulnerability Determined COVID-19 Pandemic Magnitude

المحددات الاجتماعية للصحة في الجزائر: الهشاشة الاجتماعية كمحدد لخطورة جائحة كوفيد-19

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Abstract:

More growing number of studies made the link clear between social vulnerability and the growing risk of exposure to COVID-19 contamination, developing serious forms of the disease and death. The purpose of this study is to search for health social determinants in Algeria by analysing how social vulnerability determined COVID-19 pandemic magnitude, mortality and case fatality rate.

The study depends on analysing grey literature about health social determinants based on the themes, subthemes and indicators of The Africa Covid Community Vulnerability Index (CCVI): socioeconomic status; population density; housing type and transportation; epidemiological factors; health system factors; fragility and old age.

The study found that social vulnerability determined COVID-19 pandemic magnitude in many Algerian wilayas. The inability to access adequate medical care because of fragile health systems and transportation, being old or suffering chronic diseases made great number of populations in socially vulnerable situations and at an increased risk of health challenges during COVID-19 pandemic.

Keywords: Social Vulnerability; COVID-19; The Africa Covid Community Vulnerability Index (CCVI); Health Social Determinants; Algeria

JEL Classification Codes : D63, I12, J19

ملخص:

مع استمرارية جائحة كوفيد-19 وتوفر المزيد من البيانات، أوضح عدد متزايد من الدراسات العلاقة بين الهشاشة الاجتماعية وتزايد احتمالية التعرض لخطر عدوى كوفيد-19، تفاقم مضاعفات المرض والوفاة. تهدف هذه الدراسة الى البحث عن المحددات الاجتماعية للصحة في الجزائر بالاعتماد على تحليل الهشاشة الاجتماعية كمحدد لخطورة جائحة كوفيد-19، معدل الوفايات ومعدل إماتة الحالات.

تعتمد الدراسة على تحليل الأدب الرمادي للمحددات الاجتماعية للصحة على أساس المؤشرات الفرعية لمؤشر الهشاشة الاجتماعية في أفريقيا: الحالة الاجتماعية والاقتصادية؛ الكثافة السكانية؛ نوع السكن وتوفر النقل؛ العوامل الوبائية؛ النظام الصحي؛ الهشاشة والشيخوخة.

توصلت الدراسة الى أن مؤشرات الهشاشة الاجتماعية كانت محددات لخطورة جائحة كوفيد-19 في العديد من الولايات الجزائرية. إن صعوبة الحصول على الرعاية الطبية الكافية بسبب الأنظمة الصحية الهشة، وعدم توفر النقل خاصة بالنسبة لفئة كبار السن والفئات التي تعاني من أمراض مزمنة، وضع العديد من الافراد في موقف هش اجتماعيا وفي خطر متزايد في مواجهة التحديات الصحية خلال جائحة كوفيد-19.

كلمات مفتاحية: الهشاشة الاجتماعية؛ مؤشر كوفيد للهشاشة المجتمعية في أفريقيا؛ كوفيد-19؛ المحددات الاجتماعية للصحة؛ الجزائر

تصنيفات JEL : D63, I12, J19

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INTRODUCTION:

On March 11, 2020, the World Health Organization, officially defined Covid 19 as a pandemic. The COVID-19 has hit the whole world as a health crisis, but its impact went far beyond the health sector and the consequences were felt in all economic and social sectors. The COVID-19 pandemic adversely and seriously affected socially vulnerable and minor communities in different countries around the world, in the beginning of the pandemic, this association remained undefined, but more growing number of studies made the link clear between social inequalities or vulnerability and the growing risk of exposure to contamination, developing serious forms of the disease and death.

The health crisis linked to the Covid-19 epidemic and its economic consequences raise two major issues in terms of social inequalities. On the one hand, the risk of exposure to contamination, the risk of developing serious forms of the disease and dying are unequally distributed in the population. The Nobel Prize in Economics Joseph Stiglitz summarises this as: "Covid is not an equal opportunity killer" (Stiglitz, 2020). On the other hand, the Covid-19 crisis adds an additional and new mechanism in its nature and its magnitude in the history of epidemics: inequalities in the face of confinement.

Previous work on previous pandemics such as the Spanish flu or the H1N1 flu, or other infectious diseases such as tuberculosis or measles, already emphases the importance of taking into account the various factors of social inequality in order to better control the differential impact of future pandemics (Quinn & Kumar, 2014). The mechanisms found in the Covid-19 crisis are both differential exposure to the virus, greater vulnerability to infectious diseases or their complications, as well as unequal access to care. Finally, the economic crisis risks widening inequalities, with probable long-term consequences.

Problematic

The novel coronavirus disease (COVID-19) was reported in Algeria on 25 February 2020, in the Wilaya of Ourgla. Since then, the number of positive cases has reached 42 619, and 1465 deaths have occurred (Bettayeb, et al., 2021, June). Since the start of the crisis, the Algerian government took a series of measures to prevent and mitigate the spread of the virus and reduce its negative impact on the economy and households.

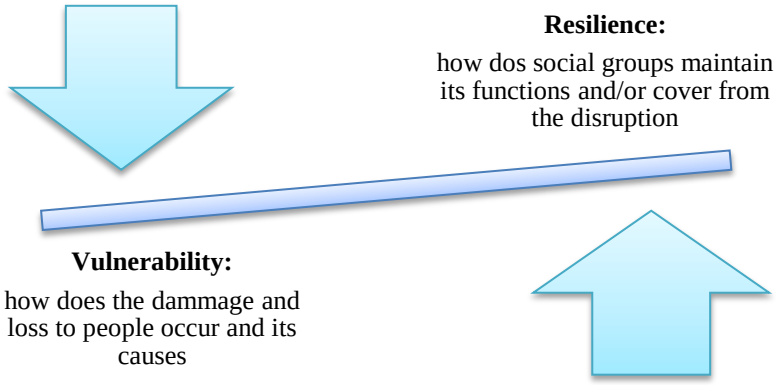
The purpose of this study is to search for health social determinants in Algeria by analysing how social vulnerability determined COVID-19 pandemic magnitude, mortality and case fatality rate or how COVID-19 has affected those who have higher social vulnerabilities. Using the methodology of The Africa Covid Community Vulnerability Index (CCVI). This study makes an initial inventory of social inequalities in this COVID 19 health crisis in the Algerian context. This approach helps identifying the most urgent challenges related to the socio-economic effect of COVID-19 in order to support the avenues of reflection for effective public policies adapted to the specificities of Algerian society and economy.

1- Theoretical framework and literature review:

1-1 Social Vulnerability

The Social Vulnerability Index (SVI), USA, defines social vulnerability as the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks. Reducing social vulnerability can decrease both human suffering and economic loss (SVI, 2022).

Fig (1): Resilience vs vulnerability



Source: authors' conception

Social vulnerability refers to the inability of people, organizations, and societies to withstand adverse impacts from multiple stressors. It refers to potential harm to people. It involves a combination of factors that determine the degree to which someone's life and livelihood are put at risk by a discrete and identifiable event in nature or in society.

1-2 Socially Vulnerable Groups

There are different dimensions categorizing socially vulnerable groups such as poverty, social class, gender, religion, race or ethnicity, income, age (such as the elderly and children), access to basic services, assess to social protection, disability, attitude and culture to risk and disasters, literacy or language, social capital, etc.

Table (1): Dimensions of Social Vulnerability After (Schmidtlein and others, 2008)

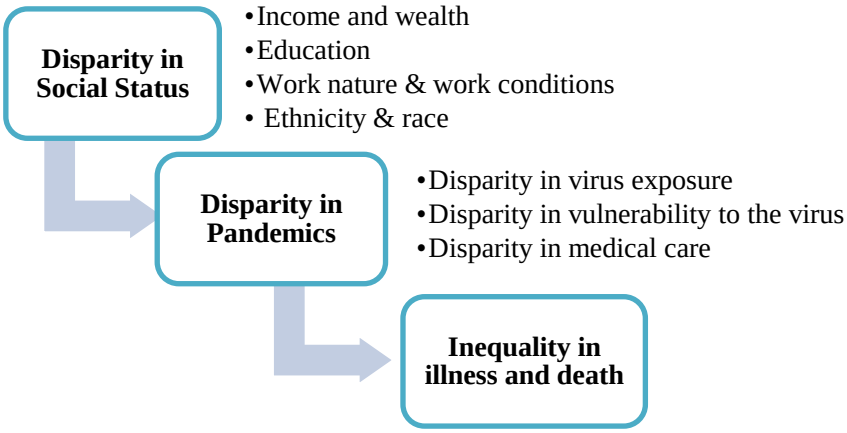
	Level of Poverty
Socially Vulnerable Groups	Lack of or limited access to resources: information, knowledge and technology.
	Lack of or limited access to political power and representation (marginalization, exclusive).
	Lack of or limited social capital including social networks and connections.
	Inadequate beliefs, customs and attitude in response to risks or disasters.
	Vulnerable residential settings (weak structure, poor protection, poor maintenance, etc.).
	Fail and physical limited individuals.
	Lack of limited access to critical services such as communication, transportation, power supply, water supply, sanitation.

Source: authors' conception based on (Schmidtlein and others, 2008)

1-3 Social Vulnerability dimensions

The potential social disparities or inequalities studied from influenza epidemics revolve around three criteria: differential exposure to the virus, differential vulnerability to the virus, and differential access to care (Blumenshine, et al., 2008).

Fig (2): Potential social disparities or inequalities



Source: authors' conception based on (Blumenshine, et al., 2008) model

1-4 Social Vulnerability indices

When reviewing the literature analysing the social vulnerability and COVID-19, the most used social vulnerability indexes were mainly:

The Social Vulnerability Index (SVI) used in USA, created and maintained by the Geospatial Research, Analysis, and Services Program (GRASP) at the Center for Disease Control and Prevention (CDC) and the Agency for Toxic Substances and Disease Registry, is a percentile-based index of county-level vulnerability to disasters designed for resource allocation to vulnerable communities during times of duress such as the COVID-19 pandemic (Biggs, Maloney, Rung, Peters, & Robinson, 2021). The SVI is composed of 16 variables grouped in to the following three categories: Urban infrastructure (three variables), Human Capital (eight variables), Income and Work (five variables) (Atsdr, 2022).

The Africa Covid Community Vulnerability Index (CCVI) includes 756 regions from 48 different nations. It's based on the US COVID-19 Community Vulnerability Index (SVI), but it's been tweaked to account for pandemic lessons and African-specific characteristics. The seven categories of vulnerability are divided into subthemes based on indicators from the DHS, IHME, WorldPop, Malaria Atlas, UNHCR, Uppsala Conflict, World Bank, and Facility databases. The Africa CCVI is modular in that a region's overall vulnerability score may be split down into seven main themes socioeconomic status, population density, housing type & transportation, epidemiological factors, health system factors, fragility, old age each of which is made up of subthemes. When calculating the theme score or the total index, each sub-theme is weighted equally, and each theme is weighted equally Multiple underlying indicators can make up a subtheme. The index's structure as well each subtheme indicators is detailed in the appendixes.

2- Social vulnerability and Covid-19 pandemic

In addition to health inequalities in the face of the pandemic mentioned by (Blumenshine, et al., 2008): differential exposure to the virus, differential vulnerability to the virus, and differential access to care, a fourth striking phenomenon has been added to the COVID-19 pandemic: social inequalities in the face of confinement.

The COVID-19 pandemic adversely affected the socially vulnerable and minority communities in different countries around the world. In the beginning of the pandemic, this association remained unknown, but more growing number of studies made the link clear between social inequalities or vulnerability and the growing risk of exposure to contamination

and death. For example, (Aditi, et al., 2020) was one of the first studies addressing the COVID-19 pandemic and its possible correlation to social vulnerability in the very beginning of COVID-19 crisis. The study resulted that even though inequalities in the face of Covid-19 are socially very marked, it's unclear whether regional differences in catastrophe social vulnerability influence COVID-19 results and incidence in the United States.

Emerging data during the COVID-19 pandemic have demonstrated that socially vulnerable neighbourhoods have had worse outcomes during the early stages of the pandemic and that the association between SVI and COVID-19 outcomes temporally varied and whether this continued to the latter durations of the pandemic is unknown. Similarly, it made an early conclusion that the largest minority groups within the USA who are black and Hispanic individuals are especially susceptible to worse COVID-19 outcomes, but the temporal trend of these associations throughout the course of the pandemic remains unknown (Aditi, et al., 2020).

With the pandemic persistence, a growing number of studies and a set of literature has emerged surrounding the COVID-19 pandemic and its possible correlation to social vulnerability. The study of (Islam, Nayak, Hu, & al, 2021) found that a higher SVI level was linked to higher COVID-19 incidence (adjusted incidence rate ratio per 10 percentile increase: 1.02 to 1.03) and mortality per capita (1.04 to 1.05). Starting in March 2020, SVI became an independent predictor of incidence, but by the winter, this link had faded or become insignificant, coinciding with a sharp increase in infection rates and mortality, and when counties with a higher proportion of white residents were disproportionately represented (the 'third wave'). SVI was once again a predictor of COVID-19 outcomes by the spring of 2021. COVID-19-related bad outcomes showed similar temporal trends in counties with a higher number of black populations and Hispanic population residents.

In their study (Souza, Machado, & Carmo, 2020) examined the link between COVID-19 incidence, death, and case fatality rates and 49 social markers of human development and social vulnerability in his ecological study. Bivariate spatial correlation, multivariate and spatial regression models (spatial lag model and spatial error models) were utilized in the study. The study found that in total, 44.8 percent of towns reported verified COVID-19 cases, with 14.7 percent reporting deaths. 56.2 percent of towns with confirmed cases had extremely low human development (COVID-19 incidence rate: 59.00/100000; death rate: 36.75/1000000), and 52.8 percent had very high vulnerability (COVID-19 incidence rate: 41.68/100000; fatality rate:27.46/1000000).

In another pooled cross-sectional study of prospectively collected data involving adults aged older than 18 years hospitalized for COVID-19 at 38 Michigan hospitals between March and December 2020. (Tipirneni, Karmakar, O'Malley, Prescott, & Chopra, 2022) results that patients with COVID-19 from socially vulnerable neighbourhoods present with increased severity of illness and require more intensive treatment. Patients in high-vulnerability ZIP codes were more likely than those in low-vulnerability ZIP codes to be treated in the intensive care unit (29.0 versus 24.5 percent), to receive mechanical ventilation (19.3 versus 14.2 percent), and to have higher rates of organ dysfunction (51.9 versus 48.6%), organ failure (54.7 versus 51.6 percent), and in-hospital death (19.4 versus 16.7 percent). In analyses that

controlled for age, sex, and comorbid conditions, a 0.25 increase in a patient's neighbourhood social vulnerability index was linked to an increased likelihood of mechanical ventilation, acute organ dysfunction, and acute organ failure with (2.1, 2.8, and 2.8 percentage point increase, respectively); no associations were found with intensive care unit stay, mortality, or discharge disposition. The study concluded that policymakers should target more socially vulnerable communities to enhance access to COVID-19 testing, treatment, and vaccination, as well as to identify and address social needs to alleviate inequities in COVID-19 health outcomes.

3- Methodology:

3-1 Data and materials

This study depends on analysing resources from grey literature and desktop review of grey and published literature and existing data sets. Grey literature is defined by the 'Luxembourg definition' as "a literature produced in print and electronic formats at all levels of government, academia, business, and industry but is not controlled by commercial publishers, i.e., where publishing is not the primary activity of the producing body" (Mahood, van Eerd, & Irvin) (Belle & Lee, 2014).

A wide range of institutions, including government and non-government organizations, research centers, health institutes, and non-profit organizations frequently use the Internet as a platform for publishing grey literature, contributing to the spread of this kind of material. Reports, theses, conference proceedings, newspapers, fact sheets, websites, and policy documents are examples of materials that are not formally published in academic sources (books or journals). Furthermore, unpublished data and research may be called grey literature (Benzies, Premji, Hayden, & Serrett, 2006).

Grey literature documents can be valuable resources for practitioners and decision-makers across disciplines, as they often contain policy- and research-relevant information (e.g., clinical practice guidelines, research reports, program evaluation studies, legislation) from reputable sources and are widely disseminated (Godin, Stapleton, Kirkpatrick, Hanning, & Leatherdale, 2015). Usually, there is frequently a significant time gap between research and publishing, and some material is never formally published. As a result, relying solely on peer-reviewed literature may lead to the omission of potentially relevant work (Pappas & Williams, 2011).

Gray literature is often a valuable source of evidence used in systematic reviews and meta-analysis due to its vast diversity of formats and scopes (Paez, 2017). About 10% of studies cited in Cochrane Reviews come from other grey literature, such as conference abstracts and proceedings (MalletS, HopewellS, & ClarkeM, 2002). Gray literature accounts for 4.5 percent to 75 percent of the research in the meta-analyses (McAuleyL, PhamB, TugwellP, & MoherD, 2000). Grey literature is a vast, but difficult-to-understand collection of information (Godin, Stapleton, Kirkpatrick, Hanning, & Leatherdale, 2015).

3-2 Grey literature study sources

Our study is essentially based on statistics provided by (ONS, etc.) and multilateral (World Bank, IMF, United Nations System, etc.) and specialized organizations (Economist Intelligence Unit). Our grey literature sources of this study were mainly extracted from the following sources detailed in table (2).

Table (2): Grey literature study sources

Source	Sub-sources	Base on the cite web
The Africa Covid Community Vulnerability Index (CCVI)		https://precisionforcovid.org/africa
GADM	The Africa CCVI is calculated for each country at the first administrative level, with regions, defined by GADM.	www.gadm.org
Public administrative institutions placed under the supervision of the ministry of Health and Hospital Reform.	The National institute of public health that provides mainly daily bulletin from the National institute of public health.	https://www.insp.dz/index.php/publications/situation-epidemiologique-covid19.html
Public administrative institutions placed under the supervision of the ministry of Higher Education and Scientific Research.	1. Thematic Research Agency in Health and Life Sciences-ATRSSV- that provided daily information bulletins. 2. Pharmacology Information special versions.	https://atrss.dz/std.php?id=1511 https://atrss.dz/std.php?id=1519

Source: authors' conception

3-3 Study tactics in searching for grey literature sources

The study uses similar searching tactics used by (Godin, Stapleton, Kirkpatrick, Hanning, & Leatherdale, 2015) to construct a grey literature search plan: (1) Google search engines, (2) targeted websites sited above as study grey literature sources. Data for the desktop review were obtained via targeted key word searches for CCVI indicators related to the impact of COVID-19 on different wilayas, demographics and life expectancy data, 2) economic indicators, 3) health systems indicators and 4) COVID-19 data. The review of the grey and published literature and data sets included: distillation, review and comparative synthesis of data and evidence from official global databases and available WHO data and continental reporting mechanisms to captured evidence for the Algerian country-level.

4- Results and discussion:

Our study results are summarised in breakdown of confirmed cases and deaths by wilaya, Breakdown of confirmed cases and deaths by health region, Algeria's Regional metrics of vulnerability based on the Africa Covid Community Vulnerability Index (CCVI) and Algeria's vulnerability charts according to (CCVI). And then to discuss these results, the desktop review will use more review of the existing data sets included: distillation, review and comparative synthesis of existing data and evidence from official global databases and available WHO data, scientific and grey literature and continental reporting mechanisms.

4-1 Algeria's epidemiological situation till February 4, 2022

Before analysing the epidemiological situation, we first define two important key concepts: case fatality rate and mortality rate. Case fatality rate is calculated by dividing the number of deaths from a specified disease over a defined period of time by the number of individuals diagnosed with the disease during that time multiplied by 100 to yield a percentage. Mortality rate is calculated by dividing the number of deaths by the population at risk during a certain period of time. As a true rate, it estimates the risk of dying of a certain disease. Hence, the two measures provide different information (Britannica, 2022).

Table (3): Breakdown of confirmed cases and deaths by wilaya till February 4, 2022

code	Wilaya	Cumulative cases	New cases	Incidence rate [1]	Cumulative deaths	Mortality rate [1]	Case fatality rate
1	Adrar	1 517	4	277,54	70	12,81	4,61
2	Chlef	1 478	7	119,01	4	0,32	0,27
3	Laghouat	2 935	7	418,18	100	14,25	3,41
4	Oum El Bouaghi	3 389	6	428,33	80	10,11	2,36
5	Batna	13 928	57	1 007,27	150	10,85	1,08
6	Bejaia	9 414	62	915,44	430	41,81	4,57
7	Biskra	3 591	14	373,14	198	20,57	5,51
8	Béchar	1 153	1	335,41	3	0,87	0,26
9	Blida	13 520	42	988,96	294	21,51	2,17
10	Bouira	6 057	23	743,79	85	10,44	1,40
11	Tamanrasset	351	1	144,74	14	5,77	3,99
12	Tébessa	6 775	45	831,99	532	65,33	7,85
13	Tlemcen	5 859	20	516,42	11	0,97	0,19
14	Tiaret	1 724	1	164,44	45	4,29	2,61
15	TiziOuzou	10 580	8	874,25	691	57,10	6,53
16	Alger	44 871	183	1 213,40	778	21,04	1,73
17	Djelfa	2 050	0	128,64	43	2,70	2,10
18	Jijel	7 143	10	952,22	149	19,86	2,09
19	Sétif	10 911	25	607,59	665	37,03	6,09
20	Saida	577	0	138,85	29	6,98	5,03
21	Skikda	2 547	18	233,66	27	2,48	1,06
22	Sidi Bel Abbes	5 794	34	784,61	248	33,58	4,28
23	Annaba	3 098	5	439,21	87	12,33	2,81
24	Guelma	1 975	3	344,15	39	6,80	1,97
25	Constantine	13 260	81	1 150,03	399	34,60	3,01
26	Médéa	2 625	17	296,49	39	4,40	1,49
27	Mostaganem	5 777	12	631,79	33	3,61	0,57
28	M'Sila	6 014	5	463,90	63	4,86	1,05
29	Mascara	1 849	12	191,56	26	2,69	1,41
30	Ouargla	6 268	106	840,59	81	10,86	1,29
31	Oran	26 456	44	1 430,55	279	15,09	1,05
32	El Bayadh	741	3	223,97	72	21,76	9,72
33	Illizi	221	0	256,31	3	3,48	1,36
34	Bordj BouArreridj	1 047	15	138,81	44	5,83	4,20
35	Boumerdes	6 866	26	650,72	305	28,91	4,44
36	El Tarf	1 588	3	316,11	64	12,74	4,03
37	Tindouf	465	0	481,70	15	15,54	3,23
38	Tissemsilt	1 135	0	326,29	15	4,31	1,32
39	El Oued	3 099	4	349,68	72	8,12	2,32
40	Khenchela	1 582	0	326,56	81	16,72	5,12
41	Souk Ahras	2 310	20	416,03	45	8,10	1,95
42	Tipaza	4 710	33	642,54	55	7,50	1,17
43	Mila	1 599	2	172,86	87	9,41	5,44
44	Ain Defla	1 111	1	117,76	16	1,70	1,44
45	Naâma	897	5	285,96	4	1,28	0,45
46	Ain Temouchent	2 994	5	670,38	13	2,91	0,43
47	Ghardaïa	698	0	149,19	24	5,13	3,44
48	Relizane	2 257	0	259,16	24	2,76	1,06
	Total	256 806	970	602,83	6 631	15,57	2,58

1.expressed per 100,000 inhabitants

Source: Epidemiological bulletin N° 259 of February 04, 2022, Algeria, P 24, on: https://www.insp.dz/index.php/publications/situation-epidemiologique-covid19.html , consulted: 21/09/2022

Table (4): Breakdown of confirmed cases and deaths by health region as of February 4, 2022

Region	Cumulative confirmed cases	New cases	Incidence rate [1]	Cumulative deaths	Mortality rate [1]	Case fatality rate
Center	104.329	417	680,79	2.784	18,17	2,67
East	76.119	280	593,75	2.468	19,25	3,24
West	54.422	128	623,30	723	8,28	1,33
South	21.936	145	383,22	656	11,46	2,99
Total	256.806	970	602,83	6.631	15,57	2,58

1.expressed per 100,000 inhabitants

Source: Epidemiological bulletin N° 259 of February 04, 2022, Algeria, P 02, on: https://www.insp.dz/index.php/publications/situation-epidemiologique-covid19.html, consulted: 21/09/2022

4-2 Algeria's Regional metrics of vulnerability based on The Africa Covid Community Vulnerability Index (CCVI)

In this table (5) each region's vulnerability is expressed relative to other regions in Algeria. A higher score indicates greater vulnerability in that subindex, relative to other parts of the country. Followed by Fig (3) putting these scores on Algeria's vulnerability charts according to (CCVI)

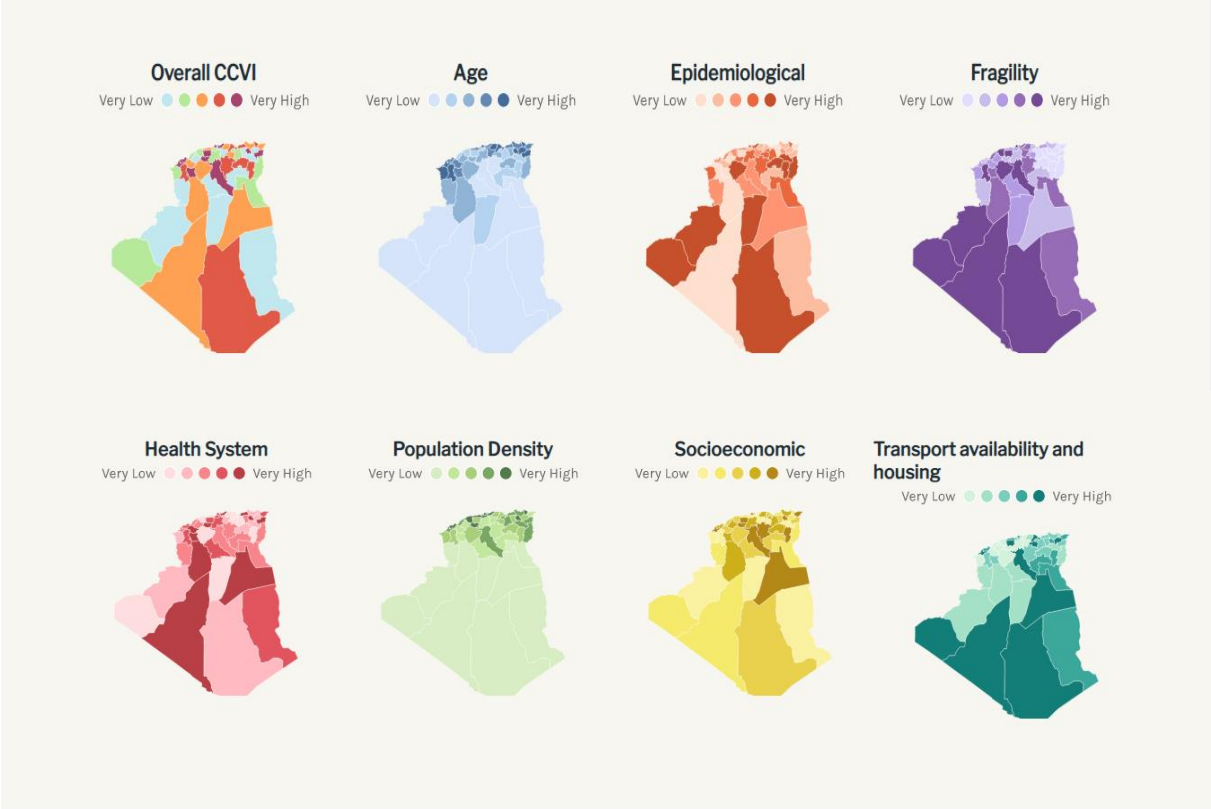
Table (5): Regional metrics of vulnerability according to (CCVI)

Region	Population	Overall CCVI Index	Age	Epidemiological Factors	Fragility	Health System	Population Density	Socio-Economic	Transport availability
Adrar	549.000	0.4	0.1	0.2	**0.9**	**1.0**	0.1	0.3	**0.8**
Alger	4.363.000	1.0	**1.0**	**0.7**	**1.0**	**0.7**	**1.0**	**1.0**	**0.6**
Annaba	831.000	0.8	**0.9**	**0.8**	0.1	0.3	**0.9**	0.3	0.4
Aïn Defla	919.000	0.9	0.4	0.1	**0.9**	**0.8**	0.4	**1.0**	**0.9**
Aïn Témouchent	437.000	0.9	**0.9**	0.1	0.4	0.5	**0.6**	**0.9**	**0.8**
Batna	1.491.000	0.7	0.5	**0.9**	0.2	0.4	**0.6**	**0.7**	**0.6**
Biskra	1.007.000	0.1	0.2	0.3	0.3	**0.6**	0.3	0.5	**0.7**
Blida	1.375.000	0.3	0.3	0.4	0.5	**0.7**	**1.0**	0.0	0.3
Bordj BouArréridj	744.000	0.6	0.4	**0.7**	**0.6**	0.0	**0.6**	0.2	**0.9**
Bouira	792.000	0.0	**0.7**	0.5	**0.7**	0.2	0.2	0.1	0.0
Boumerdès	1.053.000	0.8	**0.6**	**0.8**	**0.7**	**0.8**	**0.9**	0.2	0.0
Béchar	337.000	0.2	0.2	1.0	**0.9**	0.4	0.2	0.0	0.3
Béjaïa	988.000	0.6	1.0	0.3	0.3	0.0	0.5	**0.6**	**0.9**
Chlef	1.206.000	0.3	0.3	0.4	**0.8**	0.2	**0.8**	0.4	0.1
Constantine	1.251.000	1.0	**0.9**	0.5	0.1	**0.9**	**0.9**	**0.9**	**0.8**
Djelfa	1.679.000	0.9	0.1	0.5	**0.8**	**0.6**	**0.6**	**1.0**	**0.9**
El Bayadh	337.000	0.5	0.6	0.1	**0.7**	**0.9**	0.1	**0.7**	0.3
El Oued	881.000	0.2	0.1	**0.6**	**0.7**	0.4	0.2	0.3	**0.7**
El Tarf	487.000	0.4	**0.7**	0.0	0.2	**0.6**	0.3	**0.9**	**0.7**
Ghardaïa	463.000	0.0	0.2	**0.9**	0.5	0.1	0.1	0.0	0.4
Guelma	559.000	0.2	**0.8**	0.3	0.0	0.2	0.4	0.3	**0.9**
Illizi	88.000	0.0	0.0	0.3	**0.8**	**0.7**	0.0	0.1	**0.7**
Jijel	708.000	0.7	**0.8**	0.0	0.4	**0.9**	**0.8**	0.3	0.4
Khenchela	475.000	0.7	0.4	**0.9**	0.2	0.2	0.5	**0.9**	**0.6**
Laghouat	742.000	0.2	0.2	**0.6**	0.5	**0.7**	0.3	**0.6**	0.2
M'sila	1.298.000	0.7	0.1	**0.7**	**0.7**	0.4	0.3	**0.8**	**0.6**
Mascara	940.000	0.5	**0.6**	0.3	**0.6**	**0.9**	0.4	**0.6**	0.1
Mila	901.000	0.0	0.5	0.0	0.0	**0.6**	0.5	0.4	0.5
Mostaganem	884.000	0.2	0.3	0.5	**0.6**	0.4	**0.7**	0.5	0.0

Médéa	878.000	0.3	0.5	**0.6**	0.4	**0.6**	0.2	**0.8**	0.1
Naâma	355.000	0.1	0.5	**0.6**	0.4	0.5	0.1	0.3	0.2
Oran	2.169.000	1.0	0.7	0.4	0.3	**0.8**	**1.0**	**0.7**	**0.7**
Ouargla	778.000	0.6	0.1	0.4	0.3	**0.9**	0.1	**0.9**	**1.0**
Oum El Bouaghi	778.000	0.1	0.3	**1.0**	0.1	0.3	**0.7**	0.1	0.2
Relizane	849.000	0.1	0.4	0.1	0.5	0.5	0.4	**0.8**	0.1
Saïda	411.000	0.9	**0.7**	0.2	**0.8**	**1.0**	0.3	**0.7**	0.5
Sidi Bel Abbès	723.000	0.8	**0.9**	0.1	**0.9**	**0.7**	**0.6**	0.1	0.5
Skikda	1.056.000	0.5	**0.8**	0.2	0.2	0.2	**0.7**	**0.7**	0.5
Souk Ahras	560.000	0.8	**0.8**	0.4	0.0	**1.0**	**0.8**	0.5	**0.6**
Sétif	1.766.000	0.3	0.3	**0.8**	0.1	0.1	**0.8**	**0.6**	0.4
Tamanghasset	241.000	0.7	0.0	**0.8**	**1.0**	0.3	0.0	0.5	**1.0**
Tiaret	1.148.000	0.6	**0.6**	**0.9**	**0.9**	0.1	0.4	0.4	0.2
Tindouf	101.000	0.4	0.0	**0.9**	**1.0**	0.1	0.0	0.2	**1.0**
Tipaza	688.000	0.6	**0.7**	0.5	0.4	0.0	**0.9**	0.3	**0.8**
Tissemsilt	654.000	0.9	**0.6**	**0.7**	0.3	**0.8**	**0.9**	**0.8**	0.2
Tizi Ouzou	1.156.000	0.4	**1.0**	0.2	**0.6**	0.1	0.5	**0.6**	0.3
Tlemcen	1.100.000	0.4	**0.9**	**0.7**	0.5	0.3	**0.6**	0.1	0.1
Tébessa	801.000	0.3	0.4	**1.0**	0.1	0.5	**0.7**	0.2	0.3

Source: https://precisionforcovid.org/africa, consulted: 20/09/2022

Fig (3): Algeria's vulnerability charts according to (CCVI)



Source: https://precisionforcovid.org/africa, (accessed 20 September 2022)

4-3 Epidemiological situation in-depth analysis based on (CCVI) indicators

4-3-1 In-depth analysis of vulnerability by Age

The United Nations considers "elderly" any person who has reached the threshold of 60 years old (United Nations Sustainable Development Group, 2020). According the World Health Organization, about 80% of COVID-19-related deaths occur in people over the age of 60. More than 70% of the Algerian population is young, aged less than 30 years old. Algeria

counts 4.275.061 people aged over 60 years old, representing a national average of 9.8% of the total population, the overall the region's population is considered as younger relative to many other world regions.

The General Directorate for Prevention and Health Promotion of the ministry of population health and hospital reform define old people as vulnerable people at risk of developing a severe form of SARS-CoV2 infection as: "people aged 70 and over, although patients between 50 and 70 years old should be monitored more closely (Ministère de la santé de la population et de la reforme hospitalière, 2020).

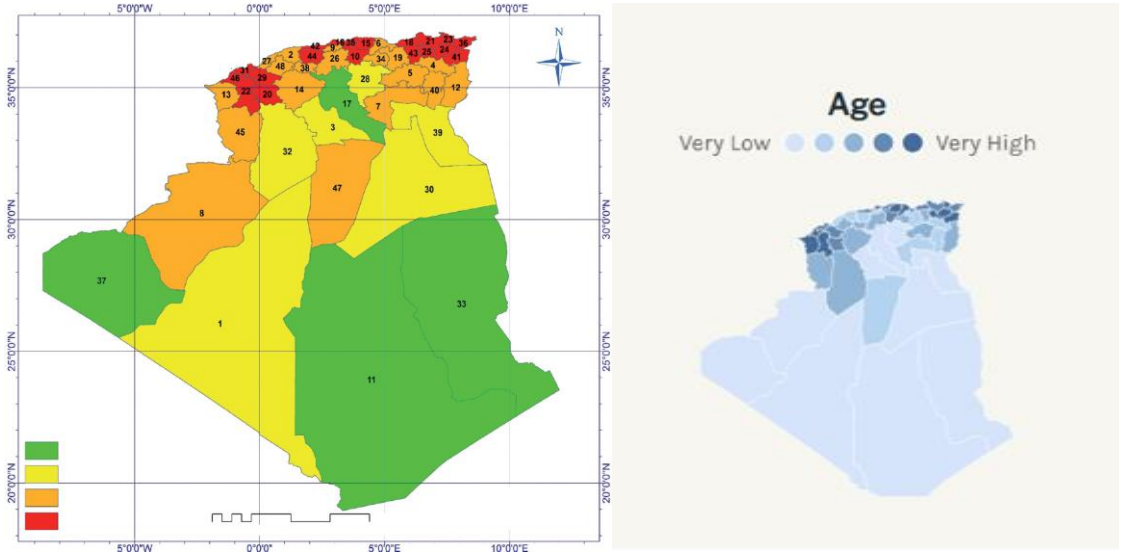
Table (6): Demographic and life expectancy data

Total population	Population 60+	Population > 60	Life expectancy	Old age dependency ratio (65+)	HDR adjusted life expectancy index	Age standerdised mortality rate attributable to NCDs (per 100.000)
43.576.691	4.275.061	9.8%	77.79	10.4	0.875	445.8

Source: (WHO Regional Office for Africa, 2021, p. 107)

The (CCVI) index shows that the COVID-19 pandemic has had a significant impact on older persons in (19) nineteen regions (wilayas). A higher score of vulnerability by the category of age is scored at Algiers and Tizi Ouzou with 1.0 score, relative to other parts of the country, followed by Tlemcen Sidi Bel Abbès Constantine Annaba Aïn Temouchent with 0.9 score. When comparing the map of age population Algeria's vulnerability charts according to (CCVI), the wilayas with high numbers of old people are the most vulnerable to COVID 19 according to the (CCVI).

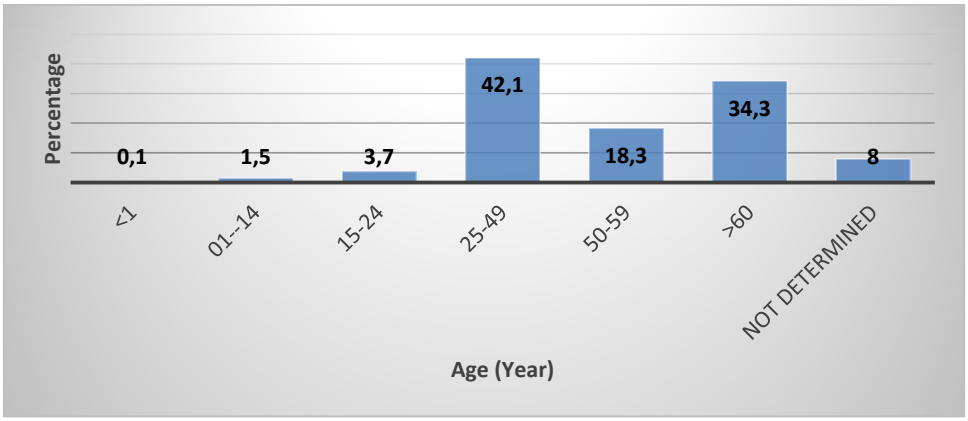
Fig (4): Map of the population age vs Algeria's vulnerability chart according to (CCVI) by age



Source: (Yahyaoui, Guellouh, Filali, & Berchiche, 2020) and https://precisionforcovid.org/africa, (accessed 20 September 2022)

In Algeria, the groups most affected by COVID-19 are those aged between 25 and 49 years (42.1%) and older adults of more than 60 years (34.3%). Patients younger than 25 years old comprise 5.3% while those aged between 50 and 59 years represent 18.3%. Men (54.2%) tend to be more impacted than women (45.8%). Regarding serious instances and fatalities in Algeria, even while not exactly determined, the available statistics show that 75% of the overall deaths in the nation were among adults older than 60 years (dashboard, 2022).

Fig (5): Repartition of confirmed COVID-19 cases by age

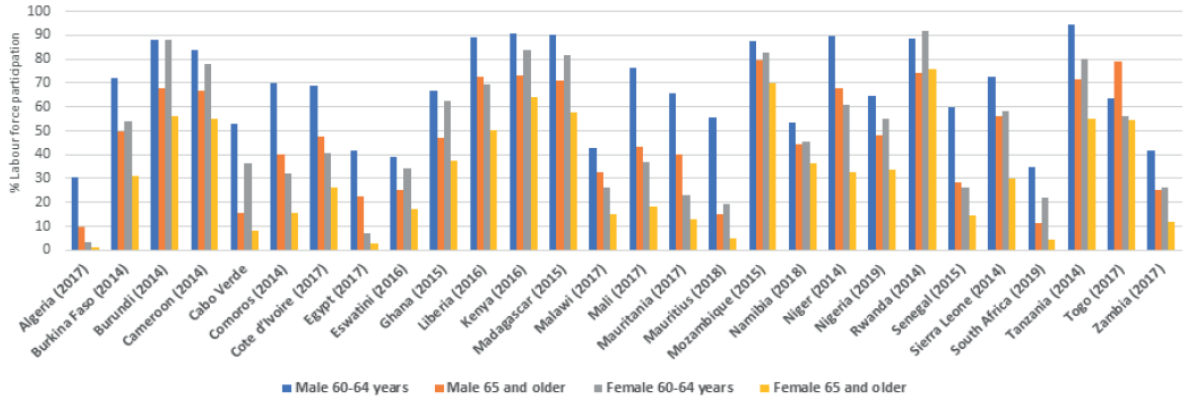


Source: COVID-19 dashboard, Available from: https://covid19.cdta.dz/dashboard/production/index.php# (accessed 26 September 2022)

Older adults are also at significantly greater risk of complications from COVID-19 and case fatality rates increase significantly with age due to reduced immunity and the increased likelihood of pre-existing chronic disease as well as reliance on other people due to disability, old age dependency ratio for old persons over 65 is 10.4. In this regard, the ONS declares that 55.3% of the population in question suffer from chronic pathologies, including more than half of women, while 30% are severely compromised health-wise, with a proportion almost equal in both sexes (Yahyaoui, Guellouh, Filali, & Berchiche, 2020).

Apart from the biological risk factors, socio-economic, long-term care and health system determinants have a major effect in health outcomes for older adults. Older people are important contributors to economic and social life in Algeria, 30% of male adults aged 60 to 64 remain in the labour market and almost third of those 65+ remain in the labour market. The ONS highlighted the introduction of a new concept concerning this category, namely "life expectancy in good health", referred to the indicators of dependence among this population (Yahyaoui, Guellouh, Filali, & Berchiche, 2020).

Fig (6): Labour force participation rates of older adults



Source: (WHO Regional Office for Africa, 2021, p. 11)

What is remarked is that contributory and noncontributory pension coverage is high which makes older labour participation rates low. Although, the need to continue to earn an income puts older people at significant risk of COVID-19 exposure and other communicable diseases.

Table (7): Pension coverage in Algeria

Old age total pension coverage	Contributory	Non-contributory	% Of population 60+ covered by a social pension (HelpAge)[2]
63.6	51.1	12.5	8

Source: (WHO Regional Office for Africa, 2021, p. 15)

4-3-2 In-depth analysis for vulnerability by epidemiological factors

The risk of severe illness and mortality among people infected with COVID-19 has mainly been concentrated among people with co-morbidities, particularly non-communicable diseases (NCDs) in many countries around the world. People with an increased likelihood of pre-existing chronic disease are also at significantly greater risk of complications from COVID-19 and case fatality rates increase significantly with reduced immunity (WHO Regional Office for Africa, 2021).

The General Directorate for Prevention and Health Promotion of the ministry of population health and hospital reform define people epidemiological factors as source of vulnerability and these people are at risk of developing a severe form of SARS-CoV2 infection as (Ministère de la santé de la population et de la reforme hospitalière, 2020):

- ✓ Patients with a cardiovascular history (ATCD): complicated arterial hypertension, ATCD of stroke or coronary artery disease, heart surgery, heart failure;
- ✓ Unbalanced insulin-dependent diabetics or those presenting with complications secondary to their pathology;
- ✓ People with a chronic respiratory pathology likely to decompensate during a viral infection;
- ✓ patients with chronic renal failure on dialysis; (1) people with congenital or acquired immunosuppression, on medication: under immunosuppressive chemotherapy, biotherapy and/or corticosteroid therapy at an immunosuppressive dose, (2) uncontrolled HIV infection with CD4 <200/min³ (3) solid organ or hematopoietic stem cell transplant recent (4) suffering from malignant hemopathy during treatment, (5) metastasized cancer, (6) Pregnant women showing no excess risk either for the mother or for the child; (7) People with morbid obesity (body mass index > 40kg/m².

The (CCVI) index shows that the COVID-19 pandemic has had a significant impact on peoples with chronic diseases as diabetes, hypertension, suffering obesity or smoking in (20) twenty wilayas of the country. A higher score of vulnerability by the category of epidemiological factors is scored at Oum El Bouaghi and Tébessa with 1.0 score, relative to other parts of the country, followed by Batna, Ghardaïa, Khenchela, Tiaret, Tindouf with 0.9 score.

4-3-3 In-depth analysis for vulnerability by health system

Total national health expenditure is constantly increasing. It roses from 3.49% to 6.6% of GDP between 2000 and 2013, then to 7% in 2015 to reach 6.4% in 2017, this is a significant percentage in comparison, for example, to its neighbour; Morocco (5.5%), although this rate remains incomparable with that of industrialized countries such as France; 8.6% of GDP for the year 2018. However, the health sector suffers major dysfunctions that continues to paralyze it, fundamental problem is poor management, management and development of human resources, health financing, public-private decompartmentalization, patient care, lack

of means, corruption, inequalities of access to care and drugs, teaching program and training of doctors, acquisition and mastery of new technologies, etc. (Snoussi, 2020).

Table (8): Health systems grouped by coverage of essential health services

Coverage of essential health services (%)	Total net official development assistance to medical research and basic health sectors per capita (USD)	Proportion of health facilities with a core set of relevant essential medicines available and affordable on a sustainable basis (%)	Density of medical doctors (per 10.000 population)	Density of nursing and midwifery personnel (per 10.000 population)	Compliance with international health regulations core capacity scores	Current health expenses (percentage GDP)
78	0.007	-	17.19	15.48	800	6.4%

Source: (WHO Regional Office for Africa, 2021, p. 109)

The Coronavirus has put Algerian health system to the test. Covid-19 has clearly revealed the dysfunctions of the health system: (1) A highly centralized health system: Pasteur institute is the only body authorized to carry out PCR tests, (2) difficult working conditions of nursing staff in public health establishments, (3) Absence of liberal doctors, (4) Completely obsolete reimbursement rates, (5) Shortage of certain drugs for chronic diseases following border closures (Snoussi, 2020).

Laboratory analysis was an important weak point of the Algerian health system during COVID-19 pandemic. In the pandemic initiation, the number of realized tests was estimated at 50 tests per day in the Pasteur Institute of Algiers, the only laboratory approved to realize them. This number has reached more than 400 tests per day with the opening of 20 new laboratories in different wilayas (Louni, 2020).

The (CCVI) index shows that COVID-19 pandemic has had a significant impact on regions with fragile health system, where (22) twenty-two wilayas of the country was highly affected. A higher score of vulnerability by the category health system is scored at Adrar, Saïda and Souk Ahras with 1.0 score, relative to other parts of the country, followed by Constantine, El Bayadh, Jijel, Mascara and Ouargla with 0.9 score.

4-3-4 In-depth analysis for vulnerability by population density

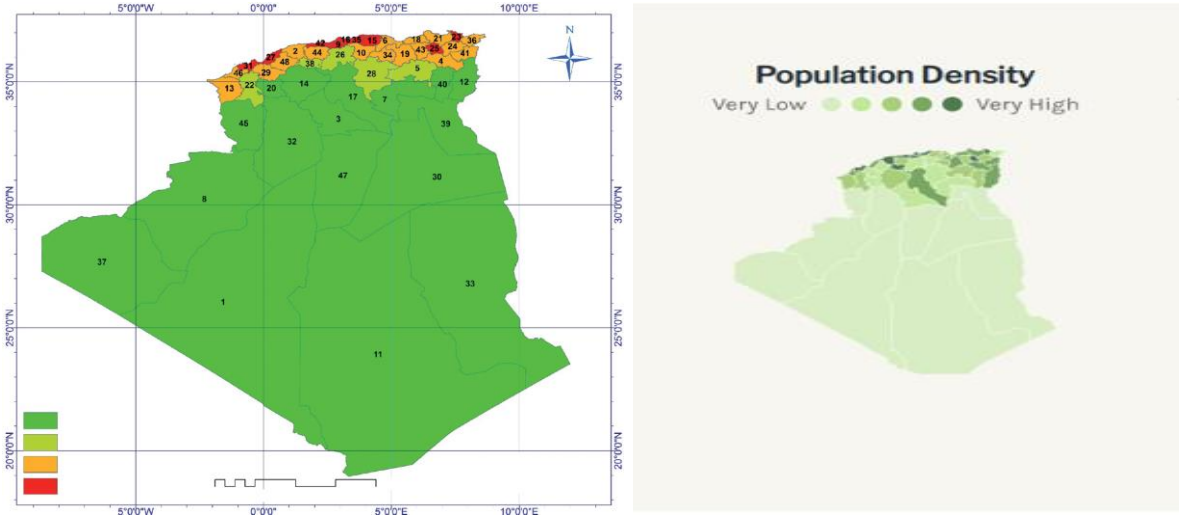
Population Density factor has an important impact on the social vulnerability of the population, this impact is clear in highly populated large cities. Population density is a helping condition to the rapid spread of the virus and the concentration of human settlements is a factor of high level of vulnerability.

The (CCVI) index shows that the COVID-19 pandemic has had a significant impact in densely populated cities where (22) twenty-two wilayas of the country was highly affected. A higher score of vulnerability by the category of population density is scored at Algiers, Blida and Oran with 1.0 score, relative to other parts of the country, followed by Annaba, Boumerdès, Constantine, Tipaza and Tissemsilt with 0.9 score. Same results were obtained by (Delmadji, 2022) when using Big Data to monitor the spread of this virus in Algeria by analysing the similarities of the 48 Algerian provinces using the Hierarchical Cluster Analysis based on 7 variables (Cumulative confirmed cases, New confirmed case, Incidence rate, Cumulative deaths cases, new death case, Mortality rate and Fatality rate %). The study found that 48 provinces have been grouped in 7 clusters in which high densely populated provinces were the most effected like Alger and Oran. Whilst, the low densely populated provinces constituted the lowest incidence of disease (Delmadji, 2022).

Examining the population density the wilaya of Algiers is of 3.666 inhabitants per km2, Blida 462 inhabitants/km2 and Oran of 685 inhabitants/km2. 539 inhabitants/km2 for

Boumerdes, for the Tell and the Steppe the imbalance is more important, marking a density of more than 429 inhabitants/km2 for the wilaya of Constantine. The Southern wilayas are considered as resilient to COVID 19 since the density is less than one inhabitant/km2 for the wilayas of Adrar (0.91 inhabitants/km2), Tamanrasset (0.32 inhabitants/km2), Tindouf (0.31 inhabitants/km2), and Illizi (0.18 inhabitants/km2). All this is obvious when comparing the population density map to Algeria's vulnerability chart according to (CCVI) by population density. In the same logic, territories with the lowest prevalence and incidence rate are declined as the territories most resistant to the pandemic. This is the case of Saida, Chlef, Sidi-Bel Abbès, Souk-Ahras, El Bayad, Tamanrasset, Relizane, El Tarf and Bordj Bou Arreridj with less than 500 cases and an incidence of less than 100 per 100,000 inhabitants.

Fig (7): Population density map vs Algeria's vulnerability chart according to (CCVI) by population density



Source: (Yahyaoui, Guellouh, Filali, & Berchiche, 2020) and https://precisionforcovid.org/africa, (accessed 20 September 2022)

4-3-5 In-depth analysis for vulnerability by fragility

The (CCVI) index shows that the COVID-19 pandemic has had a significant impact on (21) twenty-one wilayas of the country, what is remarked is that the southern wilayas considered as highly fragile were highly impacted followed by the Steppe wilayas. A total of A higher score of vulnerability by the category of fragility is scored at Algiers, Tamanghasset and Tindouf with 1.0 score, relative to other parts of the country, followed by Adrar, Aïn Defla, Béchar, Sidi Bel Abbès and Tiaret with 0.9 score.

4-3-6 In-depth analysis for vulnerability by socio-economic factors

Algeria suffers from multilevel disparities including between genders, regions (urban/rural), and income brackets. In term of disparity between northern country regions and southern ones, people living in Algeria's Sahara and the Steppe, suffer from double and triple the national poverty average, respectively. According to the latest available data indicates that while the richest 10% of the population accounted for 23% of the 2011 income, the poorest 10% accounted for only 4%. In terms of inequalities in consumption, the gap between the rich and the poor is almost 28% (Abouzzohour & Ben Mimoune, 2020).

Restrictive preventive measures as keeping social distancing to limit the spread of the virus and the mandatory mask wearing had different impacts on different wilayas. Although,

these measure's decision was left to the local governors to be hardened of softened corresponding to the pandemic situation of each wilayas territory, low income and needy families suffered vital needs shortages. The economic and social costs of measures to contain the spread of the disease have had negative impacts on populations across wilayas already faced with high levels of poverty or weak systems of essential services delivery.

Table (9): Algeria' s Economic Data

GDP estimated growth 2020 (%)	GDP per catipa (2017 PP $)	GINI co-efficient	Extreme poverty rate (those living under 1.90 $)	Unemployment total (% of labour force)	Human Development Index (F/M)	HDI ranking globally
-6.5	11.350	27.6 (2011)	0.5	11.7	0.671 / 0.782	91

Source: (WHO Regional Office for Africa, 2021, pp. 108-115)

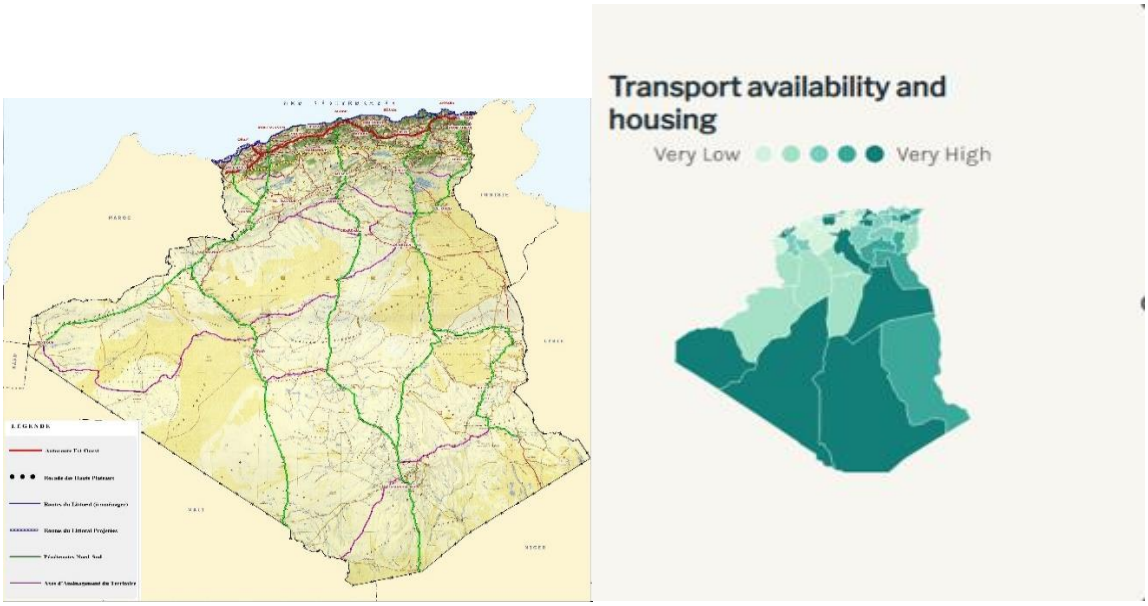
The (CCVI) index shows that the COVID-19 pandemic has had a significant impact on (21) twenty-one wilayas of the country. A total of A higher score of vulnerability by the category of socio-economic factors is scored at Algiers, Aïn Defla and Djelfa with 1.0 score, relative to other parts of the country, followed by Aïn Témouchent, Constantine, El Tarf, Khenchela and Ouargla with 0.9 score.

4-3-7 In-depth analysis for vulnerability by transportation availability and housing type

Transportation availability and housing type factor is detailed into five sub-themes: (1) Access to transportation, (2) Connectivity by road, (3) crowding in household, (4) improved housing and (5) sanitation.

The (CCVI) index shows that the COVID-19 pandemic has had a significant impact on (22) twenty-two wilayas of the country, A total of A higher score of vulnerability by the category of transportation availability and housing factors is scored at Ouargla, Tamanghasset, Tindouf with 1.0 score, relative to other parts of the country, followed by Aïn Defla, Bordj Bou Arréridj, Béjaïa, Djelfa and Guelma with 0.9 score. When comparing the transportation availability map to Algeria's vulnerability chart according to (CCVI) transportation availability it seems that the southern wilayas are the most vulnerable.

Fig (8): Transportation availability map vs Algeria's vulnerability chart according to (CCVI) by transportation availability



Source: https://precisionforcovid.org/africa, (accessed 20 September 2022)

Conclusion:

Research on COVID-19 pandemic impacts so far highlights the multi-sectoral dimensions of the depth of the epidemiological crisis, the analysis of the pandemic magnitude and the virus degree of spread requires a cross-cutting approach, linking epidemiological, geographical, demographic and socio-economic analyses and measurements of inequalities and vulnerability.

This study tried to search for health social determinants in Algeria by analysing how social vulnerability Determined COVID-19 Pandemic Magnitude. This rapid analysis of Health social determinants is based on the themes, subthemes and indicators of The Africa Covid Community Vulnerability Index (CCVI) used for majority of African countries that operationalizes the social vulnerability: (1) socioeconomic status; (2) population density; (3) housing type and transportation; (4) epidemiological factors; and (5) health system factors; (6) fragility; and (7) old age. Several indicators seem to have intervened together and in a rather complex way in the spatial configuration of Covid-19 in Algeria. What is certain is that the crossing of data relating to epidemiology and different socio-economic, geographic and demographic factors have allowed us to identify how their combination in the same territory is associated with a higher probability of pandemic expansion as has been well demonstrated by many Algerian wilayas.

The study highlights the importance of shock and crisis management plans, the importance of social protection system updating, reducing transmission, the role of public and private investments in health system and the need to focus on those most affected: the elderly, people with disabilities and people suffering chronic diseases. Managing epidemiological vulnerability by managing all these factors can be a solid foundation for adequate public policies that allows economic and social recovery in more solid, resilient and sustainable foundations. With regard to our study, it is important to consider social vulnerability factors as health social determinants to be used in epidemiological surveillance and public health policy management. The study promises to be an interesting gateway to understanding the health hazard and this in view of the territorial inequalities at different degrees of resistance and vulnerability.

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-Appendices

The Africa Covid Community Vulnerability Index (CCVI) Themes, subthemes and indicators used for majority of African countries

Africa CCVI themes	Africa CCVI subthemes	Indicators
Theme 1: Socioeconomic Status	1. Access to information 2. Education 3. Poverty 4. Unemployment	1.1Percentage of women/men with access to newspaper, television and radio at least once a week, 1.2 Percentage of households possessing a Television 1.3 Percentage of households possessing a mobile telephone 1.4 Percentage of women/men who own a mobile phone. 2.1 Percentage of women/men with primary education 2.2 Percentage of women/men with secondary or higher education 2.3 Percentage of women/men who cannot read at all 2.4 Percentage of women who are blind or visually impaired and unable to read. 3 Multidimensional poverty indices. 4.1 Percentage of women/men who did no work in the 12 months preceding the survey
Theme 2: Population Density	1. Population density	1.1 Population density per square km. 1.2 Population density at which the median individual lives in that region.
Theme 3: Housing type & Transportation	1. Access to transportation 2. Connectivity by road 3. Crowding in household 4. Improved	1.1 Percentage of households possessing a motorcycle; 1.2 Percentage of households possessing a private car 2. Mean of road meters per km2 per cell 3.1 Mean number of household members, 3.2 Percentage of households with one room used for sleeping, 3.3 Mean number of persons per sleeping room, 4 Prevalence of improved housing in sub-Saharan Africa, in 2015, 5.1 Percentage of households whose main source of drinking water is an improved source, 5.2 Percentage of

	housing 5. Sanitation	households with water on the premises, 5.3 Percentage of households using an appropriate treatment method, including boiling, bleaching, filtering or solar disinfecting, 5.4 Percentage of households with a flush or pour flush toilet not to a sewer, septic tank or pit latrine, 5.5 Percentage of households where a place for washing hands was observed, 5.6 Percentage of households with water more than 30 minutes away round trip, 5.7 Percentage of households with an unimproved sanitation facility, 5.8 Percentage of households whose main type of toilet facility is no facility (open defecation)
Theme 4: Epidemiological Factors	1. HIV 2. Other infectious diseases 3. Obesity 4. Diabetes 5. Hypertension 6. Smoking	1.1 HIV Prevalence 2000-2017: Mean Estimates, 2.1 Lower respiratory infection (LRI) prevalence among children under 5, 2.2 Annual Mean of Parasite Rate (Plasmodium falciparum), 3.1 Percentage of women who are obese according to BMI (>=30.0), 3.2 Percentage of men who are obese according to BMI (>=30.0), 4.1 Prevalence of Diabetes, 5.1 Prevalence of Hypertension, 6.1 Percentage of men who smoke cigarettes
Theme 5: Health System Factors	1. Health Facilities per capita 2. Access to healthcare systems 3. Vaccination	1.1 Number of health sites (normalized to population); 2.1 Percentage of women who had a live birth in the five (or three) years preceding the survey who received antenatal care during the pregnancy for the most recent live birth from a skilled provider Percentage of women who had a live birth in the five (or three) years preceding the survey who received antenatal care during the pregnancy for the most recent live birth from a skilled provider 2.2 Percentage of children with fever in the two weeks preceding the survey for whom advice or treatment was sought from a health facility or provider; 2.3 Percentage of live births in the five (or three) years preceding the survey delivered at a health facility; 2.4 Percentage of children born in the five (or three) years preceding the survey with diarrhea in the two weeks preceding the survey who were taken for a treatment to a healthy facility; 2.5 Percentage of women who reported they have big problems in getting money for treatment for themselves when they are sick; 2.6 Percentage of women who reported they have big problems in the distance to health facility for treatment for themselves when they are sick; 3.Percentage of children 12-23 months who had received no vaccinations.
Theme 6: Fragility	1. UNHCR population of concern sites 2. Civil Unrest 3. Population of concern sites 4. Food insecurity	1. Number of populations of concern sites (normalized to population); 2.1 Number of deaths in armed conflicts (normalized to population); 2.2 Number of battles occurrences since Jan 1, 2020; 2.3 Number of explosions occurrences since Jan 1, 2020; 2.4 Number of violence against civilians incidences since Jan 1, 2020; 2.5 Number of riots occurrences since Jan 1, 2020; 2.6 Percentage of children stunted (below -2 SD of height for age according to the WHO standard); 3.1 Percentage of children under age 5 classified as having any anemia; 3.2 Percentage of women classified as having any anemia (<12.0 g/dl for non-pregnant women and <11.0 g/dl for pregnant women); 3.3 Percentage of men classified as having any Anemia; 3.4 Percentage of households with 3 generations
Theme 7: Old age	1. Old age	1.1 Percentage of households with 3 generations 1.2 Percentage of population 60 years or older

Source: Africa COVID-19 Community Vulnerability Index: Methodology, PP 03, 10, on https://precisionforcovid.org/africa, consulted: 20/09/202