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# Application of self-assessment triage tool in COVID-19 pandemic: descriptive study

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## *Abstract*

**Background:** COVID-19 pandemic has sped up the implementation of telehealth solutions in medicine, mainly in primary health. A few symptom checkers dedicated for COVID-19 have been described. These tools have been noticed by academics, but it remains unclear if and how they can affect patients and health systems.

**Objective:** COVID-19 pandemic has sped up the implementation of telehealth solutions in medicine. This paper demonstrates our experiences with the COVID-19 Risk Assessment Tool. We tried to determine who is the user of the web-based COVID-19 triage application and compare this group with the patients of the infectious diseases ward's admission room to evaluate who could benefit from implementing the COVID-19 online symptom checker as a remote triage solution.

**Methods:** We have analyzed the answers of more than 650 000 people interacting with an online WHO-based triage tool for assessing the probability of SARS-CoV-2 infection. Based on the presented symptoms, risk factors, and demographics, the tool has assessed if the user's answers are suggestive of COVID-19 and recommended appropriate action. Subsequently, we have compared "patient profiles" of tool users with patients admitting to the Infectious Diseases Admission Room.

**Results:** COVID-19 Risk Assessment tool tended to be used by asymptomatic or oligosymptomatic individuals, which constituted 70.58% of all users. The majority of users were young (67.30% were below 40 years of age) and without significant comorbidities. On the contrary, most admission room patients were symptomatic - symptoms like fever, cough and dyspnea were prevalent in both covid positive and negative patients. COVID-suspected patients in the self-assessment tool presented similar COVID-19 symptoms as those who presented to the admission room. These were: cough (66.51% in self-assessment tool, 59.48% in the admission room, P=.03), fever (57.79% in the self-assessment tool, 62,93% in the admission room, P=.13), and shortness of breath (8.73% in the self-assessment tool vs. 37.50% in the admission room, P<.001).

**Conclusions:** The self-assessment COVID-19 tool, as it served as the means of screening and self-education, did not substitute for the consultation in the admission room for symptomatic patients. It seems that these types of solutions may serve as health information hubs for oligosymptomatic individuals, as well as a way of identifying and advising patients at risk. It fulfils the idea of remote, pre-clinical triage, however, the accuracy and influence on healthcare must be examined in the clinical setting.

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## ORIGINAL PAPER

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# Application of self-assessment triage tool in COVID-19 pandemic: descriptive study

## ABSTRACT

### Background

COVID-19 pandemic has sped up the implementation of telehealth solutions in medicine. A few symptom checkers dedicated for COVID-19 have been described, but it remains unclear if and how they can affect patients and health systems.

### Objective

This paper demonstrates our experiences with the COVID-19 Risk Assessment Tool. We tried to determine who is the user of the web-based COVID-19 triage application and compare this group with the patients of the infectious diseases ward's admission room to evaluate who could benefit from implementing the COVID-19 online symptom checker as a remote triage solution.

### Method

We have analyzed the answers of more than 240 000 people interacting with an online WHO-based triage tool for assessing the probability of SARS-CoV-2 infection. These users filled in an online questionnaire between the 7th of April 2020 - 6th of August 2020. Based on the presented symptoms, risk factors, and demographics, the tool has assessed if the user's answers are suggestive of COVID-19 and recommended appropriate action. Subsequently, we have compared sociodemographic and clinical characteristics of tool users with patients admitted to the Infectious Diseases Admission Room of J. Gromkowski Hospital in Wrocław.

## Results

COVID-19 Risk Assessment tool tended to be used by asymptomatic or oligosymptomatic individuals - they constituted 68,80% of all users. Most users were young (65,27% were below 40 years of age) and without comorbidities. Only 31.2% of the app users were suspected of COVID-19 based on their reported symptoms. On the contrary, most admission room patients were symptomatic - symptoms like fever, cough, and dyspnea were prevalent in both covid positive and negative patients. COVID-suspected patients in the self-assessment tool presented similar COVID-19 symptoms as those who presented to the admission room. These were: cough (62,64% in self-assessment tool, 59.48% in the admission room), fever (57.80% in the self-assessment tool, 62,93% in the admission room), and shortness of breath (37,89% in the self-assessment tool vs 37.50% in the admission room).

## Conclusions

The comparison between the symptomatology of the users interacting with the COVID-19 Risk Assessment tool and those visiting the Admission Room revealed two major patient groups who could have benefited from the implementation of the self-assessment application in preclinical triage settings. The primary users of the CRA tool were the young, oligosymptomatic individuals looking for screening for COVID-19 and reassurance early in the COVID-19 pandemic. The other group were the users presenting the typical symptoms suggestive of COVID-19 at that time. The CRA tool recognized these individuals as potentially COVID-19 positive and directed to the proper level of care. These use cases fulfil the idea of preclinical triage; however, the accuracy and influence on healthcare must be examined in the clinical setting.

**Keywords: COVID-19; symptom checker; preclinical triage; self-assessment tool; online applications; COVID-19 remote triage; COVID-19 self-assessment**

# Abbreviations

CRA – COVID-19 Risk Assessment
API - Application Program Interface (API) is a set of routines, protocols, and tools for building software applications. Basically, an API specifies how software components should interact. It serves as a technological core for custom-building applications

# ARTICLE

## Introduction

After the outbreak of the COVID-19 pandemic, the healthcare systems of affected countries faced an unprecedented challenge. Ensuring the continuity of care and screening the vast number of suspected patients has put a significant strain on healthcare, leading to the depletion of public health resources [1,2]. While the health system resources were transferred to provide critical services to patients suffering from COVID-19, the utilization of medical visits was reduced by even 42% [2], suggesting that patients with less severe illnesses tended to avoid in-person consultation or had no possibility to attend one.
During the pandemic, especially in the early days, there was much uncertainty regarding the symptomatology and clinical course of the novel coronavirus disease. It has been reflected in the

number of searches for the phrase “covid 19 symptoms” in the Google platform, which at the time of the study varied from 443 K to 2.2 M searches per month, just for the United States [3].
These uncertain times have presented the opportunity to popularize telehealth solutions in medicine. The means of remote consultations have found their way mostly in primary care as a substitute for the in-person visits [4] but also a way of remote triage of COVID-19 patients.
Triage is defined as a classification of patients according to their urgencies. Remote triage uses the means of distance communication such as telephones or interactive websites, allowing for the segregation of patients before they interact with healthcare professionals. Remote triage solutions have been proven helpful in telephone call centres, where they have been associated with lower in-person healthcare use [5]. They have also been demonstrated to be useful in the triage of COVID-19 patients, as they have reduced the number of unnecessary consultations, hence reducing the exposure of the staff to COVID-19 [6]. Web-based COVID-19 symptom checkers and triage tools have also proved useful in scheduling tests [7,8], monitoring symptoms [9,10,11], providing evidence-based educational value [8,9,12] and supporting self-isolation [13].

## Objective

In this study, we wanted to share our findings regarding the COVID-19 Risk Assessment (CRA) tool. It was a WHO guidelines-based online triage tool, which assessed the risk of SARS-CoV-2 infection and returned a probable outcome with a concise recommendation of what to do next, along with evidence-based educational materials about the COVID-19.

We gathered and analyzed the data of 651 757 patients interacting with the CRA focusing on their demographics, risk factors, reported symptoms, possible exposure to SARS-CoV-2, and recommended triage. The aim was to establish who are the main users of web-based COVID-19 symptom checkers (age, sex, comorbidities, presenting symptoms) and who might have benefitted from implementing COVID-19 symptom checkers as preclinical triage solutions.

Since confirming the diagnosis in an online self-assessment tool was not achievable, we compared the results - sociodemographic and clinical characteristics of CRA users - with the health records of the Infectious Diseases Admission Room in Gromkowski Hospital in Wrocław to establish if and how these groups corresponded. The goal was to evaluate who could benefit from implementing this solution as preclinical triage.

## Materials and methods

## Study population

Since the 7th of April 2020, we have been collecting and utilizing responses from the CRA tool users. The application was developed by Infermedica company, as a non-profit project. It utilized a diagnostic algorithm designed based on WHO and CDC recommendations. The specific time frame was chosen due to periodical updates of the application questions flow. In the selected period there were no major changes to the question flow so that the collected information could be unbiased.

## Inclusion criteria

The study population included individuals concerned about their risk of COVID-19 infection:

1. Users who filled the questionnaire available through the Infermedica website between 07.04.2020 and 06.08.2020.
2. Users who filled the questionnaires available on third-party websites, which obtained permission to use our tool within their platforms between 07.04.2020 and 06.08.2020

## Exclusion criteria

1. Completing the interview in an outdated 1.0 and 2.0 version (not all providers of our tool updated their software before the beginning of the study).
2. Completing the interview in a version customized for a national health system so that it was incompatible with WHO and CDC recommendations.
3. Not completing the whole interview.
4. Age below 18 years

5. Completing the interview in the language other than polish

## Data privacy and ethical statement

The study population consisted of two arms: users of the web application and the patients of the admission room.
The application arm consisted of the users of the web application who have accepted the Terms of Service. All data processed through the COVID-19 Risk Assessment Checker was anonymous and did not allow to identify an individual based on the information given during the interview. The informed consent to use anonymized data was given by the user by accepting Terms of Service. Privacy policy and personal data protection were applied.
The admission room arm of the study, according to the National Code on Clinical Trials [14], did not require an ethics committee approval as a retrospective study.

## COVID-19 symptom checker characteristics

COVID-19 Risk Assessment is a triage tool dedicated to non-professional users. The checkup was designed to assess if the user's symptoms may be the result of SARS-CoV-2 infection or not. It had a form of a responsive web application that could be embedded within a website or an API that can serve as a technological core for building custom applications. The flow of the interview was solely based on the official WHO guidelines for diagnosing COVID-19 [15]. The first version of API was released on March 20th, 2020 *(version 1.0)*, followed by updates on March 25th, 2020*(version 2.0)*, April 7th, 2020 *(version 3.0)*, and May 7th, 2020 *(version 4.0)*.

Application has been considered final from version 3.0; the set of risk factors and symptoms have reached their final form. However, the core logic of the interview, like the flow of the interview, types of acquired data, and types of output recommendations, have been consistent from the first released version. In this study, we will only consider interviews in the period between April 7th and August 6th, 2020.

## Medical Foundation

The CRA tool's logic was built around the WHO guidelines [15] and WHO daily transmission reports [16]. The interview was designed to gather enough data to establish if the user falls into any of the three categories mentioned in said guidelines as "Suspected case" for COVID-19; therefore, the reported symptoms may have resulted from SARS-CoV-2 infection.

For this reason, the interview consisted of three sets of questions that can be grouped into three categories:

1. Risk factors and symptoms
2. The places of residency and travel
3. Contact with possible COVID-19 case

In some cases, when this information was unnecessary to obtain the diagnosis, some questions were omitted.

## Data analysis

The majority of the data are compared and presented with the use of descriptive statistics. Inferential statistics had to be omitted because of the significant differences in both compared populations and vastly different sample sizes. We decided only to use statistical analysis to compare comorbidities related to COVID-19 in both CRA and the admission room. In the CRA, p-values were calculated with the test of proportions; in the admission room - Fisher exact test.

## Screen deep dive

The interview consisted of up to eight consecutive screens. Not every screen had to be included; this is the maximum number of screens that the user could have been exposed to. If the patient reported emergency evidence (i.e., acute dyspnea), the interview has been terminated with an instruction to call an ambulance. The screens in the display order were: Welcome & Terms of Service, Age and sex selection, Risk factors, Symptoms, Red flags, Possible exposure to COVID-19, Travel and Residency, Outcome.

Nine risk factors have been inquiring about user's chronic illnesses and overall medical condition: Diseases or drugs that weaken the immune system, Obesity, Long-term stay at a care facility or nursing home, Diabetes, Cardiovascular disease, History of chronic lung disease, History of chronic liver disease, History of chronic kidney disease.

Some of these comorbidities have been described as negatively impacting COVID-19 infection outcomes [17]. We have also included risk factors described in the Pneumonia Severity Index (PSI) as a negative prognostic factor indicating the need for hospitalization [18]:

The symptoms screens were oriented on inquiring about users' symptoms that should raise clinical suspicion for COVID-19 according to WHO guidelines [15]. There was a list of 11 symptoms users could choose from: Fever, Cough, Shortness of breath, Fatigue, Muscle pain, Chills, Headache, Diarrhea, Nausea, Sore throat, and Impaired taste or smell.

Furthermore, the interview was focused on assessing red flags - the immediate health threats to the user that should yield in cessation of the interview. In order to do so, the user was asked about rapid symptom deterioration, tachypnea, or hemoptysis.

There were six possible outcomes of the interview, which referred to the possibility of COVID-19 infections and the severity of the symptoms:

1. COVID-suspected, serious - "Call the emergency number. Avoid all contact."
2. COVID-suspected, non-serious - "Consult your healthcare provider. Avoid all contact."
3. Contact with COVID-19, no symptoms - "Quarantine."
4. non-COVID, serious - "Call a doctor."
5. non-COVID, non-serious - "Stay home and monitor your symptoms."
6. Asymptomatic - "Follow preventive measures.

The extensive screen description and decision tree logic can be browsed in the appendix.

## Comparison group - admission room analysis

In order to compare individuals completing the survey with real patients diagnosed with COVID-19 by healthcare professionals, we have turned to the Infectious Diseases Admission Room of Gromkowski Hospital in Wrocław. We have analyzed 291 cases of patients visiting the Admission Room between the 7th of April 2020 and the 6th of August 2020. All of the patients reporting to the admission room were suspected of COVID-19 infection; no other cases of infectious diseases were consulted in the admission room at that time. They may have been brought to the admission room by ambulance, referred by the primary care physician, or admitted by themselves. We excluded patients below 18 years of age.

Each patient has been interviewed and examined by the physician working in the admission room. The interview consisted of fixed elements such as current symptoms, comorbidities, medication, history of travel, contact with COVID-19 positive person, and workplace and family interview. The blood analysis, chest X-rays, and COVID-19 swabs were obtained in most cases.
The patient's history and examination, along with the additional tests, allowed them to decide on admission to the hospital or the discharge home. After 24 hours, the results of the COVID-19 genetic test (the RT-PCR from nasopharyngeal or pharyngeal swabs) were available, which allowed reaching the final diagnosis.

### *Setting*

Gromkowski hospital in Wrocław, Lower Silesian Voivodeship, Poland, is one of the specialist hospitals in that city. There are two Infectious Diseases wards at the hospital. The infectious diseases admission room serves as the place for preliminary triage, diagnosis, and treatment of incoming patients, suspected of contracting infectious diseases. During the COVID-19 pandemic, it served as the main consultation facility of COVID-19-suspected cases.

### *Population*

In this study, we analyzed the infectious diseases' admission room cases between the 7th of April and the 6th of August 2020. We have focused on the set of reported symptoms, comorbidities, contact with COVID-19 case, and travel history. Our goal was to determine the “patient profile”, meaning assessing the set of symptoms connected with COVID-19 cases compared to non-COVID-19 cases.
Finally, we wanted to compare the sociodemographic and clinical characteristics of hospital patients and the ones completing the self-assessment interview.

### *Symptoms*

In the study, we have screened for 8 symptoms that have been suggestive of COVID-19 infection: cough, fever, dyspnea, diarrhea, myalgia, rhinorrhea, taste and smell abnormalities, pharyngeal pain.

## RESULTS

## Demographics & Groups characteristics

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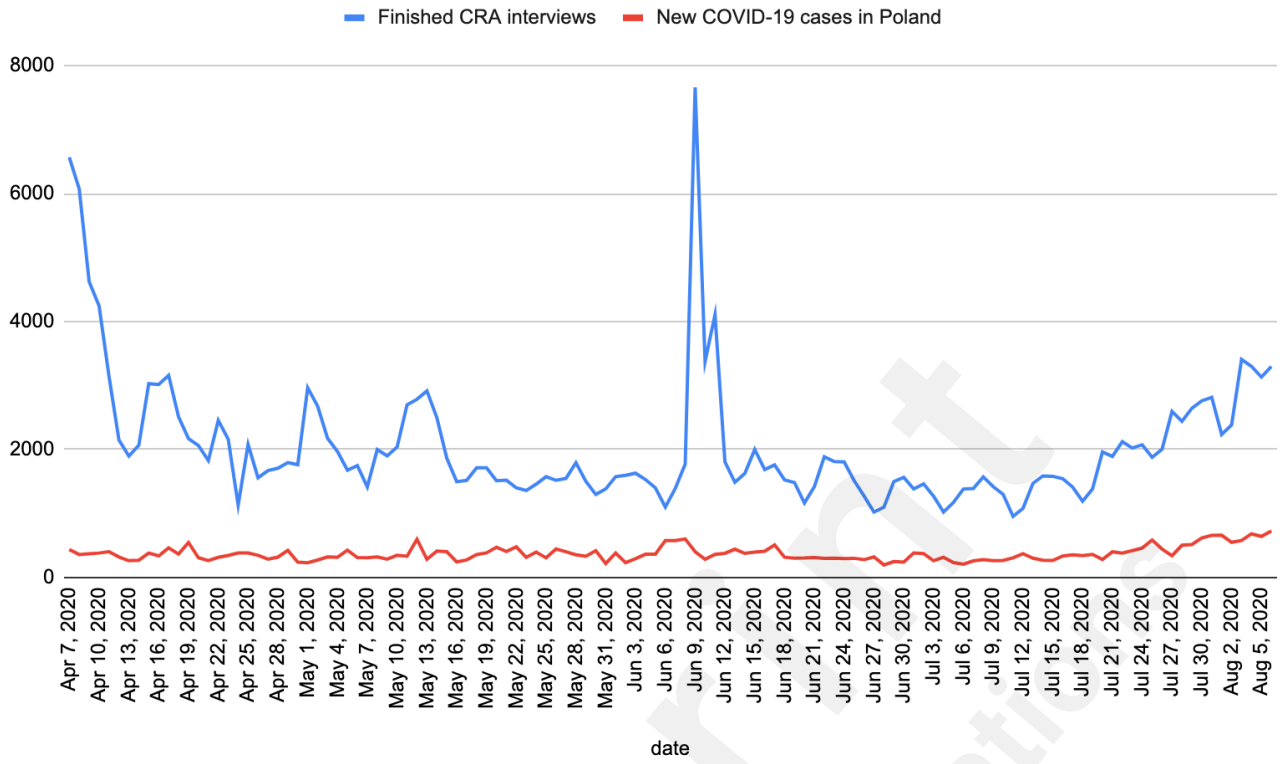


*Fig. 1. Finished CRA interviews daily (blue line). For comparison, daily number of new diagnosed COVID-19 cases in Poland (red line)*

## Self-assessment tool

Out of 697 903 individual interviews performed on the CRA tool during the 7th of April and the 6th of August of 2020, a total of 248 862 individual interviews have met the inclusion criteria. Most of the interviews came from the governmental portal of the *Polish Ministry of Health*, which embedded the application within their website [19] - 117 311 (47.14% of all interviews). 91805 (36.89%) interviews were performed on the original CRA website [20]. 17 767 (7.14%) interviews were performed on the COVID-19 mobile application commissioned by the *Polish Ministry of Health*. Other notable institutions adopting the CRA and providing us interviews analyzed in the study included: *PZU Zdrowie* (Polish biggest private healthcare provider), *Dovera* (private healthcare provider in Slovakia), *Global Excel* (medical assistance company operating in the US and Canada) and others [21]. The tool has been offered in 37 languages in total. Polish, English, Slovak, Ukrainian, Portuguese-Brazilian, and Russian were the most popular languages. However, only Polish-speaking users met the inclusion criteria.

Most of the respondents were between 18-40 years old (63.89 % of all respondents). The least prevalent were users between 80 and 90 years old (0,2%). The mean age was 37 years. The study included 130 966 or 52.6% males and 117 896 or 47.4% females.

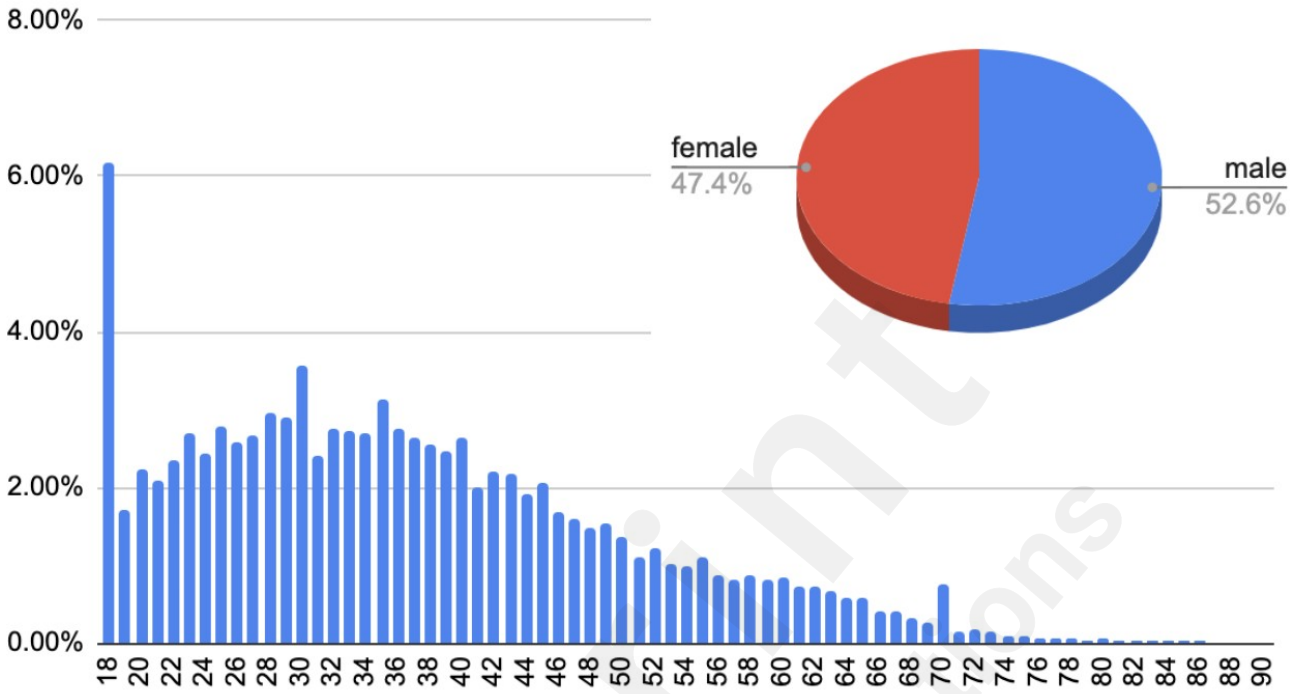


*Fig. 2. Age and sex distribution of CRA users*

## Admission Room

The study included 291 patients that visited the Infectious Diseases Admission Room of Gromkowski Hospital in Wrocław between the 7th of April and the 6th of August 2020.There were 153 women and 139 men enrolled in the study. Most of the patients were between 41-70 years old. The mean age was 58 years; the median age was 60 years old.

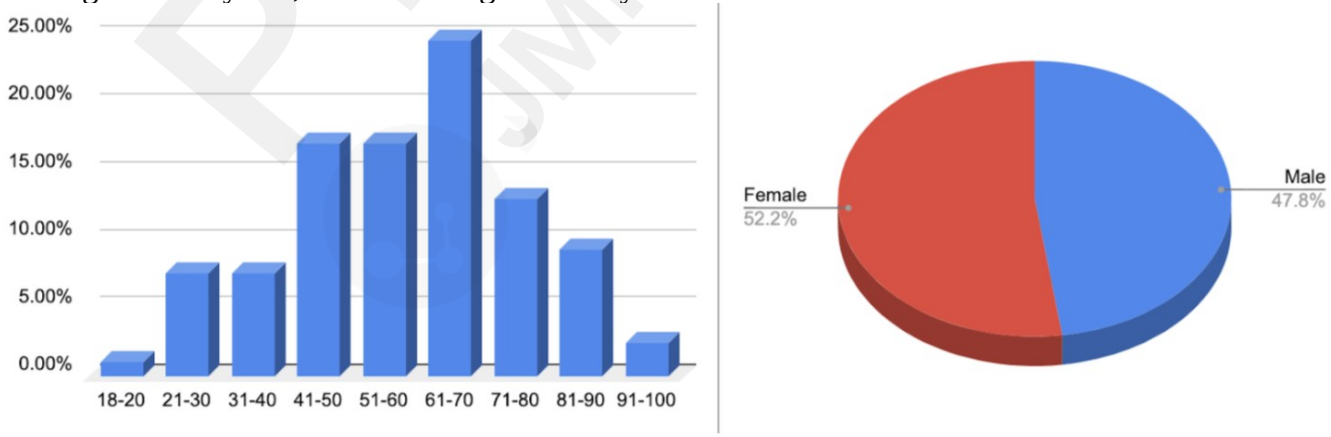


*Fig. 3. Age and sex distribution of Admission Room patients*

## Outcomes&triage results

### *CRA*

Among the users of the CRA application, the most common interview result was “asymptomatic”, or “Follow preventive measures”, which was displayed to 98 081 (39,41%) of users. This subgroup consisted of users who have undergone the questionnaire but denied having any symptoms nor COVID-19 exposure.

The second most common triage outcome was “non-COVID, non-serious” or “Stay home and monitor your symptoms” - 73 145 (29.39%) of respondents. This subgroup comprised users who have undergone the questionnaire and reported only mild symptoms like Fatigue, Muscle pain, Chills, Headache, Diarrhea, Nausea, Sore throat, and Impaired taste or smell but denied having any COVID-19 exposure (contact or travel). These users were not suspected of SARS-COV-2 infection accordingly to the diagnosing rules proposed by WHO at that time [15].

Both of these groups added up to 171 226 (68,8%), which made them the majority of the tool users

*Table 1. The distribution of CRA interview outcomes*

| Triage | no of patients | % of patients |
|---|---|---|
| asymptomatic | 98081 | 39.41% |
| non-COVID, non-serious | 73145 | 29.39% |
| COVID-suspected, serious | 30494 | 12.25% |
| non-COVID, serious | 21980 | 8.83% |
| quarantine | 15649 | 6.29% |
| COVID-suspected, non-serious | 9513 | 3.82% |
| Total | 248862 | 100.00% |

*Table 2. The distribution of CRA interview outcomes - the suspicion of COVID-19 matrix*

| | Clinical suspicion of COVID-19 | |
|---|---|---|
| **Severity of the presented symptoms** | COVID-suspected | non-COVID |
| serious | 30 494 (12.25%) | 21 980 (8.83%) |
| non-serious | 9 513 (3.82%) | 171 226 (68.80%) |

The third most common triage outcome was “Call the emergency number”, which was recommended to 30 494 (12.25%) of respondents. These were referred to as “COVID-suspected, serious” cases. Users who received that recommendation reported red flag symptoms indicating respiratory distress or potentially severe infection (shortness of breath in the elderly, tachypnea, haemoptysis, high-grade fever, rapid symptoms deterioration) and confirmed potential COVID-19 exposure.

21 980 (8.83%) of users were classified as “non-COVID, serious” - they received a “Call doctor” recommendation. These users were not suspected of SAR-CoV-2 infection because they had not met the WHO criteria of the suspected case at the time [15] but were advised to obtain a teleconsultation due to potentially severe symptoms: shortness of breath, high-grade fever, fever and cough in elderly.

The least prevalent group was the “COVID-suspected, non-serious” or “Contact Health Department”, displayed to 9 513 (3.82%) users. This group reported symptoms and COVID-19 exposure suggestive of SARS-CoV-2 infection but denied having potentially serious symptoms calling for an in-person consultation. They were advised to self-isolate and perform a COVID-19 test.

### *Admission Room*

232 of patients tested positive for COVID-19; 59 of patients tested negative for COVID-19. 126 women were COVID-19 positive, and 26 were COVID-19 negative. 106 men were COVID-19 positive, and 33 were COVID-19 negative.

Most of the patients (57.39%) of the Admission Room were classified by consulting physicians as patients in good general condition; 29.21% of the patients were judged to be in moderate general condition; 10.31% were in a bad general condition, and 3.09% were in a severely bad general condition.

## Comorbidities

The number of reported comorbidities in the self-assessment application was 71 515; at least one risk factor was reported in 28.74% of the interviews. In other words - in 71.26% of the interviews, users did not report any comorbidity.

The most frequently reported comorbidity in both of the CRA users and Admission Room patients was Cardiovascular Disease defined as hypertension, coronary disease, or heart insufficiency - confirmed by 15,12% of users and 47,42% of patients, respectively.

The distribution of other comorbidities shaped quite similarly between the two compared groups:

- In the CRA the other common risk factor Chronic lung disease (3,35%) and Diabetes (2,41%).
- In the admission room - Diabetes (19.24%), Cancer (active neoplasms of all types including hematological origin - 10.31%), and Chronic lung disease (7.56%).

A relatively high percentage of people reporting immunosuppression in the CRA (weakened immune system - 5,91% of users) compared to the admission room (2%) suggests this risk factor might have been misinterpreted and misused, despite the extensive description explaining the nature and examples of immunosupression (available in the appendix).

In general, Admission Room patients more oftenly were burdened with comorbidities, than CRA users. This can be explained by higher average age of Admission Room patients comparing to CRA users.

*Table 3. The distribution of comorbidities in the CRA and Admission Room (p-values for CRA - test of proportions; p-values for admission room - fisher exact test)*

| **CRA** | | | | | | **Admission room** | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **Covid positive** | **%** | **Covid negative** | **%** | ***p-value*** | **Covid positive** | **%** | **Covid negative** | **%** | ***p-valu*** |
| **Overall number** | **20645** | | **50870** | | | **243** | | **24** | | |
| Cardiovascular diseases | 9346 | 23.36% | 26296 | 13.61% | *<.001* | 125 | 53.88 % | 13 | 22.03 % | *<.001* |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Diabetes | 1680 | 4.20% | 4012 | 2.08% | *<.001* | 51 | 21.98 % | 5 | 8.47 % | *0.017* |
| Current cancer | 818 | 2.04% | 1517 | 0.79% | *<.001* | 28 | 12.07 % | 2 | 3.39 % | *0.055* |
| Diagnosed chronic lung disease | 2461 | 6.15% | 5425 | 2.81% | *<.001* | 20 | 8.62% | 2 | 3.39 % | *0.269* |
| History of chronic liver disease | 1064 | 2.66% | 2140 | 1.11% | *<.001* | 7 | 3.02% | 1 | 1.69 % | *1* |
| History of chronic kidney disease | 967 | 2.42% | 1851 | 0.96% | *<.001* | 7 | 3.02% | 1 | 1.69 % | *1* |
| Weakened immune system | 4309 | 10.77% | 9629 | 4.98% | *<.001* | 5 | 2.16% | 0 | 0.00 % | *0.587* |

## Symptoms distribution

Overall, the most commonly reported symptoms differed between the CRA and the Admission Room. CRA interviews were dominated by mild symptoms like Fatigue (24,73% of users), Cough (21,93%), and Headache (18,25%). Meanwhile, the admission room patients presented with more serious symptoms like Fever (60.14% of patients), Cough (57.73%), Shortness of Breath (39.18%), Fatigue and Muscle Pain (20.27% for both).

In the admission room, the distribution of most common symptoms among COVID positive and negative patients was fairly similar: Fever (62.93% of COVID-positives, 49.15% of COVID-negatives), Cough (59.48% of COVID-positives, 50.85% of COVID-negatives), Shortness of Breath (37.50% of COVID-positives, 45.76% of COVID-negatives)

On the other hand, the presentation of the COVID-suspected and non-COVID individuals differed substantially. COVID- suspected users commonly reported symptoms like Fever, Cough and Shortness of Breath, while COVID-non suspected commonly reported Headache, Cough and Fatigue.

*Table 4. Symptoms and Risk Factors distribution of CRA users and hospital admission room patients*

| **CRA** | | | | | **Admission room** | | | |
|---|---|---|---|---|---|---|---|---|
| | **Covid positive** | **%** | **Covid negative** | **%** | **Covid positive** | **%** | **Covid negative** | **%** |
| Cough | 25062 | 62.64% | 29521 | 15.28% | 138 | 59.48% | 30 | 50.85% |
| Fever | 23123 | 57.80% | 20292 | 10.50% | 146 | 62.93% | 29 | 49.15% |
| Symptoms getting worse quickly | 19816 | 49.53% | 0 | 0.00% | - | - | - | - |
| Shortness of breath | 15157 | 37.89% | 12717 | 6.58% | 87 | 37.50% | 27 | 45.76% |
| Faster breathing | 12964 | 32.40% | 0 | 0.00% | - | - | - | - |
| Fatigue | 5987 | 14.96% | 52630 | 27.24% | 40 | 17.24% | 19 | 32.20% |
| Headache | 4497 | 11.24% | 38115 | 19.73% | 19 | 8.19% | 4 | 6.78% |
| Sore throat | 3975 | 9.94% | 35645 | 18.45% | 17 | 7.33% | 9 | 15.25% |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Muscle pain | 3351 | 8.38% | 27015 | 13.98% | 42 | 18.10% | 17 | 28.81% |
| Coughing up blood | 2006 | 5.01% | 0 | 0.00% | 1 | 0.43% | 0 | 0.00% |
| Chills | 1906 | 4.76% | 13740 | 7.11% | 2 | 0.86% | 2 | 3.39% |
| Diarrhea | 1242 | 3.10% | 14109 | 7.30% | 35 | 15.09% | 4 | 6.78% |
| Contact with the infected person | 1005 | 2,51% | 0 | 0.00% | 166 | 71.55% | 5 | 8.47% |
| Nasal catharr | 954 | 2.38% | 6134 | 3.17% | 20 | 8.62% | 5 | 8.47% |
| Loss of smell or taste | 947 | 2.37% | 6034 | 3.12% | 39 | 16.81% | 2 | 3.39% |
| Nausea | 911 | 2.28% | 10599 | 5.49% | 10 | 4.31% | 3 | 5.08% |
| No contact with the infected person | 0 | 0.00% | 193206 | 100% | 66 | 28.45% | 54 | 91.53% |

## Comparative results

Fever and cough were the most commonly reported symptoms of COVID-19 in CRA tool users and the admission room. Fever occurred in 57.80% and 62.93% of the studied groups, respectively. Cough - in 62.64% and 59.48%. Pneumonia, characterized as the presence of fever, cough, and dyspnea, has been proven to be the most prevalent clinical presentation of COVID-19 in many studies [22-25].

Cardiovascular disease and diabetes mellitus occurred significantly more commonly in the covid-positive than in the covid-negative group both in CRA (23.36% vs 13.61% for cardiovascular disease, $P<.001$; 5.06% vs. 1,30%, $P<.001$ for diabetes) and the admission room (53.88% vs 22.03% for cardiovascular disease; 21.98% vs. 8.47%, $P<.001$ for diabetes).

Anosmia and ageusia (3.39%) occurred more frequently in the admission room in COVID-positive than in COVID-negative patients. In the application, we did not observe a similar finding, probably due to the rapid cessation of the interview in the high-triage scenarios.

Anosmia and ageusia occurred more frequently in mild than severe COVID in the CRA (9.62% versus 0,10%). This is consistent with studies suggesting that olfactory and gustatory disturbances are among the most commonly reported symptoms in mild-to-moderate COVID-19 [26].

The average age of users of the COVID-19 self-assessment app was 37 years old, whereas the average age of admission room patients was 58 years.

Fatigue, chills, nausea and sore throat did not turn out to be diagnostically relevant for diagnosing COVID-19. In both the CRA and the admission room, they occurred more frequently in non-COVID patients/users.

## CONCLUSIONS

Comparing the symptomatology of the users interacting with the COVID-19 Risk Assessment tool and those visiting the Admission Room revealed two major patient groups who could have benefited from implementing the self-assessment application in preclinical triage settings.

The first group are the patients with typical COVID-19 symptoms: cough and fever, sometimes accompanied by shortness of breath, tachypnea, fatigue, headache and muscle pain. Some of these patients had additional comorbidities, like diabetes or cardiovascular disease, that could have impacted the clinical course of COVID-19 [17]. The CRA could recognize patients with such symptoms as potentially COVID-19 positive and directed to the proper care. COVID-19 Risk

Assessment tool was accurate in identifying patients at risk – every patient reporting a potential red flag symptom, like rapid symptoms deterioration or acute dyspnea and tachypnea, was advised to seek immediate medical attention in the emergency room or was instructed to call the ambulance.

The other group are the patients with no symptoms suggesting COVID-19 infection but still searching for answers as to whether they could be infected and what they should do. Oligosymptomatic and asymptomatic users, which constituted the majority of the individuals interacting with the tool, were educated about their symptoms and advised to refer to the primary care in case of symptom worsening. CRA has played an educational role in advising on isolation precautions, organizing quarantine, and referring for further reading utilizing evidence-based sources like WHO and CDC.

It seems that these types of solutions may serve as health information hubs for oligosymptomatic individuals and means of remote triage for a vast audience. They possess the ability to identify patients at risk providing them with next-step recommendations, as well as sieving out asymptomatic individuals, providing them evidence-based education materials. Such patients were the most prevalent (almost 70% of the tool users).

As the study did not examine the intention of the user, it is uncertain what portion of such patients would visit a healthcare professional unnecessarily; further studies are required to assess the exact impact of online tools on reducing unnecessary visits. Still, as we observed oligosymptomatic patients visiting the hospital admission room, it can be assumed that some portion of such visits could be prevented by giving reassuring information to the patient through the online tool.

## DISCUSSION

1. The COVID-19 Risk Assessment tool ceased to be supported on the 16th of August 2021. As of now, most of the COVID-19 diagnostics are run by the Infermedica AI engine [27], and the COVID-19 Risk Assessment tool is supported only in selected use cases, i.e., the Polish Ministry of Health [19].
2. COVID-19 Risk Assessment tool, as it served as the means of screening and self-education, did not substitute for the consultation in the admission room for symptomatic users. The tool could not confirm nor exclude SARS-CoV-2 infection as it cannot perform a laboratory examination. Hence, it does not substitute for physicians' interactions. However, our tool exercised the purpose of remote triage. CRA did not overlook truly symptomatic cases; users with potentially worrisome symptoms, like fever or shortness of breath, were identified and advised to obtain a consultation and/or schedule a COVID-19 test.
3. The compared groups- one that completed the online interview and one that reported to the hospital - differed in age distribution, presence of risk factors, and probably the severity of symptoms reported. The difference between both groups impacts the results of the study, but it also shows some limitations of remote diagnostic tools like CRA- as potentially the most vulnerable to COVID-19 patients are also the least prevalent group accessing the internet for a health checkup. It is observed however, that younger patients also suffer from COVID-19 infection and with the next waves of pandemics, infections in young adults become more prevalent [29]. This growing group of patients could have benefitted from remote triage assessment tools like CRA.
4. The taste and smell disorders occurred more commonly in the Admission Room than in the CRA. (16,81% vs 2,37% for COVID-suspected individuals). In search of the possible explanation of this finding, we turn to the logic of WHO guidelines used in the CRA at that time. They did not distinguish smell and taste disorders as key diagnostic factors [15]. Once the importance of symptoms like smell and taste disorders came to the attention of academics [28], the WHO has reflected these findings in the updated guidelines for suspecting COVID-

19 infections (on the 7th of August 2020). They emphasized adjacent symptoms, like diminished taste or smell, and reduced the significance of fever in suspecting COVID-19 infection. The newer versions of the CRA, not described in the paper, follow the guidelines, increasing their diagnostic importance.

5. An actual number of false-negative cases in the COVID-19 Risk Assessment tool was not possible to assess due to a lack of data. However, we know that among the admission room records, 13,7% of patients (31 cases out of 225) did not present with fever or dyspnea but still tested positive for COVID-19. These patients would have been classified as non-covid cases by the application.
6. Concomitant symptoms, like fatigue, headache, diarrhea, occurred very infrequently in severe COVID-19-positive cases in the application. It may have been caused by the premature cessation of the interview for safety reasons.
7. The overall number of COVID-suspected cases in the CRA was 16,07% or 40 007 of individual interviews. This number corresponds with the number of scheduled tests for novel coronavirus because in both of these cases we deal with the suspicion of COVID-19 based on presented history and symptoms. During a similar time period, between the 11th of May and the 3rd of August 2020, there were 17 864 205 tests for SARS-CoV-2 performed [30].

## Limitations of the study

### *Possible misinterpretation of “red flag” question*

The outcomes of the self-assessment triage tool highlighted room for improvement when it comes to phrasing questions in web applications for the common user. The „symptoms getting worse quickly” red flag was meant to pinpoint a swiftly deteriorating user's general condition, which is a premise for hospitalization. However, a comparable number of confirmative and declined answers suggest that many of these answers could have been false positives. This answer might have been overly reported by the respondents, who may have misinterpreted its' scope. In many cases, this occurrence may have led to the overtriage of urgent COVID-19 case recommendation (“Call the emergency number”.

### *The bias of the sample*

As the tool was publicly available to everyone and no check-in or login was required, there is a possibility that some users did not present the symptoms they have reported and used the tool only out of curiosity or for educational purposes. However, this bias is probably limited by the size of the group tested with the self-assessment tool.

### *More detailed screening in the control room sample*

The screening in the Admission Room is always more exhaustive than in any self-assessment tool. There are a couple of factors contributing:

1. Physical examinations cannot be substituted by any question asked by the symptom checker.
2. A general appearance provides valuable clinical information to experienced clinicians.
3. A closed set of symptoms to choose from in the CRA
4. After detecting a potential red flag, the tool was designed to terminate the interview without inquiring about concomitant symptoms

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## Conflict of Interest

AN and JJ are affiliated professionally with Infermedica as medical consultants. They have contributed to creating the CRA tool by outlining and adapting the medical foundation based on WHO guidelines for COVID-19 surveillance.They did not receive any compensation for the study.
AN and ASP are physicians at the First Infectious Diseases Department in Gromkowski Hospital in Wrocław. ASP is an assistant at the Department of Infectious Diseases and Hepatology of Medical University in Wrocław.
KS is physician and the Head of the First Department of Infectious Diseases in Gromkowski Hospital in Wrocław, as well as the Head of Department of Infectious Diseases and Hepatology of Medical University in Wroclaw.

## Author Contributions

AN and JJ conceived and presented idea. JJ has collected and analysed the data regarding the self-assessment tool. AN collected and analysed the data regarding the infectious diseases admission room. AN and JJ wrote the first version of the manuscript. ASP and KS supervised the work, provided new ideas regarding discussion and conclusion sections, and helped with results interpretation. All authors discussed the results and contributed to the final manuscript.

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# Supplementary Files

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# Multimedia Appendixes

Application of self-assessment triage tool in COVID-19 pandemic: descriptive study - Appendix 1.
URL: http://asset.jmir.pub/assets/3e3af282538eebeff7e17f2f4055b029.docx

The distribution of symptoms and comorbidities in the CRA, displayed by the triage outcome.
URL: http://asset.jmir.pub/assets/6dd0d719ebd02536b9e47200dc1a1421.xlsx

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