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# Diagnostic accuracy of a rapid SARS-CoV-2 antigen test among people experiencing homelessness: a prospective cohort and implementation study

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## Background

People experiencing homelessness (PEH) are particularly exposed to severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection. This is due to inadequate and overcrowded living conditions in homeless shelters as well as poor sanitary conditions and limited use of face masks. Diagnostic accuracy studies and detection strategies in vulnerable, hard to reach population such as PEH need to be explored in order to promptly recognize outbreaks and avoid further viral spread. The aim of the study was to investigate the diagnostic accuracy of a rapid SARS-CoV-2 antigen test used as a screening tool in PEH during two pandemic waves compared with gold standard rtRT-PCR.

## Methods

This study is part of a well-established SARS-COV-2 surveillance program which targeted key populations to ensure the rapid implementation of public health strategies to contain the spread of SARS-CoV-2. During two periods starting from 16th November 2020 to 30th May 2021 and subsequently from 30th December 2021 to 20th April 2022, all PEH ≥ 18 years requesting residence at the available shelters in Verona, Italy were prospectively screened for SARS-CoV-2 infection regardless of the presence of symptoms. Two nasopharyngeal swabs (NPS) were collected from each PEH: one NPS to perform the Ag-RDT immediately at point-of-care, and the other one was delivered to the Microbiology Unit to perform a rtRT-PCR assay. Data regarding demographic characteristics, previous SARS-CoV-2 infection and/or vaccination, and COVID-19 symptoms were collected for each participant. All subjects who tested positive to the Ag-RDT were transferred to dedicated isolation centers. The Ag-RDT (index test) result was confirmed using the rtRT-PCR (Allplex assay kit, Seegene, Seoul, Korea) considered the clinical reference (comparator) assay for the diagnosis of SARS-CoV-2 infection. Four viral targets including the E, N, RdRp and S genes were detected. The Ct threshold was considered positive when Ct <40. The STARD (standard for reporting of diagnostic accuracy studies) statement was adopted as a guideline for study designing and reporting.
Means and standard deviations (SD) were calculated for continuous variables, and frequency tables and respective percentages were calculated for categorical variables. Significance of differences between the two study periods were evaluated by chi-squared test or Fisher's exact test for categorical variables and t-test for quantitative variables. Measures for diagnostic test accuracy included sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). All analyses were conducted with STATA®, version 17.0 (StataCorp LP, College Station, TX, USA).

## Results

Overall, 503 participants were enrolled during the two intervention periods for a total of 732 paired swabs samples collected. The majority (278, 55%) were from Sub-Saharan and Northern Africa. The specimens included 541 swabs performed during November 2020-May 2021 (corresponding to the second pandemic wave in Italy) and 191 in the period December 2021-April 2022, during the fourth pandemic wave (table 1a and b). Average age of subjects was 42 years (SD 14). Among the 732 swabs collected, 58 resulted positive with rtRT-PCR. Thus, the prevalence of SARS-CoV-2 infection in the cohort was 8%. Overall, 17/732 (2.3%) tests were performed on subjects reporting at least one COVID-related symptom at the time of swab collection. Among the 17 symptomatic subjects, there was a 100% concordance between rtRT-PCR and Biocredit COVID-19 Ag
The performance of the Biocredit COVID-19 Ag compared with the reference rtRT-PCR is shown in table 2. Overall, 21 false-negative Biocredit COVID-19 Ag results occurred among the specimens collected while only 1 false-positive result was observed. Sensitivity and specificity did not change substantially across the two periods. The mean of the Ct values was 30.4 (SD 5.3) for the RdRp/S viral targets, 30 (SD 5.3) for the E gene, and 27.4 (SD 5.2) for the N gene. The mean of S/RdRp Ct value of Ag-RDT positive samples was 29 (SD 4.7); for the Ag-RDT negative samples, the mean S gene Ct values was 35 (SD 3.8). We assessed the sensitivity of the Ag-RDT at three different Ct values ranges of S/RdRp viral targets detected by the rtRT-PCR: ≤20, 21-33, and >33≤40. The false negative results increase with higher Ct values. Sensitivity ranges from 100% (95% CI: 100% - 100%) to 32% (95% CI: 28.5%-35.5%) for S/RdRP Ct <20 and >33≤40, respectively.

**Table 1**. Characteristics of individuals (a) and distribution of tests (b) across the two study periods, 2020-21 and 2021-22.

a.

| Subjects | Overall (n=503) | Period 2020-21 (n=351) | Period 2021-22 (n=178) | P |
|---|---|---|---|---|
| **Male sex, N (%)** | 459 (91) | 325 (93) | 159 (89) | 0.203 |
| **Nationality, N (%)** | | | | |
| African | 278 (55) | 192 (55) | 98 (55) | 0.415 |
| Italian | 114 (23) | 86 (25) | 36 (20) | |
| Other | 111 (22) | 73 (20) | 44 (25) | |
| **Age, mean (SD)** | 42 (14) | 43 (14) | 41(14) | 0.222 |
| **Previous diagnosis of SARS-CoV-2 infection, N (%)** | -- | 3 (0.8) | 14 (8) | **<0.001** |
| **No previous vaccination, N (%)** | -- | 330 (94) | 48 (27) | **<0.001** |

b.

| NPS performed | Overall (n=732) | Period 2020-21 (n=541) | Period 2021-22 (n=191) | P |
|---|---|---|---|---|
| **rtRT-PCR positive, N (%)** | 58 (8) | 43 (8) | 15 (8) | 0.887 |
| **Ag-RDT positive, N (%)** | 38 (5) | 29 (5) | 9 (5) | 0.728 |
| **NPS on symptomatic subjects** | 17 (7) | 6 (1) | 11 (6) | **0.001** |
| rtRT-PCR pos; Ag-RDT pos | 7 (41) | 2 (17) | 5 (55) | |
| rtRT-PCR neg; Ag-RDT neg | 10 | 4 | 6 | |
| rtRT-PCR; Ag-RDT non-concordant | 0 | 0 | 0 | |

**Table 2**. Overview of the results: performance of the Ag-RDT (index test) compared with the rtRT-PCR for SARS-CoV-2 (comparator).

| | rtRT-PCR positive | rtRT-PCR negative | Total |
|---|---|---|---|
| **a. Overall** | | | |
| Ag-RDT positive | 37 | 1 | 38 |
| Ag-RDT negative | 21 | 673 | 694 |
| Total | 58 | 674 | 732 |
| **b. Period 2020-21** | | | |
| Ag-RDT positive | 28 | 1 | 29 |
| Ag-RDT negative | 15 | 497 | 512 |
| Total | 43 | 498 | 541 |
| **c. Period 2021-22** | | | |
| Ag-RDT positive | 9 | 0 | 9 |
| Ag-RDT negative | 6 | 176 | 182 |
| Total | 15 | 176 | 191 |

**a. Overall**: Sensitivity (exact 95% CI): 63.8% (60.3–67.3); Specificity (exact 95% CI): 99.8% (99.6–100); PPV: 97.5%; NPV: 96.8%. **b. Period 2020-21**: Sensitivity (exact 95% CI): 65.1% (61.1–69.1); Specificity (exact 95% CI): 99.8% (99.4–100); PPV: 96.5%; NPV: 97.1%. **c. Period 2021-22**: Sensitivity (exact 95% CI): 60.0% (53.1–66.9); Specificity (exact 95% CI): 100% (100–100); PPV: 100%; NPV: 96.6%. rtRT-PCR: real time-Reverse transcription polymerase chain reaction; Ag-RDT: Antigen-Rapid Diagnostic Test.

## Conclusions

Considering the low cost, ease of use, and turnaround time, from a public health perspective our findings suggest that Ag-RDTs can be useful for specific population screening programs, especially in high-prevalence setting or when the epidemic curve rises. This study suggests that detecting asymptomatic subjects with a higher viral load could be crucial to identify those individuals who are at higher risk of being contagious and allow for early intervention in terms of public health measures. Considering the low rate of false positive results, a periodic Ag-RDT-based screening approach at point-of-care could reliably guide preventive measures, including prompt isolation without referral to hospital-based laboratories for molecular test confirmation in case of positive results. This could help controlling the spread of SARS-CoV-2 infection in this vulnerable population, thus reducing the risk of outbreaks in shelter facilities.

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