

# Olfactory Dysfunction Related to SARS-CoV-2 among Healthcare Workers in N'Djamena: Prevalence, Clinical Characteristics, and Associated Factors

Aboubakar Assidick Taoussi<sup>1</sup>, Choua Ouchemi<sup>2</sup>, Mahamat Ali Bolti<sup>3</sup>, Mbaihodji Hervé<sup>4</sup>

<sup>1</sup>Department of Otorhinolaryngology-Head and Neck Surgery, Renaissance University Hospital Center, N'Djamena, Chad

<sup>2</sup>Department of General Surgery, National Reference University Hospital Center, N'Djamena, Chad

<sup>3</sup>Department of Internal Medicine, Renaissance University Hospital Center, N'Djamena, Chad

<sup>4</sup>Faculty of Health Sciences, University of Abeché, Abeché, Chad

Email: abastaoussi@gmail.com

**How to cite this paper:** Taoussi, A.A., Ouchemi, C., Bolti, M.A. and Hervé, M. (2026) Olfactory Dysfunction Related to SARS-CoV-2 among Healthcare Workers in N'Djamena: Prevalence, Clinical Characteristics, and Associated Factors. *International Journal of Otolaryngology and Head & Neck Surgery*, 15, 108-122.  
<https://doi.org/10.4236/ijohns.2026.152011>

**Received:** January 27, 2026

**Accepted:** February 23, 2026

**Published:** February 26, 2026

Copyright © 2026 by author(s) and Scientific Research Publishing Inc. This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).  
<http://creativecommons.org/licenses/by/4.0/>



Open Access

## Abstract

**Background:** Olfactory dysfunction (OD) is a common manifestation of SARS-CoV-2 infection but remains insufficiently documented in sub-Saharan Africa, particularly among highly exposed healthcare workers. **Objective:** To estimate the prevalence of OD during RT-PCR-confirmed COVID-19, describe its clinical characteristics, and identify associated factors among hospital staff in N'Djamena. **Methods:** An analytical cross-sectional study was conducted between January and June 2023 among hospital workers with RT-PCR-confirmed SARS-CoV-2 infection, interviewed at least four weeks after the acute episode. A standardized questionnaire documented OD occurring during infection, including type, onset characteristics, nasal obstruction, associated dysgeusia, duration, and recovery. A simplified psychophysical olfactory test using five locally familiar odorants was proposed to participants reporting persistent symptoms or uncertainty regarding recovery. Factors associated with OD were assessed using multivariable logistic regression analysis. **Results:** Among 161 participants, 115 reported OD (71.4%). Anosmia was the predominant presentation (91.3%), typically of sudden onset (85.2%) and most often without nasal obstruction (87.8%). Assignment to clinical departments was strongly associated with OD (adjusted OR 12.4; 95% CI 5.2 - 29.8), whereas age was inversely associated (adjusted OR 0.94 per year increase). Complete recovery was reported by 90.4% of affected participants; 5.2% had persistent, objectively confirmed OD (score  $\leq 2/5$ ). Additionally, 50.4% reported difficulty detecting potentially hazardous odors. **Conclusion:** Olfactory dysfunction

tion related to SARS-CoV-2 remains highly prevalent among healthcare workers in N'Djamena, particularly among those assigned to clinical services, and is associated with a measurable functional impact on workplace safety. These findings support systematic post-COVID evaluation and targeted preventive strategies in this high-risk professional group.

## Keywords

Olfactory Dysfunction, Anosmia, COVID-19, Healthcare Workers, SARS-CoV-2

---

## 1. Introduction

Since the emergence of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), a wide range of otorhinolaryngological manifestations has been reported. Among these, olfactory and gustatory dysfunction rapidly emerged as frequent—and sometimes inaugural—symptoms of infection. Numerous studies have documented a high prevalence of these disorders in patients with COVID-19, underscoring their potential diagnostic value [1]-[4].

Healthcare workers constitute a particularly vulnerable population due to repeated occupational exposure to infected patients, with a risk of SARS-CoV-2 infection exceeding that of the general population [5]. In this context, alterations of smell—including anosmia, hyposmia, and parosmia—have been commonly described. These disturbances typically occur abruptly and most often in the absence of nasal obstruction or rhinorrhea [1] [2]. This distinctive clinical presentation differentiates COVID-19-related olfactory dysfunction from that observed in other viral respiratory infections and has led to its recognition as a potential clinical biomarker of SARS-CoV-2 infection [3] [4]. Beyond its diagnostic significance, olfactory impairment among healthcare workers may compromise the detection of hazardous odors such as chemicals or smoke, raising important concerns regarding occupational safety.

From a pathophysiological standpoint, experimental and clinical studies have shown that SARS-CoV-2 entry receptors are predominantly expressed in non-neuronal cells of the olfactory epithelium, particularly sustentacular cells, supporting a primarily peripheral mechanism of olfactory impairment [6]. Furthermore, the clinical profile of COVID-19 has evolved throughout the pandemic, partly in relation to the circulation of different viral variants. A relative decline in the prevalence of olfactory dysfunction has been observed during periods dominated by the Delta and Omicron variants; nevertheless, these symptoms remain clinically relevant [7] [8].

Despite the expanding literature on COVID-19-related olfactory dysfunction, most available data originate from Europe, Asia, and North America. Evidence from sub-Saharan Africa remains limited, particularly among healthcare workers.

In Chad, and specifically in N'Djamena, the epidemiological and clinical characteristics of SARS-CoV-2-related olfactory dysfunction in this high-risk professional group have not been adequately documented.

The present study therefore aimed to determine the prevalence of olfactory dysfunction among healthcare workers with RT-PCR-confirmed SARS-CoV-2 infection in N'Djamena, to describe its clinical characteristics, and to identify factors associated with its occurrence.

## **2. Materials and Methods**

### **2.1. Study Design and Period**

This analytical cross-sectional study was conducted between January and June 2023. Its primary objective was to assess the occurrence of olfactory dysfunction (OD) during RT-PCR-confirmed SARS-CoV-2 infection and to identify individual and occupational factors associated with its onset and potential persistence.

### **2.2. Study Sites**

The study was carried out in five tertiary hospitals in N'Djamena: Renaissance University Hospital Center, National Reference University Hospital Center, Mother and Child University Hospital Center, Refondation Hospital, and Chad-China Friendship Hospital. These institutions represented the principal centers involved in COVID-19 management in Chad and encompassed staff members with varying degrees of occupational exposure to SARS-CoV-2.

### **2.3. Study Population**

The study population consisted of hospital staff members, including both healthcare and non-healthcare workers, with RT-PCR-confirmed SARS-CoV-2 infection during the study period. Participants were eligible if they had documented proof of infection and were interviewed at least four weeks after the acute episode to ensure assessment of a stabilized post-infectious olfactory status.

The median interval between the positive RT-PCR test and the interview was 16 weeks (range: 8 - 24 weeks). Participants with documented multiple SARS-CoV-2 infections were included; however, analyses were based on the most recent confirmed episode.

Individuals with a history of olfactory disorders unrelated to COVID-19 or those unable to complete the questionnaire were excluded.

### **2.4. Sample Size and Recruitment**

The minimum required sample size was calculated using the Schwartz formula for proportions, based on an expected prevalence of 64% among infected healthcare workers [9]. Assuming a 5% margin of error and a 95% confidence level, the theoretical sample size was 354 participants. Given the finite size of the eligible population (245 staff members), a finite population correction was applied. After accounting for an anticipated 10% non-response rate, the final target sample size

was adjusted to 161 participants.

Eligible participants were identified from official lists of SARS-CoV-2-positive staff provided by hospital COVID-19 response committees. Among the 245 eligible individuals, 178 were successfully contacted. Seventeen declined participation or were unavailable at the time of contact. Ultimately, 161 participants were enrolled in the study and included in the final analysis. No significant differences in age, sex, or professional category were observed between respondents and non-respondents.

## 2.5. Data Collection

Data were collected through face-to-face interviews using a structured and pre-tested questionnaire administered by trained investigators. The questionnaire gathered information on sociodemographic characteristics, occupational factors (job category, department assignment as clinical or non-clinical, and hospital affiliation), and clinical features of OD occurring during SARS-CoV-2 infection, including type of disorder, onset characteristics, presence of nasal obstruction, associated dysgeusia, duration, and recovery.

## 2.6. Psychophysical Olfactory Test

A simplified psychophysical olfactory test was proposed to participants reporting persistent olfactory symptoms or uncertainty regarding complete recovery. Designed as a pragmatic tool adapted to the local context, the test was based on the sequential identification of five familiar odorants (lemon, roasted peanut, fresh onion, heated eucalyptus leaves, and khoumra), yielding a total score ranging from 0 to 5.

A score  $\leq 2$  defined persistent anosmia, a score of 3 or 4 indicated partial recovery, and a score of 5 corresponded to normal olfactory function. Odorants were presented in a standardized order for all participants, in a well-ventilated environment and without blinding. This test was not formally validated against standardized olfactory batteries and should therefore be considered a complementary pragmatic assessment tool rather than a normative diagnostic instrument.

## 2.7. Assessment of Functional Impact

The functional impact of OD on quality of life and professional practice was evaluated using a visual analog scale (VAS) ranging from 0 (no impact) to 10 (maximum impact). Participants were also asked to report specific difficulties encountered, particularly impairment in daily activities and reduced ability to detect potentially hazardous odors in the hospital environment.

## 2.8. Statistical Analysis

Statistical analyses were performed using SPSS version 26 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages and compared using Pearson's chi-square test or Fisher's exact test, as appropri-

ate. Continuous variables were summarized as means  $\pm$  standard deviations.

Variables with a *p* value  $< 0.20$  in univariate analysis were entered into a multivariable logistic regression model using a backward stepwise approach to identify factors independently associated with OD. Department assignment (clinical vs. non-clinical) was used as a proxy for occupational exposure intensity. Profession and hospital affiliation were excluded from the final model due to collinearity with department assignment. Statistical significance was defined as *p*  $< 0.05$ .

## 2.9. Ethical Considerations

The study protocol was approved by the National Ethics Committee of the Ministry of Public Health of Chad. Written informed consent was obtained from all participants prior to enrollment. Data were collected anonymously and handled in strict confidentiality.

## 3. Results

### 3.1. General Characteristics of the Study Population

A total of 161 hospital staff members with RT-PCR-confirmed SARS-CoV-2 infection were included in the analysis. The sociodemographic and occupational characteristics of participants are summarized in **Table 1**.

The mean age was  $36.4 \pm 8.7$  years (range: 23 - 58 years), and men represented 113 participants (70.2%). The most represented age groups were 31 - 40 years (57; 35.4%) and 20 - 30 years (55; 34.2%).

Nurses, physicians, and nursing assistants accounted for 121 participants (75.2%). Seventy-five participants (46.6%) were assigned to clinical departments with high potential exposure to SARS-CoV-2, including internal medicine, emergency medicine, and intensive care units. Regarding hospital distribution, 58 participants (36.0%) were employed at the National Reference University Hospital Center and 35 (21.7%) at Refondation Hospital.

### 3.2. Prevalence of Olfactory Dysfunction

Olfactory dysfunction (OD) during SARS-CoV-2 infection was reported by 115 participants, yielding a prevalence of 71.4%. The distribution of OD according to sociodemographic and occupational characteristics is detailed in **Table 2** and **Table 3**.

The prevalence of OD decreased significantly with age (*p*  $< 0.001$ ), from 80.7% in the 31 - 40-year age group (46 participants) to 43.8% among those aged 51 - 60 years (7 participants). OD was more frequently reported in men than in women (75.2% vs. 62.5%); however, this difference did not reach statistical significance (*p* = 0.09).

Healthcare workers were significantly more affected than non-healthcare staff (106; 78.5% vs. 9; 34.6%, *p*  $< 0.001$ ). A comparable pattern was observed according to department assignment, with higher prevalence in clinical services than in non-clinical departments (68; 90.7% vs. 47; 54.7%, *p*  $< 0.001$ ).

Marked inter-hospital variability was observed, with OD prevalence ranging from 50.0% (9 participants) at the Chad-China Friendship Hospital to 86.7% (26 participants) at the Renaissance University Hospital Center ( $p = 0.008$ ).

**Table 1.** Sociodemographic and professional characteristics of the study population (n = 161).

Variable	n	%
<b>Sex</b>		
Male	113	70.2
Female	48	29.8
<b>Age group (years)</b>		
20 - 30	55	34.2
31 - 40	57	35.4
41 - 50	33	20.5
51 - 60	16	9.9
<b>Profession</b>		
Nurse	45	28.0
Physician	41	25.4
Nursing assistant	35	21.7
Midwife	8	5.0
Radiology technician	6	3.7
Laboratory technician	9	5.6
Administrative staff	11	6.8
Biomedical staff	6	3.7
<b>Department</b>		
Medicine/Emergency/Intensive Care	75	46.6
Surgery	44	27.3
Pediatrics/Maternity	10	6.2
Medical imaging	6	3.7
Laboratory	9	5.6
Administrative department	11	6.8
Biomedical department	6	3.7
<b>Hospital</b>		
Renaissance University Hospital Center	30	18.6
National Referral University Hospital Center	58	36.0
Mother and Child University Hospital Center	20	12.4
Refondation Hospital	35	21.7
Chad-China Friendship Hospital	18	11.2

**Table 2.** Distribution of olfactory dysfunction (OD) according to sociodemographic and professional characteristics.

Variable	Total (n)	OD cases (n)	% within group
<b>Sex</b>			
Male	113	85	75.2
Female	48	30	62.5
<b>Age group (years)</b>			
20 - 30	55	41	74.5
31 - 40	57	46	80.7
41 - 50	33	21	63.6
51 - 60	16	7	43.8
<b>Profession</b>			
Nurse	45	40	88.9
Physician	41	32	78.0
Nursing assistant	35	29	82.9
Midwife	8	2	25.0
Radiology technician	6	3	50.0
Laboratory technician	9	2	22.2
Administrative staff	11	4	36.4
Biomedical staff	6	3	50.0
<b>Department</b>			
Medicine/Emergency/Intensive Care	75	68	90.7
Surgery	44	31	70.4
Pediatrics/Maternity	10	4	40.0
Medical imaging	6	3	50.0
Laboratory	9	2	22.2
Administrative department	11	4	36.4
Biomedical department	6	3	50.0
<b>Hospital</b>			
Renaissance University Hospital Center	30	26	86.7
National Referral University Hospital Center	58	38	65.5
Mother and Child University Hospital Center	20	13	65.0
Refondation Hospital	35	29	82.9
Chad-China Friendship Hospital	18	9	50.0

**Table 3.** Factors associated with olfactory dysfunction (OD): univariate analysis.

Factor	Category	OD prevalence (%)	p value	Statistical test
Sex	Male	75.2	0.09	Pearson's $\chi^2$
	Female	62.5		
Age (years)	20 - 30	74.5	<0.001	$\chi^2$ for trend
	31 - 40	80.7		
	41 - 50	63.6		
	51 - 60	43.8		
Profession	Healthcare workers*	78.5	<0.001	Pearson's $\chi^2$
	Non-healthcare workers**	34.6		
Department	Clinical departments***	78.5	<0.001	Pearson's $\chi^2$
	Non-clinical departments****	34.6		
Hospital	Overall range	50.0 - 86.7	0.008	Pearson's $\chi^2$

\*Nurses, physicians, nursing assistants, midwives, radiology technicians. \*\*Laboratory technicians, administrative and biomedical staff. \*\*\*Medicine/Emergency/Intensive Care, Surgery, Pediatrics/Maternity, Medical imaging. \*\*\*\*Laboratory, Administrative and Biomedical departments.

### 3.3. Factors Associated with Olfactory Dysfunction

The results of the multivariable logistic regression analysis are presented in **Table 4**.

Assignment to a clinical department was the primary factor independently associated with OD (adjusted odds ratio [aOR]: 12.4; 95% CI: 5.2 - 29.8;  $p < 0.001$ ). Age was inversely associated with OD, with an aOR of 0.94 per additional year (95% CI: 0.90 - 0.98;  $p = 0.002$ ).

Sex ( $p = 0.15$ ) and profession considered individually ( $p = 0.12$ ) were not independently associated with OD in the multivariable model.

**Table 4.** Factors independently associated with olfactory dysfunction: multivariable logistic regression analysis.

Factor	Reference category	Adjusted OR (95% CI)	p value
Clinical department	Non-clinical departments	12.4 (5.2 - 29.8)	<0.001
Age (per year increase)	—	0.94 (0.90 - 0.98)	0.002
Male sex	Female sex	1.8 (0.8 - 4.0)	0.15

Abbreviations: OR, odds ratio; CI, confidence interval.

### 3.4. Clinical Characteristics of Olfactory Dysfunction

Among the 115 participants reporting OD, total anosmia was the predominant phenotype (105; 91.3%), followed by hyposmia (6; 5.2%) and parosmia (4; 3.5%) (**Table 5**).

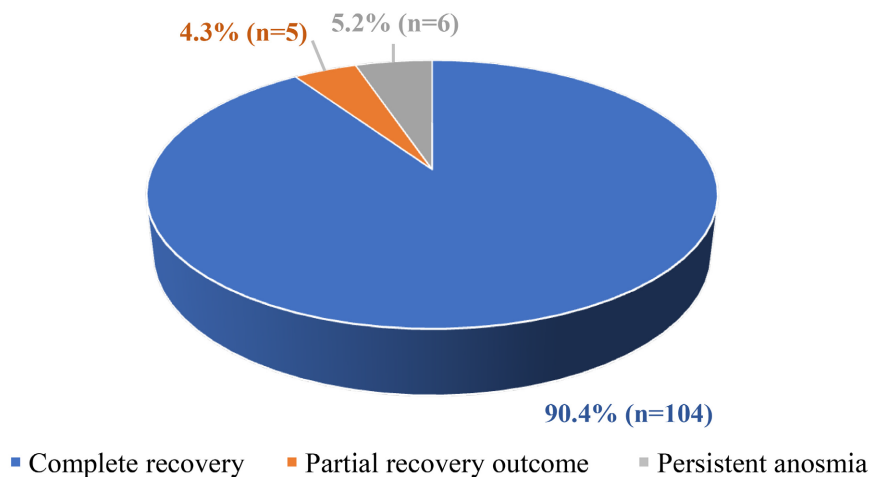
**Table 5.** Clinical characteristics of olfactory dysfunction among affected participants (n = 115).

Characteristic	n	%
<b>Type of dysfunction</b>		
Complete anosmia	105	91.3
Hyposmia	6	5.2
Parosmia	4	3.5
<b>Time to onset</b>		
Initial symptom	31	27.0
Early onset ( $\leq 3$ days)	59	51.3
Late onset ( $> 3$ days)	25	21.7
<b>Mode of onset</b>		
Sudden ( $\leq 48$ h)	98	85.2
Progressive ( $> 48$ h)	17	14.8
<b>Associated features</b>		
Without nasal obstruction	101	87.8
With nasal obstruction	14	12.2
Associated dysgeusia	115	100.0

Onset was sudden ( $\leq 48$  hours) in 98 participants (85.2%) and occurred in the absence of nasal obstruction in 101 (87.8%). Associated dysgeusia was reported by all participants (115; 100%).

### 3.5. Course of Olfactory Dysfunction

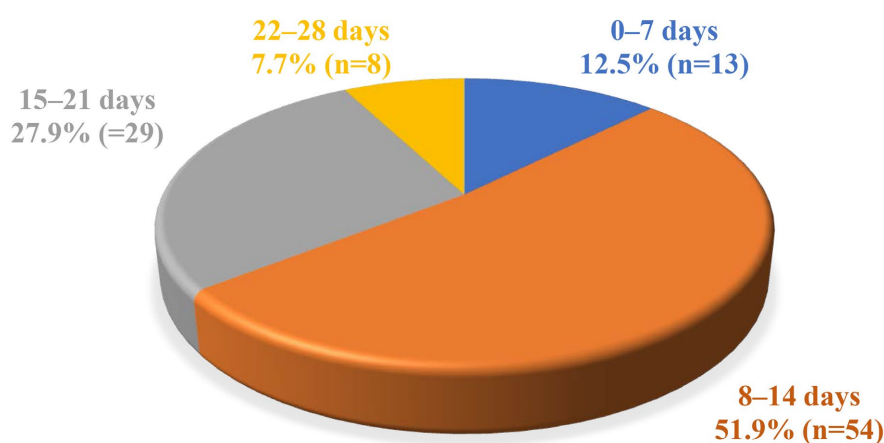
All participants reporting OD (n = 115) received treatment according to the national COVID-19 management protocol; 81 (70.4%) required hospitalization.



**Figure 1.** Outcome of olfactory dysfunction after SARS-CoV-2 infection among healthcare workers (n = 115). Complete recovery was observed in 104 participants (90.4%), partial recovery in 5 (4.3%), and persistent anosmia in 6 (5.2%).

The evolution of OD is illustrated in **Figure 1**. Complete recovery was observed in 104 participants (90.4%), partial recovery in 5 (4.3%), and persistent anosmia in 6 (5.2%).

Among participants with complete recovery ( $n = 104$ ), the mean duration of OD was  $13.1 \pm 5.5$  days, with a median of 11 days (range: 3 - 28 days). As illustrated in **Figure 2**, recovery most commonly occurred within the first two weeks following symptom onset.



**Figure 2.** Duration of olfactory dysfunction among participants with complete recovery ( $n = 104$ ). Distribution of recovery times, showing that normalization of olfactory function occurred predominantly within the first two weeks after symptom onset.

### 3.6. Results of the Psychophysical Olfactory Test

A simplified psychophysical olfactory test was administered to 15 participants reporting persistent symptoms or uncertainty regarding recovery.

Objective testing confirmed persistent anosmia in 6 participants (40.0%), partial recovery in 5 (33.3%), and normal olfactory function in 4 (26.7%).

### 3.7. Functional Impact of Olfactory Dysfunction

The overall functional impact of OD, assessed using a visual analog scale (VAS), is presented in **Table 6**. The mean impact score was  $4.0 \pm 2.2$ .

**Table 6.** Functional impact of olfactory dysfunction reported by healthcare workers ( $n = 115$ ).

Aspect of impact	n	%
<b>Overall impact score (VAS 0 - 10)</b>		
Mild impact (0 - 4)	80	69.6
Moderate to severe impact (5 - 10)	35	30.4
<b>Specific consequences</b>		
Loss of appetite	81	70.4
Difficulty detecting chemical odors	58	50.4

A low impact (VAS 0 - 4) was reported by 80 participants (69.6%), whereas 35 participants (30.4%) reported a moderate to severe impact (VAS 5 - 10). The most frequently reported consequences were loss of appetite (81; 70.4%) and difficulty detecting potentially hazardous odors, such as chemicals or smoke (58; 50.4%). Qualitative reports also described professional discomfort, particularly in tasks requiring olfactory detection.

#### 4. Discussion

This multicenter study conducted among healthcare workers in N'Djamena demonstrates a high prevalence of olfactory dysfunction (71.4%) following SARS-CoV-2 infection. This prevalence falls within the upper range reported in early European and international studies, where prevalence varied between 40% and 86%, depending on the populations studied, circulating variants, and assessment methods used [1]-[3] [10] [11]. The addition of psychophysical testing to self-reported symptoms has been shown to reveal a broader extent of olfactory impairment, suggesting that the true impact of SARS-CoV-2 on olfaction may be underestimated in many series [3] [12]. In a sub-Saharan African setting that remains sparsely documented and within a highly exposed professional population, our findings confirm that olfactory dysfunction is a major clinical marker of COVID-19.

From a clinical perspective, the phenotype observed in our cohort—sudden-onset, non-obstructive anosmia associated with near-constant dysgeusia—corresponds to the now well-established olfactory signature of COVID-19 [2] [13]. The absence of nasal obstruction in most participants distinguishes these disorders from classical post-viral anosmia, which is typically accompanied by nasal congestion [1]. These features are consistent with pathophysiological evidence showing that SARS-CoV-2 preferentially targets sustentacular cells of the olfactory epithelium expressing ACE2 and TMPRSS2, rather than olfactory sensory neurons themselves [6] [10] [11]. Damage to these supporting cells disrupts epithelial architecture and the neuronal microenvironment, which may explain the severity of olfactory loss despite relative neuronal preservation [6] [10] [14]. The near-systematic association between anosmia and dysgeusia observed in our study likely reflects combined impairment of orthonasal and retronasal olfactory pathways, a mechanism widely documented in the literature [8] [15] [16].

A major finding of this study is the determinant role of occupational exposure. Healthcare workers assigned to clinical departments had a more than twelve-fold higher risk of olfactory dysfunction compared with non-clinical staff, independently of age and sex. This observation reinforces international evidence indicating increased vulnerability among frontline healthcare workers repeatedly exposed to high viral loads [6] [15] [16]. Initial viral load may therefore represent a key factor modulating the intensity of olfactory impairment. The inter-hospital variability observed further suggests that organizational factors—such as the availability of personal protective equipment or patient management practices—may influence

exposure risk [17].

The categorization of professions as healthcare versus non-healthcare and departments as clinical versus non-clinical was based on the level of direct patient contact and presumed exposure to SARS-CoV-2. Although this classification may oversimplify heterogeneous exposure patterns within departments, it provides a pragmatic framework for approximating occupational risk in a resource-limited setting and should be interpreted accordingly.

Age was inversely associated with the occurrence of olfactory dysfunction, with younger participants being more frequently affected. This finding aligns with several international studies reporting a higher prevalence of olfactory impairment among young and middle-aged adults [18]-[20]. Proposed explanations include age-related differences in ACE2 expression in the nasal mucosa [21], a more robust local inflammatory response in younger individuals, or a physiological decline in baseline olfactory sensitivity with aging, which may render olfactory loss less perceptible in older subjects.

The clinical course of olfactory dysfunction was generally favorable, with complete recovery reported in more than 90% of participants within two weeks, consistent with longitudinal data [9] [22]-[24]. Nevertheless, a small proportion experienced persistent symptoms, confirming that approximately 5% - 10% of patients may develop long-term olfactory sequelae following COVID-19 [25]-[27]. These persistent cases warrant specific management, particularly olfactory training, which is currently recommended as first-line therapy in international guidelines [27].

An original contribution of this study lies in the assessment of the functional and occupational impact of olfactory dysfunction. A substantial proportion of healthcare workers reported difficulty detecting potentially hazardous odors, such as chemicals or smoke, raising important safety concerns within the hospital environment. Reduced appetite and diminished quality of life were also frequently reported, consistent with existing evidence on the broader consequences of olfactory disorders [15] [16].

### Study Limitations and Strengths

This study has several limitations. Olfactory dysfunction was self-reported and retrospectively assessed with a median delay of 16 weeks (range: 8 - 24 weeks), which may have introduced recall bias [12]. Psychophysical testing was conducted in a limited subgroup using a simplified, non-validated protocol, potentially leading to misclassification of residual dysfunction. In addition, the study included only RT-PCR-confirmed cases during a specific epidemic period, which may limit generalizability to other variants, milder community infections, or different epidemiological contexts. The cross-sectional design further precludes long-term follow-up and limits causal inference.

Despite these limitations, the multicenter design and focus on a highly exposed professional population strengthen the relevance of the findings. This study pro-

vides original data from sub-Saharan Africa on COVID-19-related olfactory dysfunction among healthcare workers and underscores the importance of systematic evaluation of these disorders in post-COVID follow-up, given their clinical and occupational implications.

## 5. Conclusions

Olfactory dysfunction represents a frequent manifestation of SARS-CoV-2 infection among healthcare workers in N'Djamena, affecting more than two-thirds of infected individuals. Its occurrence is strongly associated with occupational exposure in clinical settings and is more commonly observed among younger staff members. Clinically, these disorders display the characteristic COVID-19 phenotype and generally follow a favorable course, although persistent forms occur in a minority of cases.

Beyond their diagnostic relevance, olfactory disorders carry meaningful functional and occupational implications, particularly regarding workplace safety. These findings highlight the importance of systematic evaluation of olfactory dysfunction in post-COVID follow-up among healthcare workers and support the implementation of targeted preventive and management strategies, especially in resource-limited settings.

## Acknowledgements

The authors express their sincere gratitude to the administrations of the participating hospitals—Renaissance University Hospital Center, National Reference University Hospital Center, Mother and Child University Hospital Center, Refondation Hospital, and Chad-China Friendship Hospital—for their collaboration and institutional support in the conduct of this study. They also thank all healthcare workers who agreed to participate in the survey, as well as the medical students involved in data collection.

## Conflicts of Interest

The authors declare that they have no conflicts of interest related to this study.

## References

- [1] Lechien, J.R., Chiesa-Estomba, C.M., De Siati, D.R., Horoi, M., Le Bon, S.D., Rodriguez, A., *et al.* (2020) Olfactory and Gustatory Dysfunctions as a Clinical Presentation of Mild-To-Moderate Forms of the Coronavirus Disease (COVID-19): A Multicenter European Study. *European Archives of Oto-Rhino-Laryngology*, **277**, 2251-2261. <https://doi.org/10.1007/s00405-020-05965-1>
- [2] Hopkins, C., Surda, P. and Kumar, N. (2020) Presentation of New Onset Anosmia during the COVID-19 Pandemic. *Rhinology journal*, **58**, 295-298. <https://doi.org/10.4193/rhin20.116>
- [3] Moein, S.T., Hashemian, S.M., Mansourafshar, B., Khorram-Tousi, A., Tabarsi, P. and Doty, R.L. (2020) Smell Dysfunction: A Biomarker for COVID-19. *International Forum of Allergy & Rhinology*, **10**, 944-950. <https://doi.org/10.1002/alar.22587>

- [4] Renaud, M., Leon, A., Trau, G., Fath, L., Ciftci, S., Bensimon, Y., et al. (2020) Acute Smell and Taste Loss in Outpatients: All Infected with SARS-CoV-2? *Rhinology journal*, **58**, 406-409. <https://doi.org/10.4193/rhin20.199>
- [5] Nguyen, L.H., Drew, D.A., Graham, M.S., Joshi, A.D., Guo, C.G., Ma, W., et al. (2020) Risk of COVID-19 among Frontline Healthcare Workers and the General Community: A Prospective Cohort Study. *The Lancet Public Health*, **5**, e475-e483.
- [6] Brann, D.H., Tsukahara, T., Weinreb, C., Lipovsek, M., Van den Berge, K., Gong, B., et al. (2020) Non-Neuronal Expression of SARS-CoV-2 Entry Genes in the Olfactory System Suggests Mechanisms Underlying COVID-19-Associated Anosmia. *Science Advances*, **6**, eabc5801. <https://doi.org/10.1126/sciadv.abc5801>
- [7] Vihta, K.D., Pouwels, K.B., Peto, T.E., Pritchard, E., House, T., Studley, R., et al. (2022) Omicron-Associated Changes in SARS-CoV-2 Symptoms in the United Kingdom. *Clinical Infectious Diseases*, **76**, e133-e141.
- [8] Menni, C., Valdes, A.M., Polidori, L., Antonelli, M., Penamakuri, S., Nogal, A., et al. (2022) Symptom Prevalence, Duration, and Risk of Hospital Admission in Individuals Infected with SARS-CoV-2 during Periods of Omicron and Delta Variant Dominance: A Prospective Observational Study from the ZOE COVID Study. *The Lancet*, **399**, 1618-1624. [https://doi.org/10.1016/s0140-6736\(22\)00327-0](https://doi.org/10.1016/s0140-6736(22)00327-0)
- [9] Lechner, M., Counsell, N., Liu, J., Eynon-Lewis, N., Paun, S., Lund, V.J., et al. (2020) Anosmia and Hyposmia in Health-Care Workers with Undiagnosed SARS-CoV-2 Infection. *The Lancet Microbe*, **1**, e150. [https://doi.org/10.1016/s2666-5247\(20\)30096-3](https://doi.org/10.1016/s2666-5247(20)30096-3)
- [10] Zazhytska, M., Kodra, A., Hoagland, D.A., Frere, J., Fullard, J.F., Shayya, H., et al. (2022) Non-Cell-Autonomous Disruption of Nuclear Architecture as a Potential Cause of Covid-19-Induced Anosmia. *Cell*, **185**, 1052-1064.e12. <https://doi.org/10.1016/j.cell.2022.01.024>
- [11] Ye, Q., Zhou, J., He, Q., Li, J., Zheng, S., Wang, L., et al. (2021) SARS-CoV-2 Infection Regenerates Olfactory Epithelium through Reprogramming of Sustentacular Cells. *Cell Research*, **31**, 759-772.
- [12] Vaira, L.A., Deiana, G., Fois, A.G., Pirina, P., Madeddu, G., De Vito, A., et al. (2020) Objective Evaluation of Anosmia and Ageusia in Covid-19 Patients: Single-Center Experience on 72 Cases. *Head & Neck*, **42**, 1252-1258. <https://doi.org/10.1002/hed.26204>
- [13] Cooper, K.W., Brann, D.H., Farruggia, M.C., Bhutani, S., Pellegrino, R., Tsukahara, T., et al. (2020) COVID-19 and the Chemical Senses: Supporting Players Take Center Stage. *Neuron*, **107**, 219-233. <https://doi.org/10.1016/j.neuron.2020.06.032>
- [14] Butowt, R. and von Bartheld, C.S. (2020) Anosmia in COVID-19: Underlying Mechanisms and Assessment of an Olfactory Route to Brain Infection. *The Neuroscientist*, **27**, 582-603. <https://doi.org/10.1177/1073858420956905>
- [15] Gómez-Ochoa, S.A., Franco, O.H., Rojas, L.Z., Raguindin, P.F., Roa-Dueñas, J., Wyssmann, B.M., et al. (2021) COVID-19 in Health-Care Workers: A Living Systematic Review and Meta-Analysis. *BMJ*, **374**, Article No 2066.
- [16] Wang, X., Pan, Z. and Cheng, Z. (2020) Association between 2019-Ncov Transmission and N95 Respirator Use. *Journal of Hospital Infection*, **105**, 104-105. <https://doi.org/10.1016/j.jhin.2020.02.021>
- [17] Boscolo-Rizzo, P., Borsetto, D., Fabbris, C., Spinato, G., Frezza, D., Menegaldo, A., et al. (2020) Evolution of Altered Sense of Smell or Taste in Patients with Mildly Symptomatic Covid-19. *JAMA Otolaryngology—Head & Neck Surgery*, **146**, 729-732. <https://doi.org/10.1001/jamaoto.2020.1379>

- [18] Dell’Era, V., Farri, F., Garzaro, G., Gatto, M., Aluffi Valletti, P. and Garzaro, M. (2020) Smell and Taste Disorders during Covid-19 Outbreak: Cross-Sectional Study on 355 Patients. *Head & Neck*, **42**, 1591-1596. <https://doi.org/10.1002/hed.26288>
- [19] Brandão Neto, D., Fornazieri, M.A., Dib, C., *et al.* (2021) Olfactory Dysfunction in COVID-19: New Insights into Neurological Symptoms. *American Journal of Rhinology & Allergy*, **35**, 169-177.
- [20] Bunyavanich, S., Do, A. and Vicencio, A. (2020) Nasal Gene Expression of Angiotensin-Converting Enzyme 2 in Children and Adults. *JAMA*, **323**, 2427-2429. <https://doi.org/10.1001/jama.2020.8707>
- [21] Lechien, J.R., Chiesa-Estomba, C.M., Beckers, E., Mustin, V., Ducarme, M., Journe, F., *et al.* (2021) Olfactory and Gustatory Recovery in COVID-19 Patients: A European Multi-Center Study. *European Archives of Oto-Rhino-Laryngology*, **278**, 343-352.
- [22] Borsetto, D., Hopkins, C., Philips, V., Obholzer, R., Tirelli, G., Polesel, J., *et al.* (2020) Self-Reported Alteration of Sense of Smell or Taste in Patients with COVID-19: A Systematic Review and Meta-Analysis on 3563 Patients. *Rhinology journal*, **58**, 430-436. <https://doi.org/10.4193/rhin20.185>
- [23] Addison, A.B., Wong, B., Ahmed, T., Macchi, A., Konstantinidis, I., Huart, C., *et al.* (2021) Olfactory Dysfunction in COVID-19: A Systematic Review and Meta-Analysis to Identify Predictors of Recovery. *International Forum of Allergy & Rhinology*, **11**, 1469-1488.
- [24] Otte, M.S., Eckel, H.N.C., Poluschkin, L., Klussmann, J.P. and Luers, J.C. (2020) Olfactory Dysfunction in Patients with COVID-19: A Systematic Review and Meta-Analysis. *European Archives of Oto-Rhino-Laryngology*, **277**, 3815-3820.
- [25] Boscolo-Rizzo, P., Hummel, T., Hopkins, C., *et al.* (2021) Long-Lasting Olfactory Dysfunction in COVID-19 Patients. *Journal of Internal Medicine*, **290**, 653-664.
- [26] Hummel, T., Whitcroft, K.L., Andrews, P., Altundag, A., Cinghi, C., Costanzo, R.M., *et al.* (2017) Position Paper on Olfactory Dysfunction. *Rhinology Journal*, **54**, 1-30. <https://doi.org/10.4193/rhino16.248>
- [27] Speth, M.M., Singer-Cornelius, T., Oberle, M., Gengler, I., Brockmeier, S.J. and Sedaghat, A.R. (2020) Smell and Taste Disorders in COVID-19: A Cross-Sectional Study. *Allergy*, **75**, 2677-2681.