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Impact of COVID-19 mild lockdowns on residential water consumption: evidence from Brazil

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ABSTRACT

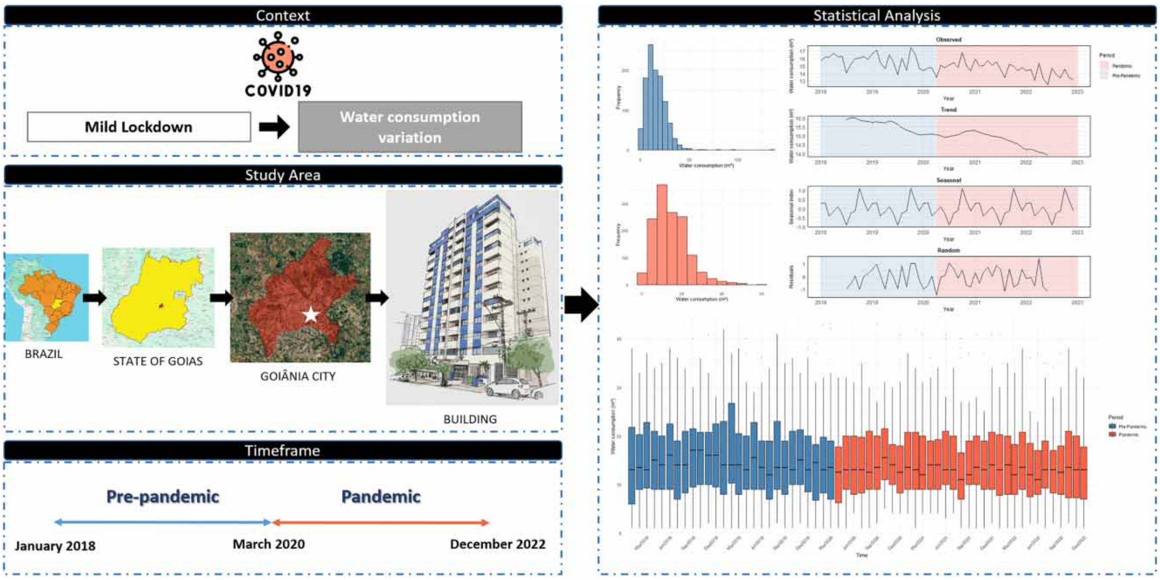
During the COVID-19 pandemic, the strictness of confinement measures varied widely across regions and countries, potentially influencing household water-use behaviour and leading to different consumption patterns between pre-pandemic and pandemic periods. This study investigates changes in residential water consumption in a mid-rise condominium in Goiânia, Brazil, by comparing data from the pre-pandemic and pandemic phases under conditions of a mild lockdown. Monthly water consumption records from 44 apartments were analysed from January 2018 to December 2022 using a multi-method statistical approach. The data were non-normally distributed, with most monthly consumption values ranging between 5 and 25 m^3. Fewer outliers were observed during the pandemic, along with a general downward trend in water consumption over time. Comparison of means using the non-parametric Kruskal-Wallis test suggested potential differences between the two periods; however, these differences were not statistically significant under the adopted significance threshold. The results diverge from patterns commonly reported in the literature. These can be attributed to the specific local context experienced during the COVID-19 pandemic, characterised by a short period of effective isolation, resistance to restrictive measures, low adherence to social distancing, and recurrent water scarcity in the region.

Key words: COVID-19, residential demand, statistical analysis, water consumption

HIGHLIGHTS

- Five-year apartment dataset analyzed to assess residential water use in Brazil.
- Non-parametric methods applied to evaluate COVID-19 impacts on water demand.
- Time-series analysis showed a downward trend and an atypical lockdown-related decrease.
- Local contexts critically shape water use, even during extreme events like pandemics.
- Findings support evidence-based, post-pandemic urban water management strategies.

GRAPHICAL ABSTRACT



1. INTRODUCTION

The spread of the SARS-CoV-2 virus, first identified in the city of Wuhan, China, following several cases of severe pneumonia in mid-December 2019, triggered the most recent global pandemic declared by the World Health Organisation (WHO). On January 30, 2020, the WHO declared the outbreak a Public Health Emergency of International Concern (PHEIC), and approximately two months later, it was officially characterised as a global pandemic. On May 5, 2023, the WHO declared the end of the COVID-19 pandemic and the associated global health emergency. By that time, more than 777 million cases and over 7 million deaths had been recorded worldwide, with Brazil being the second most affected country in terms of total deaths, reporting 702,000 fatalities (WHO 2023).

During the outbreak period, in an effort to reduce mobility and thereby contain the spread of the virus, governments implemented sanitary restrictions and lockdowns, requiring people to stay at home except for essential activities. In this context, the COVID-19 pandemic led to significant lifestyle changes worldwide, including reduced travel and leisure activities, restrictions on social gatherings, and the promotion of remote work, commonly referred to as home office arrangements (Badr *et al.* 2020). The increase in time spent at home represented a drastic shift in behaviour and lifestyle for most people (Chan *et al.* 2020; Chen & Qiu 2021). These changes had a direct impact on household water consumption, driven by both extended home occupancy (Chen & Qiu 2021) and intensified hygiene practices, such as frequent handwashing, more frequent bathing, and enhanced food sanitation (Campos *et al.* 2021).

Thus, the COVID-19 pandemic introduced significant shifts in residential water consumption patterns, as reported in the literature, which have had both positive and negative impacts compared to pre-pandemic behaviour. Several studies indicate an increase in daily consumption relative to the pre-pandemic period, as well as changes in demand peaks (Abu-Bakar *et al.* 2021). Rizvi *et al.* (2021) reported a 30% increase in monthly consumption during Ramadan in Mecca, while Kalbusch *et al.* (2020), analysing data from Joinville (Brazil), identified a reduction in water use in commercial, industrial, and public buildings, but an increase in residential buildings, particularly in apartment complexes. Almulhim & Aina (2022) conducted an online survey in Dammam, Saudi Arabia, and found that 50–86% of respondents reported increased water consumption, which they attributed to higher water bills during the lockdown.

On the other hand, several authors argue that the pandemic's impact on residential water consumption may not be as significant, or may even lead to a decrease in consumption levels. In practice, the implementation of stringent lockdown measures can be strongly influenced by the population's economic conditions (Cominato *et al.* 2022), with much higher adherence to restrictions observed in developed countries compared to poorer regions (Kalbusch *et al.* 2020). This situation is further exacerbated when the cost of water represents a high financial burden relative to household income (Almulhim & Aina 2022). Özbaş *et al.* (2022) also note that the behaviour changes triggered by the pandemic may have only minor effects on overall average consumption, as increases in certain activities (such as more frequent handwashing or additional showers) can be offset by reductions in others (such as fewer car washes). Li *et al.* (2021) note that the shift from commercial to residential environments does not necessarily produce substantial changes in consumption. Because households represent controlled environments, they do not reproduce the repetitive hygiene routines typical of public places, such as handwashing upon entering a restaurant. Another relevant factor is building typology. Lüdtke *et al.* (2021) report that increases in water consumption during lockdown are more limited in apartments than in single-family houses with outdoor areas. Several water-intensive activities associated with staying at home, such as garden irrigation or swimming pool use, are absent in apartment buildings, which inherently constrains the potential for significant increases in residential water consumption in this type of dwelling.

While there is a broad consensus that the COVID-19 pandemic had perceptible effects on household water consumption, an aspect still scarcely explored in the literature concerns the role of the stringency of lockdown and social distancing measures and their direct relationship with residential water use. Governmental responses to the pandemic varied substantially across countries, with some regions enforcing highly stringent lockdowns, whereas others adopted milder measures or pursued a gradual and continuous relaxation of restrictions (Dzúrová & Květoň 2021).

In Brazil, for instance, governmental actions implemented in response to COVID-19 were highly fragmented and decentralised, marked by an almost complete absence of federal coordination (Borges *et al.* 2020; Silva *et al.* 2020). This led to wide variability in sanitary measures and restrictions among states and municipalities, which was, in turn, strongly influenced by political dynamics: governors and mayors in opposition to the federal administration tended to adopt stricter distancing measures (as observed in northeastern states such as Maranhão and Ceará), whereas authorities aligned with the federal government, such as in the city of Goiânia and the state of Goiás, implemented comparatively softer restrictions (Valadão *et al.* 2022).

Despite this diversity of contexts, no case studies were identified in the literature that specifically examine how residential water consumption behaves under mild social-isolation conditions, nor studies that systematically investigate the relationship between the flexibility of containment measures and the magnitude of changes in consumption. This gap is particularly relevant because most conclusions available in the literature are derived from settings characterised by strict lockdowns, which may provide only a partial view of the phenomenon.

Therefore, this study conducts a detailed assessment of the impact of the COVID-19 pandemic on residential water consumption in a medium-standard multifamily building located in the Brazilian city of Goiânia, through comparative analyses of water-use volumes recorded before and during the pandemic. The goal is to understand changes in water-use patterns within a context of relatively mild and partial sanitary restrictions, thereby providing evidence from a setting that is underrepresented in the international literature and expanding the understanding of how different levels of isolation intensity can modulate residential water consumption.

2. METHODOLOGY

2.1. Study area

This study was conducted in Goiânia, the capital of the Brazilian state of Goiás, located on the country's central plateau (Figure 1). The city has an average temperature of 23 °C, an average annual rainfall of 1,617.31 mm, and a highly seasonal rainfall pattern, characterised by a distinct wet season (October to April) and a dry season (May to September) (Souto *et al.* 2023). Despite the significant spread of COVID-19 in the city (nearly half a million confirmed cases with a 2% mortality rate), Goiânia experienced only 15 days of strict lockdown over the course of the SARS-CoV-2 pandemic (Borges *et al.* 2020).

The selected building is a mid-income, multifamily residential condominium located in an upscale neighbourhood of Goiânia. The complex comprises 44 apartments, 40 of which are three-bedroom units of 120 m^2, and four are penthouses of 200 m^2. The estimated population of the condominium is 103 residents. The apartments feature conventional plumbing layouts, including a kitchen tap, a water filter point, a utility sink, and a washing machine connection. Each unit also contains two bathrooms equipped with flush toilets, washbasins, and electric showers.

2.2. Data collection

The local public water utility provided water consumption data for the apartments. The dataset comprises monthly consumption per apartment over five years, classified as follows:

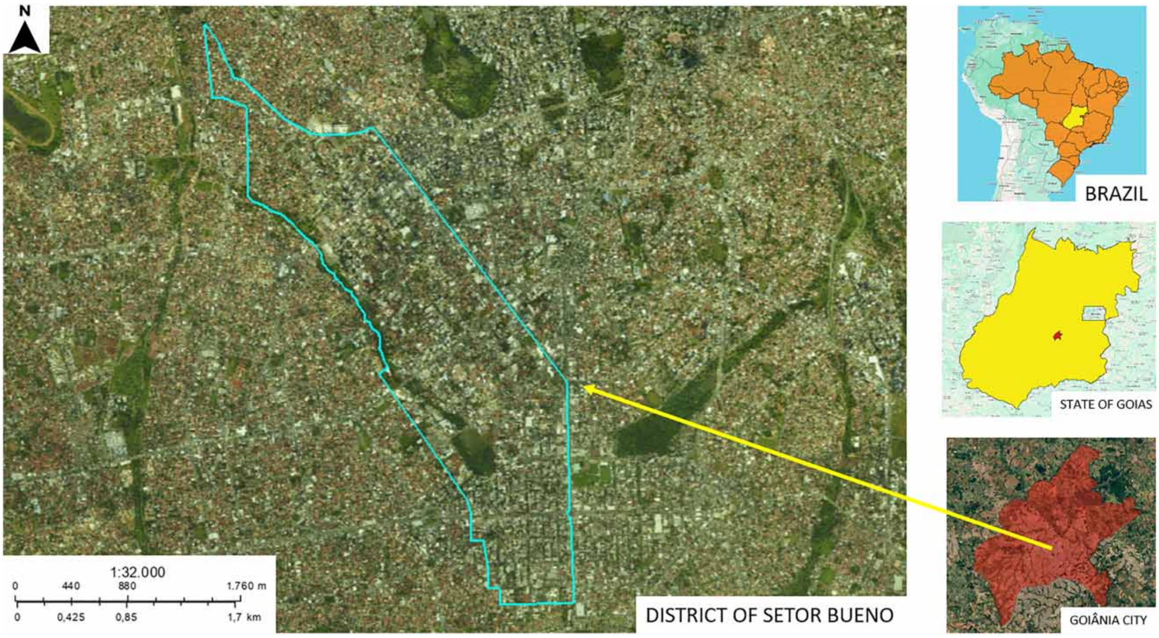


Figure 1 | Location of the case study. *Source*: Adapted from (Google 2025) and (COMDATA 2025).

- January 2018 to March 2020: pre-pandemic period.
- April 2020 to December 2022: pandemic period.

The condominium's building manager provided the number of residents and the built area of each apartment. According to the administrator, no significant changes occurred in the number of residents per apartment during the study period. The condominium is characterised by stable occupancy, typically comprising families with an older population profile.

2.3. Statistical analysis of the data

Statistical analysis was conducted using the methodology proposed by Kalbusch *et al.* (2020), who had performed a similar study. The analyses were carried out using RStudio, version 2024.04.2 (R Core Team 2024), with the following packages: ggplot2 (Wickham *et al.* 2016), writexl (Ooms 2025), tidyr (Wickham *et al.* 2024), readxl (Wickham & Bryan 2025), ggthemes (Arnold 2024), dplyr (Wickham *et al.* 2023) and ggrepel (Slowikowski 2024). The significance level adopted was $\alpha = 0.05$.

Initial analyses included descriptive statistics such as mean, standard deviation, median, minimum, maximum, and first and third quartiles. Frequency distributions of monthly consumption values were also examined based on the observed continuous variables. Boxplots were generated to identify upper and lower limits and detect outliers, while histograms were used to visually assess the overall shape of the data distribution.

Subsequently, annual average water consumption was compared by year and by period (pre-pandemic and pandemic), using Analysis of Variance (ANOVA) to assess whether significant differences existed. At a 5% significance level, if the p-value was below 0.05, the null hypothesis was rejected, indicating a statistically significant difference.

Because the data did not follow a normal distribution, two ANOVA assumptions were checked: (1) normality of residuals using the Shapiro–Wilk test and (2) homogeneity of variances using Levene's test. In both cases, p-values below 0.05 indicated violation of these assumptions, rendering ANOVA unsuitable.

Due to the non-normality of the water consumption data and residuals, as well as the heterogeneity of variances, the Kruskal–Wallis test was applied to assess differences between years and between the pre-pandemic and pandemic periods. This non-parametric test is suitable for comparing more than two groups when the assumptions of ANOVA are not met. In the specific comparison of pandemic-related periods (i.e., only two groups), the Kruskal–Wallis test followed the same methodology as the Mann–Whitney U test.

3. RESULTS

The dataset used for statistical analysis was provided by the local water utility and consisted of monthly water consumption records from 2018 to 2022 (five years) for each apartment. The building contains apartments of two characteristic sizes, along with information on the number of residents per unit, totalling 103 people across the condominium. Table 1 presents the descriptive statistics by year and by period (pre-pandemic and pandemic). A decreasing trend was observed for all parameters over the years, and a reduction in water consumption was also noted during the pandemic period. For the assessment of minimum recorded values, the analysis excluded null entries (zeros and blanks) and any inconsistent observations.

Figure 2 presents, for each period, a boxplot of water consumption, reflecting the descriptive statistics previously discussed. Graphically, a slight downward shift of the boxplot is observed during the pandemic period (1st quartile, mean, and 3rd quartile). Outliers were identified in both periods, with notable extreme values of 136 m^3 (October 2019), 93 m^3 (February 2018), and 79 m^3 (March 2018) in the pre-pandemic period, and 58 m^3 (May 2020) during the pandemic. In the pre-pandemic period, the point cloud appears slightly more dispersed. In contrast, during the pandemic, it became more compact, with most observations falling within the boxplot limits and fewer outliers, generally of lower magnitude.

Analysing the histograms of water consumption, constructed in 5 m^3 intervals (Figures 3 and 4), reveals a higher frequency of consumption between 5 and 25 m^3 during the pre-pandemic period, whereas values between

Table 1 | Descriptive data on water consumption (m^3/month) by period

Year/Period	Minimum	First quartile	Average	Median	Third quartile	Maximum	Standard deviation
2018	1.00	9.00	15.89	15.00	21.00	93.00	10.18
2019	1.00	9.00	15.72	13.00	22.00	136.00	10.90
2020	1.00	8.50	14.89	13.00	20.00	58.00	9.00
2021	1.00	9.00	14.97	13.00	20.00	49.00	8.72
2022	1.00	8.00	13.86	13.00	19.00	41.00	7.78
Pre-pandemic	1.00	9.00	15.68	14.00	21.00	136.00	10.43
Pandemic	1.00	8.00	14.56	13.00	20.00	58.00	8.44

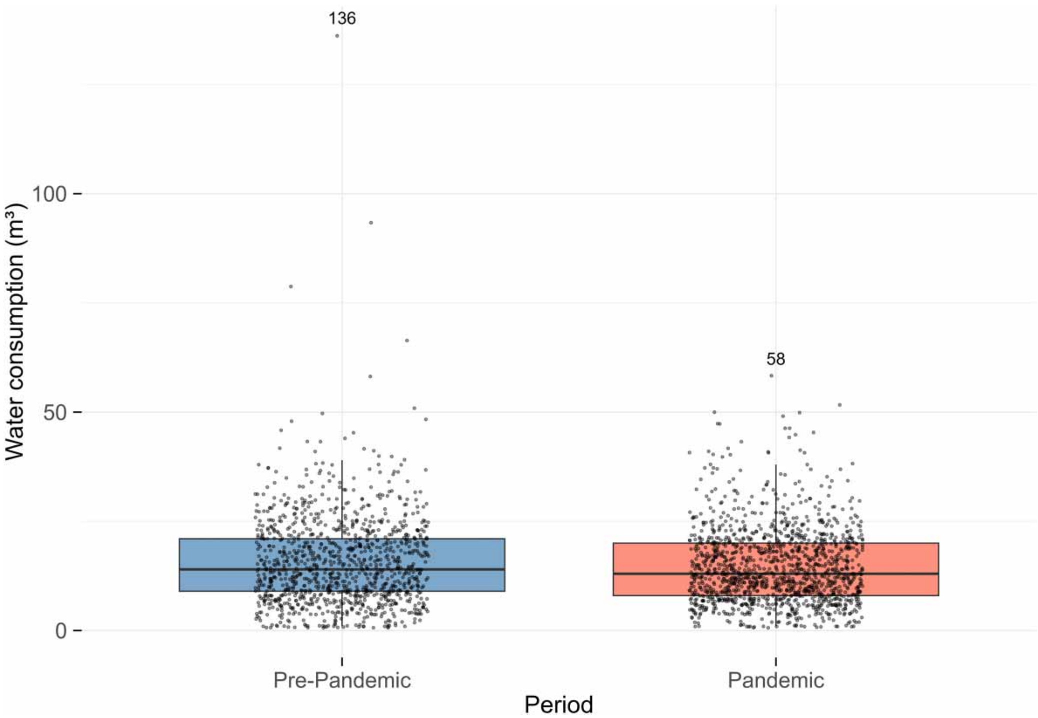


Figure 2 | Boxplots of water consumption before and during the COVID-19 pandemic period.

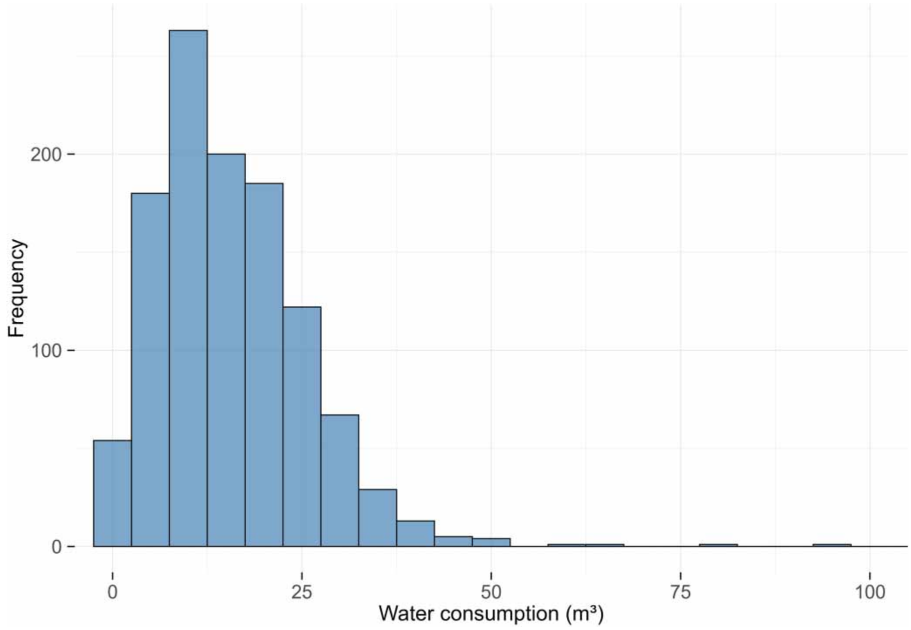


Figure 3 | Histogram of water consumption data before the COVID-19 pandemic.

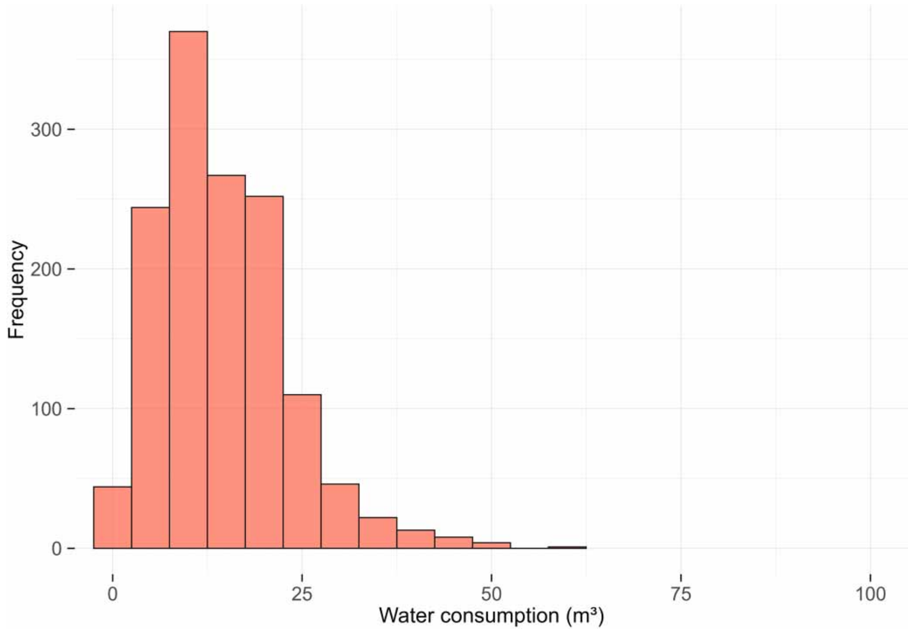


Figure 4 | Histogram of water consumption data during the COVID-19 pandemic period.

5 and 20 m^3 are more frequent during the pandemic. The data also exhibits a strongly skewed distribution, with most observations concentrated on the left side of the histogram. Previous studies involving residential water-use monitoring have similarly reported non-normal distributions, as noted by Kalbusch *et al.* (2020), Deyà-Tortella *et al.* (2017), and Tian *et al.* (2019).

Regarding the density curves (Figure 5), the pandemic period (red curve) displays a higher and more left-shifted peak. In contrast, the pre-pandemic curve exhibits a less pronounced peak and a more extended tail, especially beyond approximately 25 m^3, where the blue curve becomes dominant. This behaviour indicates a prevalence of higher consumption values in the pre-pandemic period. In contrast, the pandemic period shows a moderate reduction and a certain homogenisation of typical consumption ranges across the analysed months.

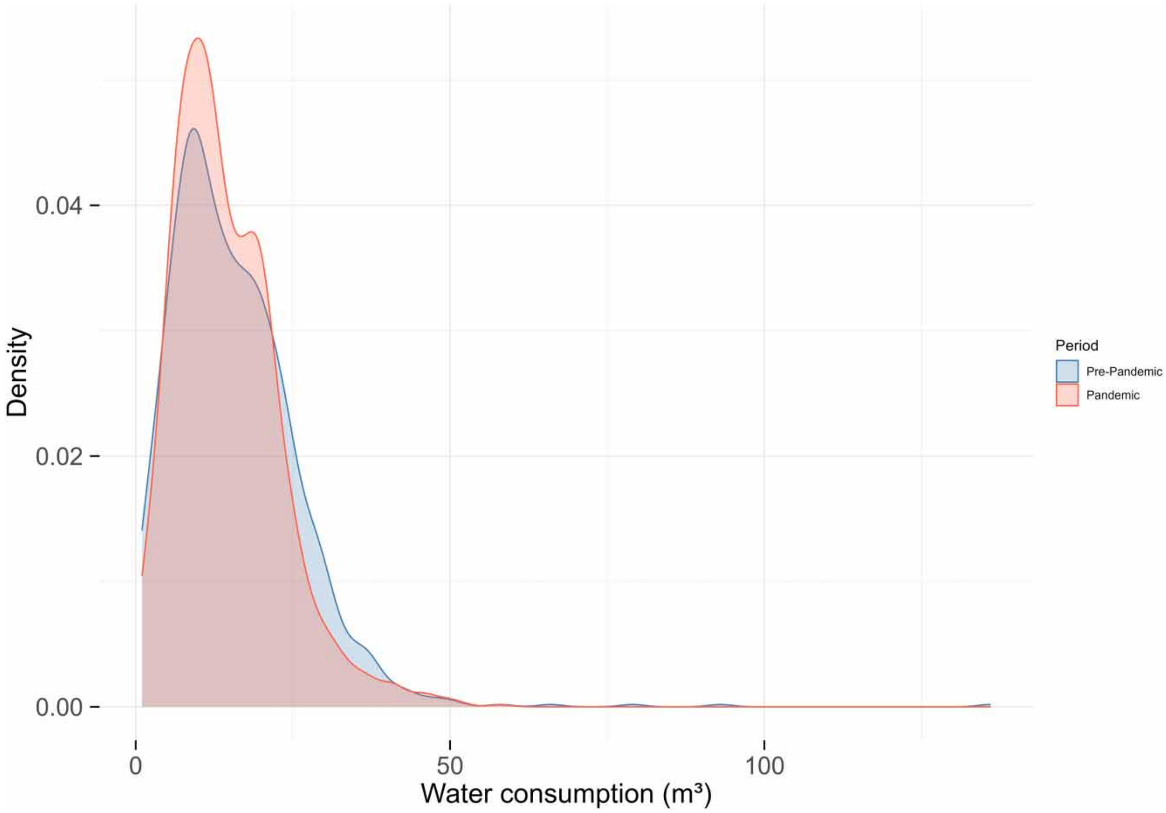


Figure 5 | Probability density functions of water consumption.

The distribution of the number of residents per apartment is presented in Figure 6. Three or four residents occupy most apartments, although a considerable number of two-occupant units are also observed (the most common case). The correlation between the number of residents per apartment and water consumption was

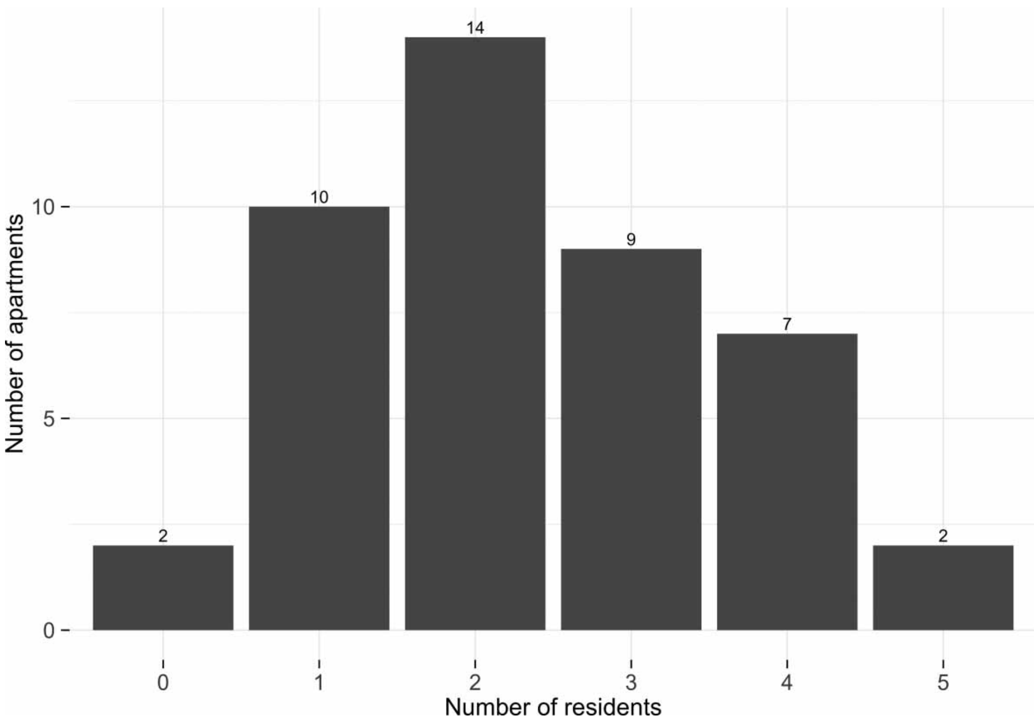


Figure 6 | Number of residents per apartment.

assessed using Pearson's correlation coefficient (Figure 7). This coefficient ranges from −1 to 1, with values closer to zero indicating weaker relationships between variables. In this study, the Pearson coefficient was 0.466, indicating a moderate positive correlation, which suggests that an increase in the number of residents is associated with higher monthly water consumption.

Figure 8 presents the temporal statistical data displayed as monthly boxplots, distinguishing the pre-pandemic and pandemic periods. Visually, the upper and lower limits of the boxplots appear relatively similar in both periods; however, the pandemic period shows a more compact distribution, suggesting greater homogeneity in the data. The medians in the pre-pandemic period (blue) are higher at various points along the timeline, whereas the medians during the pandemic are slightly lower. It is essential to note that, in this visualisation, the *y*-axis was truncated between 0 and 45 m^3 to emphasise the central tendency. However, all boxplot statistics were computed using the full range of observed data.

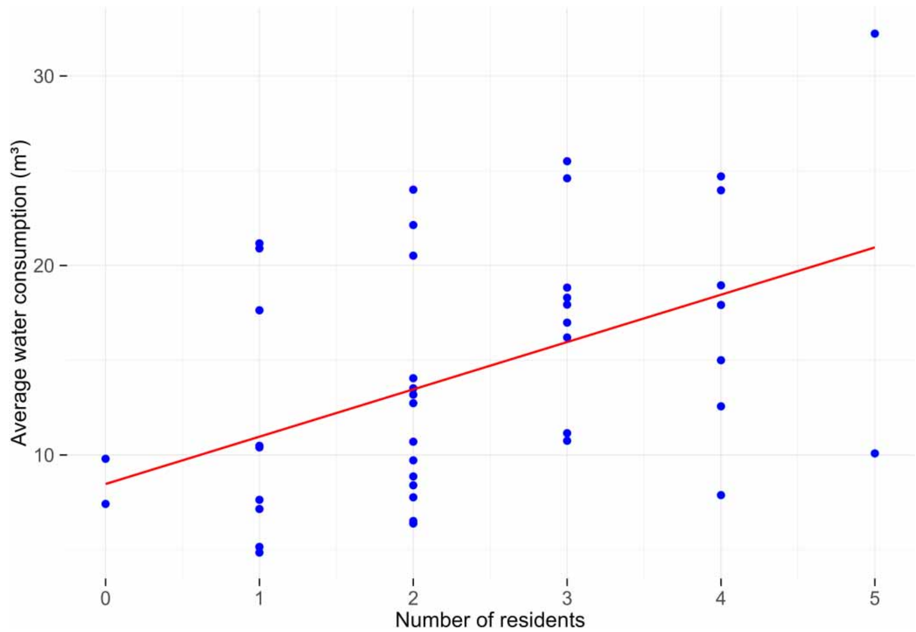


Figure 7 | Correlation between the number of residents and average water consumption.

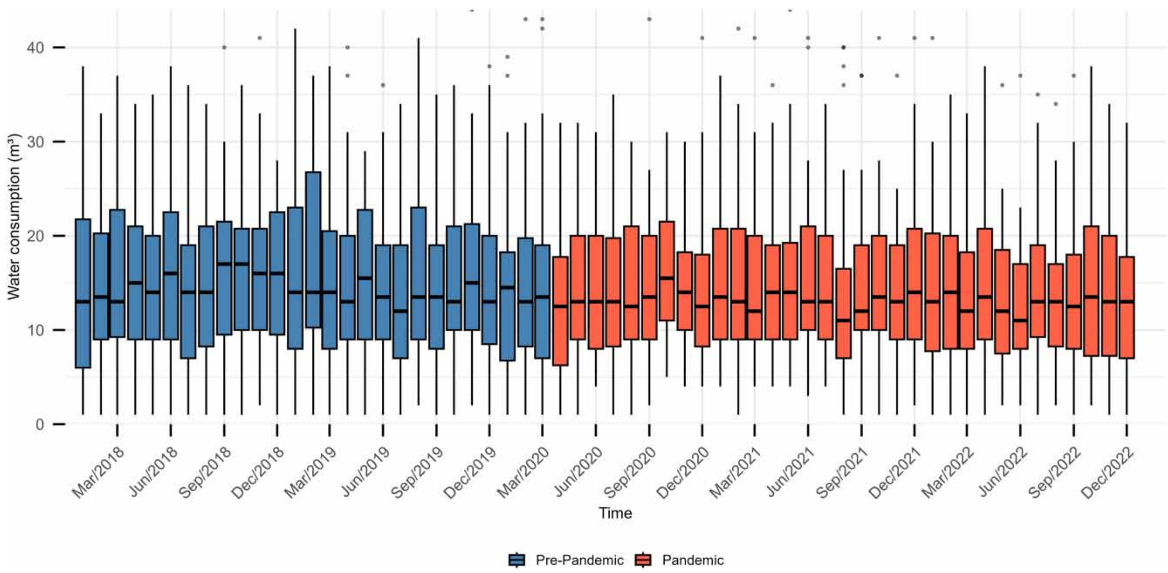


Figure 8 | Temporal statistical data displayed as monthly boxplot intervals.

To assess the behaviour of water consumption over time, a time series (trend) analysis was conducted (Figure 9). The decompose function was used for the temporal analysis, breaking down the time series into four components: observed values, trend, seasonality, and random (residual) variation.

The observed values represent the average monthly consumption across the entire evaluation period. Higher consumption levels were recorded in 2019, while lower levels were observed in 2022. The trend line illustrates the long-term direction of the data, independent of seasonal or random fluctuations. A sharp decline in water consumption is evident, beginning in February 2019 (pre-pandemic) and continuing through 2020. Overall, the trend suggests a consistent decrease in water consumption over the years.

The seasonal component reveals regular, cyclical variations over time. A recurring pattern of monthly consumption was identified, with peak usage occurring in October and a corresponding reduction in usage in July. This pattern aligns with local temperature extremes, as July represents the coldest month in the evaluated city, with an average temperature of 19.3 °C, and October the warmest, at 23.1 °C (INMET 2025). These temperature characteristics may influence the seasonal dynamics of water consumption in the condominium.

The random component captures residual variation not explained by the trend or seasonal structure, such as unexpected fluctuations, outliers, or measurement errors. To evaluate the adequacy of the decomposition model,

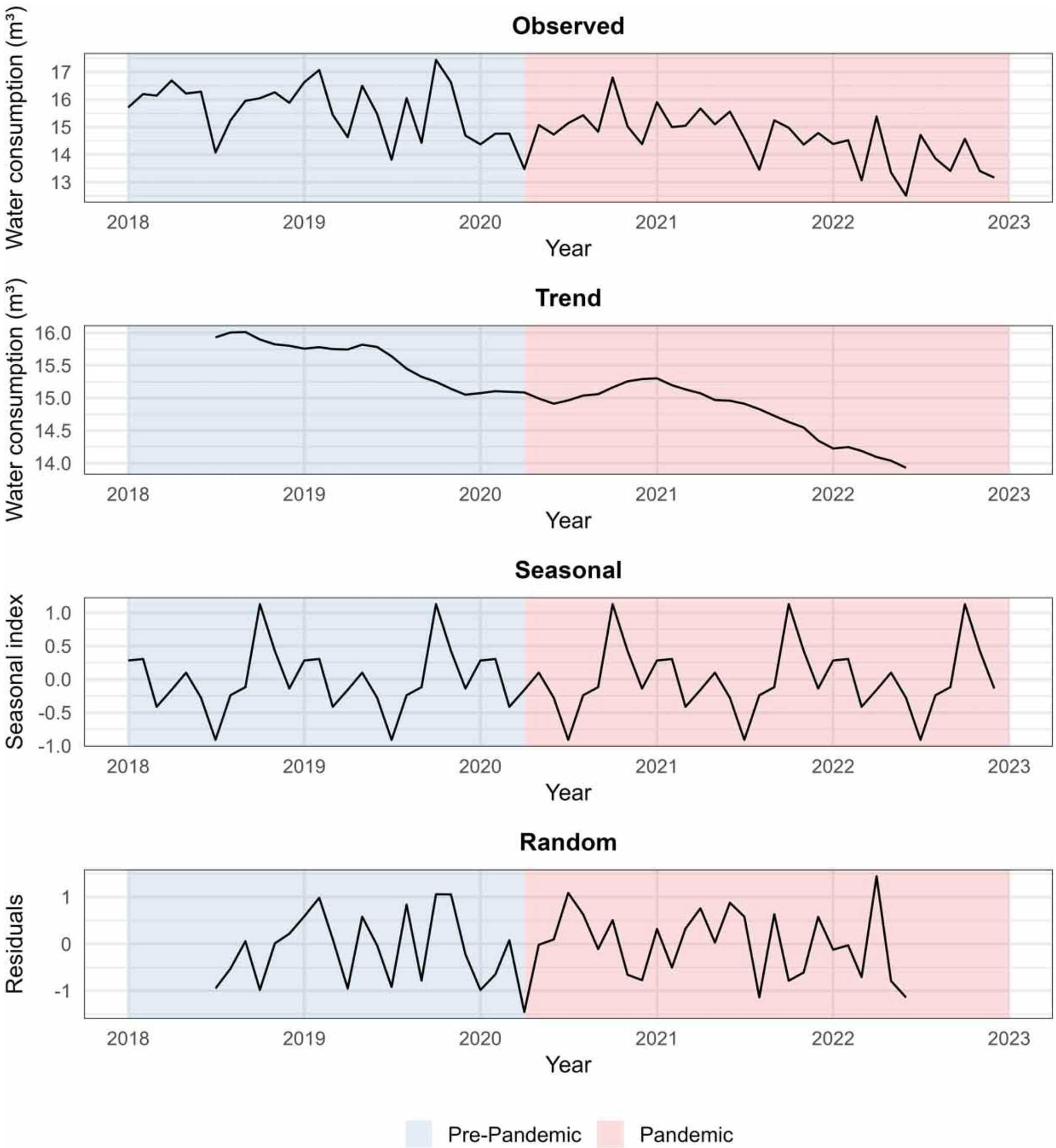


Figure 9 | Decomposition of the average water consumption time series.

the normality of the residuals was tested using the Shapiro–Wilk test at a 5% significance level. The test returned a *p*-value of 0.67, which fails to reject the null hypothesis and indicates that the residuals follow a normal distribution. This result confirms that the decomposition model successfully captured the main temporal patterns and is considered robust and appropriate for this analysis.

Table 2 presents the ANOVA results by year, along with the evaluation of residual normality and variance homogeneity for the water consumption data. The ANOVA test returned a *p*-value of 0.0348, which is below the 0.05 significance threshold, indicating statistically significant variation in water consumption between the evaluated years. However, when checking the underlying assumptions of the ANOVA model, the *p*-values for both the Shapiro–Wilk test (normality of residuals) and Levene's test (homogeneity of variances) were below the significance level. These results indicate that the residuals do not follow a normal distribution and that the variances are heterogeneous. Because these assumptions were not met, the application of ANOVA is not valid for comparing means in this context.

A similar outcome was observed in the comparison between the pre-pandemic and pandemic periods. Although the ANOVA results indicated statistically significant variation in water consumption between the two periods, the assumptions of residual normality and variance homogeneity were not satisfied, as shown in Table 3.

Considering the results presented in Tables 2 and 3, which confirm the non-normality of the water consumption data and ANOVA residuals, as well as the heterogeneity of variances, the Kruskal–Wallis test was applied to evaluate whether statistically significant differences existed in consumption across years and between the pre-pandemic and pandemic periods (Table 4). The *p*-values for both evaluations were greater than 0.05, indicating insufficient statistical evidence to reject the null hypothesis. This suggests that there are no statistically significant differences in the distributions of water consumption across the evaluated years. In the specific comparison between the pre-pandemic and pandemic periods, a *p*-value of 0.05604 was obtained. Although this value does not meet the conventional 0.05 threshold for statistical significance, it is sufficiently close to suggest weak (but not negligible) evidence against the null hypothesis. In other words, there may be a difference in water consumption patterns between the two periods, but it is not statistically significant according to the criteria adopted in this study.

Table 2 | ANOVA results, Shapiro-Wilk test, and Levene's test for annual periods of monthly water consumption

Evaluation between annual periods

Block	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Factor (ano)	4	980	244.95	2594	0.0348
Residuals	2634	248700	94.42	–	–
Normality of residuals					
Shapiro-Wilk test				*p*-value	2.2×10^{-16}
Homogeneity of variances					
Levene's test				Pr (>F)	0.0004536

Table 3 | Results of the ANOVA Shapiro-Wilk test and Levene's test for periods before and during the COVID-19 pandemic of monthly water consumption

Evaluation between periods before and during the pandemic

Block	Df	Sum Sq	Mean Sq	F value	Pr (>F)
Factor (period)	1	678	677.9	7.18	0.00742
Residuals	2637	249002	94.4	–	–
Normality of residuals					
Shapiro-Wilk test				*p*-value	2.2×10^{-16}
Homogeneity of variances					
Levene's test				Pr (>F)	1.198×10^{-5}

Table 4 | Kruskal-Wallis test results for annual periods and monthly water consumption before and during the COVID-19 pandemic

Evaluation between annual periods	
p-value	0.1746
Evaluation between periods before and during the pandemic	
p-value	0.05604

4. DISCUSSION

As evidenced by the statistical evaluation, the pandemic period was characterised by a decrease in water consumption in the analysed apartments compared to the pre-pandemic period. The time series analysis also indicated a gradual downward trend over the years. Comparison of means using the non-parametric Kruskal–Wallis test suggested potential differences between the two periods; however, these differences were not statistically significant at the adopted significance level. These findings contrast with the vast majority of similar studies reported in the literature. Among 14 case studies that compared residential water consumption before and during the pandemic, 12 reported an increase in consumption (Kalbusch *et al.* 2020; Campos *et al.* 2021; Di Mauro *et al.* 2021; Kim *et al.* 2021; Li *et al.* 2021; Lüdtke *et al.* 2021; Rizvi *et al.* 2021; Almulhim & Aina 2022; Bera *et al.* 2022; Cominato *et al.* 2022; Özbaş *et al.* 2022; Vizanko *et al.* 2024), one study reported stability (Cristiano *et al.* 2024), and only one identified a reduction (Birişçi & Öz 2021). Given this scenario, it becomes necessary to investigate the possible causes of this atypical reduction in consumption during the lockdown, particularly in the context of the present case study.

The first aspect to be considered concerns the particularities of the COVID-19 pandemic context in the city of Goiânia and the specific conditions under which the lockdown was experienced. In Goiás, the first decree addressing the pandemic was issued on March 13, 2020, declaring a public health emergency and introducing strict distancing measures (Guedes *et al.* 2022). However, under intense political, economic, and social pressure, the progressive relaxation of these measures began approximately 15 days later (Borges *et al.* 2020). By April 3, 2020, in the fourth decree, several commercial and religious activities had already been loosened (Silva *et al.* 2020). Thus, the period of effective isolation in Goiânia was relatively short (around 15 days), followed by early flexibilisation and limited public adherence to confinement practices, which contributed to sustained community transmission and high mortality rates in the region.

Another relevant aspect concerns the discrepancy between perceived changes in daily habits during the pandemic and the actual impact of these changes on water consumption, particularly in the context of resistance to social distancing and isolation measures in Goiânia. In several studies, most notably Campos *et al.* (2021), although participants reported an increase in hygiene-related activities, objective assessments of their routines indicated that these changes were not as substantial. Thus, the social expectation of increased water consumption may exceed the actual behavioural change that occurs.

A third factor involves local characteristics related to water use. Goiânia is situated in a region that frequently faces shortages in the public water supply (Battisti *et al.* 2025), leading part of the population to adopt continuous water-saving practices (Birişçi & Öz 2021). Additionally, throughout the entire study period, the city experienced recurring water scarcity within its local watershed, characterised by consistently low stream flows. This condition worsened particularly during the pandemic period: in the second half of 2021, after several months without rainfall, the local utility was required to prepare a rationing plan due to the imminent risk of supply rotation, a situation widely reported in the media (Goiás 2021; Goiânia 2022). In 2021 and 2022, the municipality also approved its own rationing plan. Although these measures ultimately did not need to be implemented due to operational adjustments and emergency works in the supply infrastructure (Goiás 2022), the overall atmosphere of scarcity, public awareness campaigns, and the prospect of rationing may have encouraged more rational water-use behaviours. This is consistent with the reduction observed even during the pandemic period, as also noted by Birişçi & Öz (2021).

5. CONCLUSIONS

This study conducted a robust statistical analysis of more than 2,600 monthly cold water consumption records from 44 apartments in a mid-sized residential condominium in the city of Goiânia, covering both the pre-pandemic and pandemic periods, a time marked by significant social and behavioural changes.

The histograms revealed a non-normal distribution of the data, which required the application of statistical methods suited to this distribution type. Monthly water consumption was primarily concentrated between 5 and 20 m^3, with several outliers likely due to household leaks. More extreme values were observed during the pre-pandemic period. Time series analysis indicated a downward trend in water consumption over time, particularly during the pandemic period, and the normality of residuals supported the validity of the model used. A moderate positive correlation ($r = 0.466$) was found between the number of residents per apartment and water consumption.

Given the nature of the data, the ANOVA test was deemed inappropriate for comparing groups due to the violation of two key assumptions: residual normality and homogeneity of variance. Therefore, the non-parametric Kruskal–Wallis test was applied, yielding a p-value of 0.05604, which suggests a potential difference between the periods, although not statistically significant under the adopted criterion.

In summary, the statistical analysis revealed a downward trend in water consumption throughout the entire study period, with a decline already noticeable before the pandemic (from February 2019 onward) and reduced levels persisting during the subsequent years of the pandemic. These results diverge from the pattern widely reported in the literature and may be explained by the particularities of the local context experienced during the COVID-19 pandemic.

The absence of a prolonged lockdown in the study area, combined with social, political, and economic pressures on restrictive measures, low adherence to isolation among the population, and recurrent water scarcity in the region, helps explain this atypical behaviour. This underscores that water demand forecasting and crisis management plans cannot assume uniform behavioural responses to external shocks, such as pandemics; local political, social, and hydrological contexts are critical determinants. These findings are relevant because they provide novel evidence on water consumption at the building scale under an exceptional context, while also reinforcing the importance of considering local factors in such analyses. Consequently, they contribute to the development of more effective strategies for water planning and management within the built environment, especially given that specific pandemic-related effects, such as the widespread adoption of remote work, are likely to persist in the future.

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CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Lucas Salomão Rael de Morais: Conceptualisation, Methodology, Software, Validation, Investigation, Formal analysis, Data curation, Writing – original draft, Writing – review & editing. Marcus Andre Siqueira Campos: Methodology, Software, Validation, Formal analysis, Data curation, Writing – review & editing, Visualisation. Luis Rodrigo Fernandes Baumann: Conceptualization, Methodology, Resources, Validation. Ricardo Cobacho: Conceptualisation, Methodology, Validation, Investigation, Formal analysis, Data curation, Writing – review & editing, Visualisation.

DATA AVAILABILITY STATEMENT

Data cannot be made publicly available; readers should contact the corresponding author for details.

CONFLICT OF INTEREST

The authors declare there is no conflict.

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