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ORIGINAL ARTICLE

THE INFLUENCE OF THE COVID-19 PANDEMIC ON THE DETECTION OF LEPROSY: AN OVERVIEW OF THE STATE OF GOIÁS, 2018-2021

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ABSTRACT

Leprosy is a neglected bacterial infectious disease with great disabling and stigmatizing potential. In Brazil, the difficulties imposed on diagnosis seem to have been exacerbated by the logistical obstacles caused by the COVID-19 pandemic. Therefore, this study aimed to analyze the impact of the COVID-19 pandemic on leprosy diagnosis indicators in Goiás. This is an ecological study based on the Notifiable Diseases Information System. All cases diagnosed and notified between 2018 and 2021 were considered for the following variables: date of notification, location, gender, age group, race, education level, clinical form, operational form, and degree of physical disability at the time of diagnosis. Quantitative and comparative analysis was carried out by calculating percentage variation using Chi-square or simple regression. Between the periods 2018-2019 and 2020-2021, no statistically significant differences were observed in the proportion of multibacillary cases, grade 2 physical disability at diagnosis, and cases not assessed for physical disability. However, a percentage variation of -37.64% (p = 0.005) in general detection rates was found. The abrupt reduction in general detection rates in 2020 and 2021 indicates the worsening of underreporting of leprosy in Goiás during the pandemic. It is, therefore, necessary to improve active search and longitudinal monitoring actions in communities to reach the most vulnerable and susceptible populations to leprosy.

KEY WORDS: Hanseniasis; epidemiological monitoring; neglected diseases; SARS-CoV-2; cross-sectional studies.

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INTRODUCTION

Leprosy is a slowly evolving infectious disease. Along with other diseases such as dengue fever, malaria, Chagas disease, and leishmaniasis, leprosy is part of the list of neglected diseases – a term proposed by the World Health Organization (WHO) for diseases whose occurrences are often related to conditions of socioeconomic precariousness, and that receive little investment for the development of new drugs and vaccines (Lindoso & Lindoso, 2009; WHO, 2020).

In recent years, Brazil has shown a reduction in the prevalence and detection of new cases of leprosy (Ribeiro et al., 2018). However, the high endemicity of the disease is still notable in the territory, being the second country with the highest number of cases in the world (WHO, 2021). The North, Northeast, and Central-West regions are responsible for the highest leprosy prevalence rates, revealing a heterogeneous distribution across the national territory (Ribeiro et al., 2018). In the State of Goiás, the study area of this research, the high endemicity for leprosy has remained (Lima et al., 2020).

The primary etiological agent of leprosy is the bacillus *Mycobacterium leprae*, although *M. lepromatosis* has also been described. The transmission mechanisms are not yet well understood; however, it is believed that contagion occurs mainly through the inhalation of saliva droplets from untreated multibacillary carriers. Transmission occurs mainly through intimate and prolonged contact between susceptible individuals and the patient, with household contacts being at greater risk of contracting the disease (Araujo et al., 2016).

The clinical picture of leprosy is mainly characterized by skin lesions with altered sensitivity, associated or not with thickening of peripheral nerves, which may affect hands, feet, and/ or eyes. The disease may present as papules, macules, hypochromic or erythematous plaques, nodules, or diffuse infiltration, depending on the type of immunological response developed against the bacillus (Froes et al., 2022). Without adequate treatment, the dermato-neuro condition has the potential for the development of functional disabilities and physical deformities, such as lagophthalmos, ectropion, reduction in visual acuity, fallen or claw hand, foot drop, trophic and/ or traumatic injuries on hands or feet, bone resorption and muscle atrophy (Rivitti, 2014). Therefore, people with leprosy often suffer from stigmatization and compromised quality of life, especially patients with low education (Pinto et al., 2021).

Early detection of leprosy is crucial so that treatment can be promoted at the onset of the condition and, thus, limit transmission and prevent the development of disabilities. However, in Brazil, leprosy detection suffers from a series of operational flaws: incomplete coverage and low quality of contact surveillance; failures in the ongoing training of health professionals; underreporting of new cases; lack of care at the primary level, an essential

action for the longitudinal monitoring of a disease with a long incubation period (Boigny et al., 2020; de Oliveira et al., 2021).

With the COVID-19 pandemic, new challenges have emerged for leprosy surveillance and control services. Health measures against the SARS-CoV-2 virus have limited not only the population's access to outpatient care but also health education and active search activities in communities (Fernandez et al., 2021). Thus, even though the Brazilian Ministry of Health has advised the continuity of leprosy treatment during the pandemic (Ministério da Saúde, 2020), it is clear that the detection of new cases was hampered.

Therefore, the present study aims to analyze the impact of the COVID-19 pandemic on leprosy diagnosis indicators in the State of Goiás, Brazil.

MATERIAL AND METHODS

Study design and period

This is an ecological study with quantitative and comparative analysis, referring to the years 2018 to 2021. The first stage of the study consisted of a descriptive analysis of the clinical-epidemiological profile of leprosy, while the second stage consisted of a time series analysis of epidemiological indicators.

Study area and population

The present study included the population residing in the State of Goiás, located in the Brazilian Central-West region. According to the 2022 Demographic Census, the state's population was 7,055,228 inhabitants, with a demographic density of 20.74 inhabitants/km^2. The Human Development Index (HDI) had a value of 0.737 in 2021 (IBGE, 2023a).

Source of data and inclusion and exclusion criteria

The source of the data was the Notifiable Diseases Information System (SINAN), a Brazilian Unified Health System database fed by the notification of cases on the list of compulsory notification diseases. In the case of leprosy, the Individual Notification Form is filled out only with the case confirmation (Ministério da Saúde, 2022b). The data were extracted in June 2023.

All cases diagnosed and reported between 2018 and 2021, with a "New Case" description in the entry mode, were included. Records whose output mode was "Diagnostic Error" were excluded. The following variables were collected: date of notification, location, sex, age group, race, education,

clinical form, operational classification, and degree of physical disability at the time of diagnosis.

For the calculation of the annual and monthly intercensal population estimates in Goiás, public data from the 2010 and 2022 Censuses of the Brazilian Institute of Geography and Statistics were obtained. An exponential function was used as the mathematical model for population growth.

Data processing and analysis

Clinical-epidemiological profile

For the description of the clinical-epidemiological profile, all notifications were grouped according to two periods: the first from 2018 to 2019 and the second from 2020 to 2021. The data were imported and tabulated in the Microsoft Excel software, where the relative frequencies of each population stratum were calculated.

Calculation of epidemiological indicators

The leprosy detection rate in the general population (DR) was used to assess the morbidity burden and magnitude of the disease. Monthly and annual rates were calculated using Equation 1.

$$DR = \frac{total\ new\ cases\ \in Goiás,\ \in a\ given\ month/year}{total\ population\ residing \in Goiás,\ \in the\ respective\ month/year} \times 100.000 \qquad \text{Equation 1}$$

In order to smooth the curve and better visualize the trend of the series, the moving average of monthly DR was used to present the graph.

The proportion of detection of new multibacillary cases (%MB) was used to evaluate the transmission dynamics of the disease. Annual proportions were calculated using Equation 2.

$$\%MB = \frac{number\ of\ new\ MB\ cases \in Goiás,\ \in a\ given\ year}{total\ new\ cases \in Goiás,\ \in the\ respective\ year} \times 100 \qquad \text{Equation 2}$$

The proportion of detection of new cases with grade 2 disability at the time of diagnosis (%G2D) was used to indirectly evaluate the effectiveness of activities for early case detection. Annual proportions were calculated using Equation 3.

$$\%G2D = \frac{number\ of\ newc\ ases\ with\ G2D \in Goiás,\ \in a\ given\ year}{total\ new\ cases\ with\ GD\ evaluated \in Goiás,\ \in the\ respective\ year} \times 100 \qquad \text{Equation 3}$$

The proportion of cases not evaluated for the grade of physical disability at the time of diagnosis (%NE), in turn, was used to partially assess

the quality of healthcare services. Annual proportions were also calculated using Equation 4.

$$\%NE = \frac{number\ of\ not\ evaluated\ new\ cases \in Goiás,\ \in a given\ year}{total\ new\ cases \in Goiás,\ \in the\ respective\ year} \times 100 \qquad \text{Equation 4}$$

All epidemiological indicators were calculated according to the formulas used in Brazil´s Ministry of Health epidemiological surveillance (Ministério da Saúde, 2022b).

Time series analysis

Two comparative analysis were conducted to estimate the impact of the COVID-19 pandemic on the detection of new leprosy cases in the State of Goiás. The first analysis used annual detection rate values to compare the pre-pandemic (2018-2019) to the pandemic period (2020-2021). The second analysis compared, within the pandemic, the period with social distancing decrees in force (March 2020-July 2021) and the period in which those measures were made more flexible (August 2020-December 2021), utilizing monthly detection rate values.

For each analysis, the means and standard deviations of the DR from each period were calculated. Then, the percentage change (%change) of the DR was calculated, according to the Equation 5:

$$\%change = \frac{average\ DR\ second\ period - average\ DR\ first\ period}{average\ DR\ first\ period} \qquad \text{Equation 5}$$

The *p*-value of the %change indicator was calculated using the Student's *t*-test. In the analysis of the %G2D and %MB indicators, the Chi-square test was performed, and for %MB, the Odds Ratio (OR) was presented. The evolution of the %NE indicator over time was evaluated by simple linear regression. In all analysis, p values ≤ 0.05 were considered statistically significant.

Ethical aspects

The present study was carried out in partnership with the Goiás State Health Department. The research was approved by the Ethics Committee of the Clinics Hospital of the Federal University of Goiás (CAAE 63378722.3.0000.5078) and by the Leide das Neves Ferreira Ethics Committee (CAAE 63378722.3.3001.5082), respecting the ethical precepts described in

the Declaration of Helsinki and in the 466/2012 Resolution of the Brazilian National Health Council.

RESULTS

During the 2018-2019 period, 2,929 cases of leprosy were reported in Goiás, while 1,876 cases were reported during the 2020-2021 period. Table 1 describes the clinical-epidemiological profile of the new leprosy cases.

Table 1. Clinical-epidemiological profile of new leprosy cases, State of Goiás, Brazil, from 2018 to 2021.

Variables	2018-2019		2020-2021	
	n	%	n	%
Sex				
Male	1,765	60.3	1,876	60.6
Female	1,164	39.7	740	39.4
Race/Color				
White	710	24.2	444	23.7
Black	360	12.3	226	12.0
Yellow	21	0.7	21	1.1
Brown	1,782	60.8	1,135	60.5
Indigenous	13	0.4	10	0.5
No record	43	1.5	40	2.1
Age group				
0-4	4	0.1	2	0.1
5-9	26	0.9	17	0.9
10-14	63	2.2	30	1.6
15-19	95	3.2	56	3.0
20-29	254	8.7	180	9.6
30-39	473	16.1	232	12.4
40-49	656	22.4	434	23.1
50-59	605	20.7	388	20.7
60-69	460	15.7	315	16.8
70-79	213	7.3	159	8.5
≥ 80	80	2.7	63	3.4

Education level				
Illiterate	213	7.3	114	6.1
Incomplete primary education	1,266	43.3	723	38.5
Complete primary education	235	8.0	128	6.8
Incomplete secondary education	220	7.5	128	6.8
Complete secondary education	430	14.7	267	14.2
Incomplete higher education	36	1.2	42	2.2
Complete higher education	121	4.1	67	3.6
No record	396	13.5	400	21.3
Not applicable	12	0.4	7	0.4
Operational form				
Paucibacillary	513	17.5	301	16.0
Multibacillary	2,416	82.5	1,575	84.0
Clinical form				
Indeterminate	289	9.9	179	9.5
Tuberculoid	246	8.4	172	9.2
Borderline	1,629	55.6	982	52.3
Lepromatous	644	22.0	409	21.8
Not classified	121	4.1	134	7.1
Grade of physical disability at the time of diagnosis				
Grade 0	1,888	64.5	1,144	61.0
Grade 1	660	22.5	437	23.3
Grade 2	239	8.2	169	9.0
Not evaluated	142	4.8	126	6.7
Total	2,929	100	1,876	100

The annual detection rate in the general population was 22.24 in 2018 and 21.28 in 2019. In 2020 and 2021, the DR were 13.88 and 13.26, respectively. Figure 1 shows the temporal evolution of the monthly DR smoothed by a moving average of order 4.

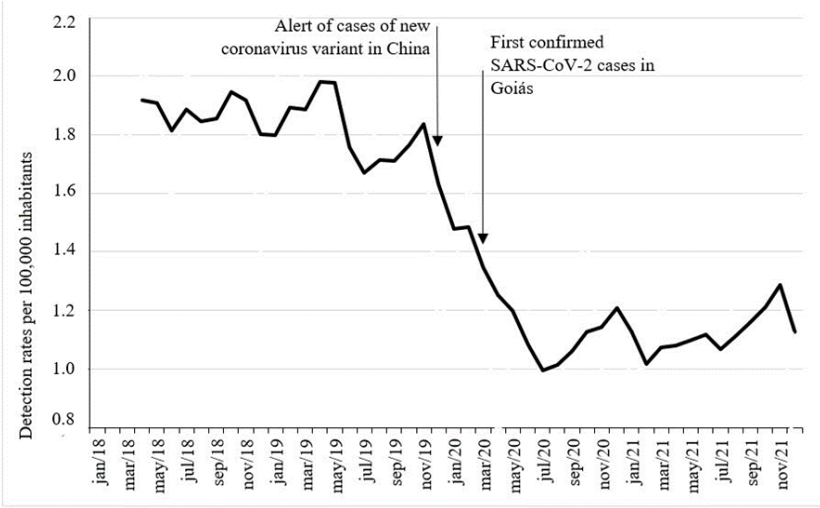

Figure 1. Monthly detection rates smoothed by a moving average of order 4, State of Goiás, Brazil, 2018 to 2021.

Table 2 shows a percentage variation of -37.64% (p= 0.005) between the pre-pandemic and pandemic periods. A percentage variation of 5.899% was observed between the social distancing and flexibilization periods, although it was not statistically significant (p= 0.564).

Table 2. Percentage of change of detection rates, State of Goiás, Brazil, from 2018 to 2021.

Analysis 1: Pre-pandemic *versus* pandemic period				
Period	Average of annual DR per 100,000 inhabitants	Standard deviation	%change	*p*-value
2018-2019	21.76	0.68		
2020-2021	13.57	0.44	-37.6%	0.005
Analysis 2: Social distancing *versus* flexibilization period				
Period	Average of monthly DR per 100,000 inhabitants	Standard deviation	%change	*p*-value
Mar/20 - Jul/20	1,051	0.215		
Aug/20 – Dec/21	1,113	0.205	5.9%	0.564

In Figure 2, it is possible to evaluate the temporal evolution of the proportion of multibacillary cases in the State of Goiás.

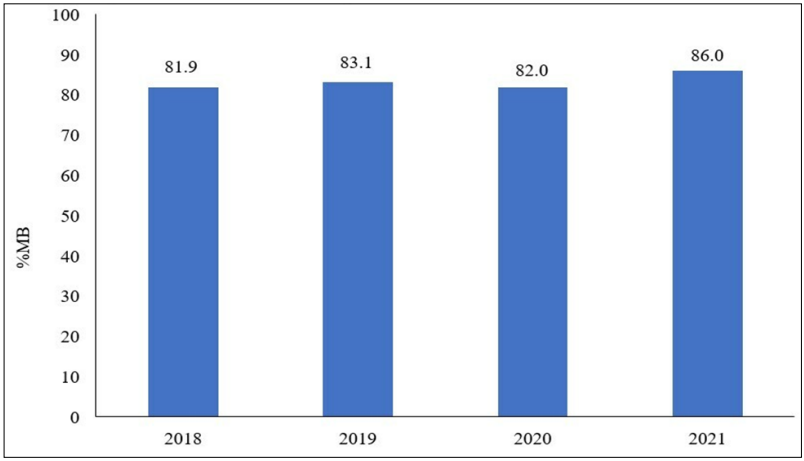

Figure 2. The proportion of new multibacillary cases (%MB) in the State of Goiás, Brazil, 2019 to 2021.

When comparing the proportion of multibacillary cases, no statistically significant difference was observed between 2018-2019 and 2020-2021 (Table 3).

Table 3. Analysis of the proportion of new multibacillary cases in the State of Goiás, Brazil, 2018 to 2021.

Period	Total new cases	Multibacillary cases		OR*	*p*-value
		n	%MB*		
2018-2019	2,929	2,416	82.5	1.00	
2020-2021	1,876	1,575	84.0	1.11	0.185

*%MB: new multibacillary cases (%MB), OR: Odds Ratio.

Regarding the %NE indicator, values of 4.10, 5.62, 6.19, and 7.26% were obtained for the years 2018, 2019, 2020, and 2021, respectively. A linear trend was observed in the simple regression (p= 0.015); therefore, significant differences in values were not shown over the years observed. Regarding the proportion of cases with G2D, values of 7.22, 9.99, 9.62, and 9.70% were observed for the years 2018, 2019, 2020, and 2021, respectively. In the Chi-square test, X^2=6.79 and p= 0.079 were found, indicating no significant differences between the values of the observations.

DISCUSSION

Between the periods of 2018-2019 and 2020-2021, the epidemiological profile of new leprosy cases in Goiás did not undergo significant changes. However, the abrupt drop in detection rates during the COVID-19 pandemic reveals a contradiction: the apparent reduction in endemicity concomitant with the worsened vulnerability of populations susceptible to leprosy.

In both periods, males had the highest number of notifications, a result similar to other studies in the State of Pará and in the Brazilian territory as a whole (Rocha et al., 2020; Ministério da Saúde, 2022a; Damasceno et al., 2023). A higher incidence of leprosy in men has been linked to behavioral factors, such as a tendency to have more significant social contact with other men, leading to a higher risk of exposition to the bacillus (Alves et al., 2021).

Brown people were responsible for the majority of new case notifications. According to Véras et al. (2021), the presentation of this variable depends mainly on the racial composition of the region, as there is no scientific evidence of an association between race (as a biological factor) and the development of leprosy. According to the 2022 Census, the brown population corresponded to 54.18% of the population of Goiás (IBGE, 2023b).

The association between education and leprosy is well-established in the literature. Low education tends to imply a context of neglect and social vulnerability, which, in turn, predisposes to more precarious sanitary conditions (Soares et al., 2021; Veras et al., 2021). The large proportion of patients with incomplete primary education corroborates this statement. However, it is notable that, especially in the period from 2020 to 2021, the "No record" category corresponds to a large portion of notifications.

The completeness of the data, with the exception of the "education level" variable, was considered to be of a regular level (incompleteness between 11 and 20%) or good level (incompleteness between 5 and 10%) according to the criteria adopted by Mendes et al. (2023). In general, it is possible to see that the percentages of incompleteness increase in 2020 and 2021. However, the %NE variable did not show statistically significant changes during the pandemic.

The higher incidence in the 40-49 and 50-59 age groups points to the impairment of the productive capacity of the economically active population. However, when assessing the age groups of 60 years and over, notifications correspond to more than a quarter of the total, a fact that may be associated with the aging of the population or the weakening of recent transmission of the disease (Rocha et al., 2020).

Regarding children under 15 years of age, a reduction in the absolute and relative frequency of cases was observed in the 2020-2021 period, indicating a possible decrease in early contact with bacilliferous patients. Reductions in cases in this age group were also found in other studies in Maranhão, Goiás,

and Brazil (Oliveira et al., 2023). These isolated findings, however, are not sufficient to estimate the persistence of leprosy transmission, as a longer time series would be needed to evaluate this age group. Furthermore, the clinical form and operational classification of new cases also provide information about the dynamics of endemic maintenance.

The borderline clinical form had the highest number of notifications, probably due to the development of exuberant neural conditions, which more easily lead to disabilities and, consequently, to the search for medical assistance (Rivitti, 2014). In both periods, multibacillary cases were the majority, indicating a large proportion of bacilliferous patients and a high probability of transmission to contacts (Veras et al., 2021).

In the historical series of the %MB variable, it was observed that, in 2021, the proportion of multibacillary cases increased in relation to previous years of the study. Although this increase may indicate the strengthening of the leprosy transmission chain, it is also possible that this result reflects the improvement in underreporting after the relaxation of social distancing measures (Goiás, 2021). In the Chi-square test, no statistically significant change in %MB was found between the pre-pandemic and during the pandemic periods. Therefore, based on these findings, it is impossible to affirm whether there was a weakening or strengthening of the leprosy transmission chain during the years 2020 and 2021.

The grade zero of physical disability was the most frequently observed, similar to those found in the State of Pará and Brazil as a whole (Ministério da Saúde, 2022a; Damasceno et al., 2023). In contrast to the expected in the context of impaired timely diagnosis, no statistically significant changes were observed in the %G2D indicator in 2020 and 2021. More significant changes should only be seen in the coming years, as leprosy is a slowly evolving disease with a long incubation period.

A reduction was observed between the two periods in the number of new case notifications and overall detection rates. This fact can be illustrated both by the percentage variation of -37.64% and by the Brazilian Ministry of Health evaluation parameters: the annual DR values for 2018 and 2019 entered the “Very high” category, while, in 2020 and 2021, the annual DR values entered the “High” category (Ministério da Saúde, 2022b).

When analyzing the graph of monthly detection rates, it is noticeable that, from January 2018 to November 2019, the rates appear to have suffered a gradual decline. Previous studies also found a reduction in DR in Goiás, with a decreasing trend observed between 2001 and 2017 and between 2007 and 2015 (Lima et al., 2020; de Oliveira et al., 2021). Between December 2019 and January 2020, the abrupt drop in diagnoses could be explained by the end-of-year festivities and school holidays.

Another significant drop in detection rates began in March 2020, alongside the first social distancing decrees in Goiás (Goiás, 2021). In Brazil,

the drop in DR was also observed from March 2020 onwards (da Paz et al., 2022). However, there are no reasons to consider an absolute reduction in leprosy cases during this period. Although leprosy and COVID-19 are both transmitted through droplets, the epidemiological measures applied to these diseases are dramatically different. While the transmission chain of COVID-19 can be broken by isolating patients, timely treatment of carriers is considered the only way to eliminate leprosy transmission (WHO, 2020). Moreover, given that contagion in leprosy occurs with close and prolonged contact, social distancing measures might have increased the risk of transmission within households.

It is known that the pandemic accentuated socioeconomic vulnerabilities in populations already susceptible to leprosy, making it challenging to adopt hygiene habits and promote close intra-household contact in crowded housing (da Paz et al., 2022). Therefore, underreporting is the most plausible explanation for the reduction in leprosy cases during this period.

The underreporting of leprosy cases was already a problem before the pandemic, and its intensification can be explained by a series of factors, including the suspension of active search and health education activities in Primary Care, the prioritization of resources for the response to flu syndrome, restrictions on urban mobility and fear of COVID-19 infection (Mahato et al., 2020; de Oliveira et al., 2021; Fernandez et al., 2021).

As of August 2020, leprosy detection rates appear to rise discreetly but without reaching pre-pandemic values. In fact, during this period, COVID-19 control measures were already relaxed, facilitating access to health care. In January 2021, the vaccination campaign against COVID-19 began in Brazil, significantly reducing deaths and the burden imposed on the health system (Fiocruz, 2022; Goiás, 2023). Still, it is unlikely that leprosy diagnostic activities would have been re-established in 2021 – a hypothesis that could explain the lack of statistically significant difference between the average DR of the March 2020-July 2020 period and the August 2020-December 2021 period.

Some limitations of the study must be discussed. As this is an ecological analysis, individual variables of the health-disease process were not considered, such as genetic factors of susceptibility to leprosy. Furthermore, knowledge of the epidemiological reality in Goiás is hampered by underreporting and incomplete data in leprosy notification forms. Lastly, the time frame from 2018 to 2021 may have omitted variations in epidemiological indicators in the years prior to 2018, possibly compromising the precision of inferences.

It is clear that the health crisis imposed by the COVID-19 pandemic has exacerbated health inequities, making socioeconomic conditions even more precarious and access to the health system even more difficult. Therefore, more studies are needed to investigate the long-term effects of the pandemic on

an already neglected disease, especially with regard to transmission dynamics and the profile of physical disabilities.

The worsening of underreporting reinforces the need to improve active search and longitudinal monitoring actions in communities in order to reach the most vulnerable populations susceptible to leprosy. In addition to robust epidemiological surveillance, it is also essential to strengthen primary care and ongoing health education.

CONFLICT OF INTEREST

The authors declare they have no conflicts of interest to disclose.

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