Early Detection of COVID-19 in Portugal: Use of Clinical Records

Deteção Precoce de COVID-19 em Portugal: Uso de Registos Clínicos

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ABSTRACT

Introduction: Syndromic surveillance allows early detection of changes in the population's morbidity pattern. The aim of this study is to evaluate the usefulness of indicators related to access to healthcare services, in COVID-19 surveillance.

Material and Methods: A time series analysis was performed using the weekly incidence rate of COVID-19 in Mainland Portugal, between weeks 14/2020 (March 30 to April 5) and 25/2020 (June 15 to 21), and six indicators: 1) COVID-19 consultations in primary healthcare; 2) number of COVID-19 emergency department visits; 3) number of emergency department visits due to viral pneumonia; 4) number of hospitalizations due to viral pneumonia; 5) proportion of emergency department visits due to viral pneumonia; and 6) proportion of hospitalizations for viral pneumonia. Pearson correlation and cross-correlations were computed.

Results: A strong correlation was found between the weekly incidence rate of COVID-19 and all indicators. [(1) 0.76; (2) 0.82; (3) 0.77; (4) 0.84; (5) 0.86; e (6) 0.90]. Emergency department visits and hospitalizations for viral pneumonia detect variations in the frequency of the disease with a one week lag compared to the incidence rate of COVID-19, in one week. COVID-19 consultations in primary healthcare and emergency department visits trail behind the incidence rate of COVID-19, in one week. The proportion of viral pneumonias in emergency department visits, or hospitalizations, is temporally aligned with the weekly incidence rate of COVID-19.

Discussion: The delay found in the COVID-19 primary healthcare consultations and emergency department visits, may be related to changes in access to healthcare services and clinical coding. Emergency department visits and hospitalizations for viral pneumonia may be useful in the early detection of COVID-19. Viral pneumonia may have been coded as being of unknown origin. Future monitoring of these indicators is necessary to ascertain whether the incidence of COVID-19 is significantly influenced by changes in testing strategies. The indicators described in this study will be an asset for the optimization of testing strategies, allocation of healthcare resources to the communities that are most vulnerable to severe morbidity and assessing vaccination impact. As such, surveillance systems based on clinical data will be a valuable complementary tool to SINAVE.

Conclusion: The indicators under analysis could be used regularly, with special attention to viral pneumonias, to detect outbreaks of COVID-19. Information on pneumonia of unknown etiology may be considered in the surveillance of COVID-19.

Keywords: COVID-19; Coronavirus Infections/diagnosis; Pneumonia, Viral/diagnosis; Portugal; SARS-CoV-2; Sentinel Surveillance

RESUMO

Introdução: A vigilância sindrómica permite a identificação precoce de alterações no padrão de morbilidade da população. Este estudo tem como objetivo avaliar a utilidade de indicadores relativos a cuidados de saúde primários e hospitalares, na vigilância da COVID-19.

Material e Métodos: Foi realizada uma análise de séries temporais utilizando a taxa de incidência semanal de COVID-19 em Portugal Continental, entre as semanas 14/2020 (30 março a 05 abril) e 25/2020 (15 a 21 junho), e seis indicadores: 1) consultas em cuidados de saúde primários por COVID-19; 2) número de episódios de urgência por COVID-19; 3) número de episódios de urgência por pneumonia vírica; 4) número de internamentos por pneumonia vírica; 5) proporção de episódios de urgência por pneumonia vírica face ao total de episódios de urgência por pneumonia; e 6) proporção de internamentos por pneumonia vírica face ao total de internamentos por pneumonia. Foram calculadas correlações de Pearson e correlações cruzadas.

Resultados: Foi encontrada uma correlação forte entre a taxa de incidência semanal de COVID-19 e todos os indicadores [(1) 0,76; (2) 0,82; (3) 0,77; (4) 0,84; (5) 0,86; e (6) 0,90]. Os episódios de urgência e internamento por pneumonias víricas detetam variações na frequência da doença, com uma semana de antecedência. As consultas em cuidados de saúde primários e urgências por COVID-19 registam uma semana de atraso relativamente à evolução da taxa de incidência. A proporção de pneumonias víricas face ao número de pneumonias em episódios de urgência, ou internamentos, encontra-se alinhada temporalmente com a evolução da taxa de incidência semanal de COVID-19.

Discussão: O atraso encontrado no padrão de evolução de consultas em CSP, e de episódios de urgência por COVID-19 face à incidência de COVID-19, poderá estar relacionado com a reorganização dos serviços de saúde e criação de códigos específicos para estas consultas. Episódios de urgência e internamentos por pneumonia vírica poderão ser úteis para a deteção precoce de possíveis surtos de COVID-19. Pneumonias víricas poderão ter sido classificadas como pneumonias de causa indeterminada. A monitorização futura destes indicadores é necessária de modo a averiguar se a incidência de COVID-19 é influenciada significativamente por alterações na estratégia de testagem. Os indicadores deste trabalho serão uma mais valia para a adequação de estratégias de testagem, alocação de recursos de saúde a comunidades mais vulneráveis à morbilidade severa e avaliação de programas de vacinação. Como tal, os sistemas de vigilância com base em registos de saúde serão um complemento valioso ao SINAVE.

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Conclusão: Sugere-se que os indicadores em análise sejam utilizados de forma regular, com especial atenção à informação relativa a pneumonias víricas, como forma de detetar precocemente surtos de COVID-19. A informação relativa a pneumonias de causa indeterminada poderá ser considerada na monitorização da COVID-19.
Palavras-chave: COVID-19; Infecções por Coronavírus/diagnóstico; Pneumonia Viral/diagnóstico; Portugal; SARS-CoV-2; Vigilância de Evento Sentinela

INTRODUCTION

The infectious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), known as coronavirus disease 2019 or COVID-19, was declared by the World Health Organization (WHO) as a public health emergency of international concern on 30 January 2020 and as a pandemic on 11 March.[1]

Since the beginning of the epidemic, the preparation and response to the disease caused by the new Coronavirus has been prioritised in Portugal as in many other countries, with the identification of three main components of surveillance, including (i) verification and detection; (ii) risk and severity assessment and (iii) monitoring of the epidemic.[2] In Portugal, COVID-19 surveillance currently relies on case identification and notification of confirmed cases (taking into account the origin, clinical presentation of the cases, patient destination, contacts and location) through the National Epidemiological Surveillance System (SINAVE) platform. The notification of positive cases is mandatory and should be recorded on this platform by physicians and laboratories, in compliance with the Standard 004/2020 of 23/03/2020, updated on 25 April 2020.[3]

However, as recommended by the National Plan for Preparedness and Response to New Coronavirus Disease, with the progressive spread of the epidemic in Portugal, starting with the confirmation of the first case of disease on 2 March 2020, surveillance should no longer be only based on the identification and notification of all confirmed cases and should rather focus on syndromic surveillance systems.[2,4]

This recommendation was also published by the European Centre for Disease Control (ECDC) in the context of the fight against the pandemic of COVID-19, as a way to monitor the spread of the virus within the community, assessing the effectiveness of contingency measures or the disease progression with easing of restrictions.[5] The effectiveness of syndromic surveillance systems, as opposed to other health monitoring and surveillance systems, stems from the use of information that does not require laboratory confirmation or is directly dependent on healthcare professionals, such as self-report data or automated clinical records. This procedure allows for a faster and timely response aimed at mobilising and subsequently reducing the number of new infections and deaths.[6]

These objectives are particularly relevant when the time lapse between infection and disease notification is taken into account: laboratory surveillance of COVID-19 is estimated to reveal the status of disease in the population with a delay of two to four weeks.[7] On the other hand, a need to complement laboratory surveillance systems with others that allow earlier disease monitoring becomes clear with the presence of laboratory under-reporting or inconsistencies in official databases (due to changes in information structure, case definition or date of notification).[8]

Syndromic surveillance has been used in epidemiological surveillance of respiratory tract diseases, such as influenza and acute respiratory infections.[6,9-13] As influenza and COVID-19 share a similar symptomatic presentation, the following question naturally arises on whether indicators used for influenza monitoring (including the number of primary care consultations or hospitalisations due to pneumonia) could be effectively used in COVID-19 surveillance.[11,14,15]

Some studies have attempted answering this question, despite the recent onset of the epidemic. In the state of Kentucky, a composite syndromic surveillance indicator involving data on emergency and inpatient episodes (related to COVID-19 and influenza) was used for public health decision-making regarding lockdown easing in the region.[16] In turn, indicators related to primary care consultations and emergency episodes (related to COVID-19 and pneumonia) were used by the Public Health England platform for COVID-19 monitoring.[17,18] This surveillance system gave its contribution to the detection of the peak incidence of the first wave of COVID-19 in the UK.[19]

Variations in the pattern of access to healthcare related to viral pneumonia could specifically correspond to the circulation of the SARS-CoV-2 agent in the community, as this is one of the ways of presentation of COVID-19.[20,21] However, to our knowledge, no study has yet been carried out to assess the efficacy of these indicators in COVID-19 monitoring in Portugal.

This study was aimed at assessing the relevance of syndromic indicators (related to the suspicion of COVID-19) and pneumonia-related diagnostic indicators in COVID-19 monitoring in Portugal, comparing these with COVID-19 weekly incidence rate within the period between week 14/2020 (30 March to 05 April) and 25/2020 (15 to 21 June). Primary care and hospital data were selected as these were easily obtained, with proven effectiveness in monitoring the disease according to literature and the experience of the use of these data in influenza monitoring.[11,14 -16,19] The onset of the study [week 14/2020 (30 March to 05 April)] was selected taking into account the launch of COVID-19 dedicated areas within each emergency department (*ADC-SU*)

and dedicated COVID-19 community areas (*ADC-COMUNIDADE*).[3] The end of the study [week 25/2020 (15 to 21 June)] regared the latest available data at the time of the study.

MATERIAL AND METHODS

A time series analysis was carried out by using COVID-19 weekly incidence rate in mainland Portugal throughout the period from week 14/2020 (30 March to 05 April) and 25/2020 (15 to 21 June) and six indicators were obtained from the universe of public health departments in mainland Portugal, including two syndromic indicators [(1) primary care consultations related to COVID-19 and (2) number of emergency episodes related to COVID-19], in addition to pneumonia indicators [(3) number of emergency episodes related to viral pneumonia; (4) number of hospitalisations related to viral pneumonia; (5) proportion of emergency episodes related to viral pneumonia *vs.* total emergency episodes related to pneumonia (any aetiology) and (6) proportion of hospitalisations related to viral pneumonia *vs.* total hospitalisations related to pneumonia (any aetiology)].

Time series analysis was based on the same period for all indicators, as a matter of standardisation. The lower limit of the time period was chosen taking into account the onset of the implementation of *ADC-SU* and *ADC-COMUNIDADE*, in compliance with Standard No. 004/2020 of 23/03/2020, in force since 00:00 hours on 26 March 2020.[3]

The weekly incidence rate is referred to 100,000 population. The remaining indicators are described in absolute numbers of total primary care consultations or total hospitalisations, since rate calculation was not possible because no population-based denominators were available.

COVID-19 incidence rate

Data regarding laboratory-confirmed cases of COVID-19 provided by the network of laboratories that carry out the diagnosis of COVID-19 nationwide were obtained from the SINAVE platform and was updated on 26 June 2020. The weekly number of confirmed cases of COVID-19 and weekly incidence rates were based on the 2018 annual estimates of the resident population in mainland Portugal available from the National Institute of Statistics.[22]

Primary care consultations related to COVID-19

Data regarding primary care consultations related to COVID-19 were made available by the *Serviços Partilhados do Ministério da Saúde, E.P.E.* (*SPMS*) and were updated on 26 June 2020, regarding all health centre groupings (*ACES*) in mainland Portugal.

ICPC-2 A77.01 (COVID-19 infection) and ICPC-2 A29.01 (suspected COVID-19 infection) codes were considered, within the scope of the recommendations issued by the *Centre for Clinical Terminologies* (CTC) for the recording of clinical information related to COVID-19 in the Portuguese health information systems and based on the International Classification of Primary Health Care (ICPC-2).[23] Weekly counts were based on the date of consultation.

Emergency and inpatient care episodes related and recorded as COVID-19, viral pneumonia and pneumonia of any aetiology

Data regarding emergency or inpatient care episodes related to COVID-19, viral pneumonia and pneumonia of any aetiology in public healthcare institutions are based on administrative records, were provided by SPMS and updated on 26 June 2020, corresponding to 57.1% of public hospitals and *serviços básicos de urgência* (SUB) (basic emergency services) regarding data on emergency episodes and 45.5% of public hospitals regarding inpatient data. The list of public hospitals and emergency services used in the compilation of the information remained unchanged, so both ratios also remained unchanged throughout the study.

Codes U07.1 (COVID-19, identified virus) and U07.2 (COVID-19, unidentified virus) were considered in case counts of emergency episodes related to COVID-19, according to the recommendations issued by CTC for the registration of clinical data related to COVID-19 into the health information systems in Portugal, based on the 10th edition of the WHO's International Classification of Diseases (ICD-10).[23]

Codes 480 to 486 of the ninth edition of the WHO International Classification of Diseases (ICD-9) or codes J12 to J18 of ICD-10 were considered in case counts of emergency and inpatient episodes due to pneumonia of any aetiology.

Weekly counts were based on the date of the emergency or inpatient care episode.

All referral hospitals prepared to manage patients with COVID-19 were included in this data collection: Braga Hospital, São João Hospital, Santo António Hospital, Pedro Hispano Hospital, Coimbra Paediatric Hospital, Sousa Martins Hospital, Nossa Senhora da Assunção Hospital, Curry Cabral Hospital, Egas Moniz Hospital, São Francisco Xavier Hospital, Dona Estefânia Hospital and Faro Hospital.

Statistical analysis

The following correlations were analysed:

1. COVID-19 weekly incidence rate and weekly number of primary care consultations related to COVID-1;
2. COVID-19 weekly incidence rate and weekly number of emergency episodes related to COVID-19;
3. COVID-19 weekly incidence rate and weekly number of emergency episodes related to viral pneumonia;

4. COVID-19 weekly incidence rate and weekly number of inpatient episodes related to viral pneumonia;
5. COVID-19 weekly incidence rate and weekly proportion of emergency episodes related to viral pneumonia *vs.* total emergency episodes related to pneumonia (any aetiology);
6. COVID-19 weekly incidence rate and weekly proportion of inpatient episodes related to viral pneumonia *vs.* total inpatient episodes related to pneumonia (any aetiology).

Initially, the linear relationship between the indicators was assessed by using Pearson correlations ($0 \leq p < 0.3$ - negligible correlation; $0.3 \leq p < 0.5$ - weak correlation; $0.5 \leq p < 0.7$ - moderate correlation; $0.7 \leq p < 0.9$ - strong correlation; $0.9 \leq p$ - very strong correlation).[24] Cross-correlations between the same indicators were subsequently obtained.

The cross-correlation analysis allowed the identification of the lag between two time series. With a peak cross-correlation value of zero, the values of the first series (COVID-19 incidence rate) will be correlated with the values of the second series (remaining indicators, as described above), with no lag. When the peak cross-correlation value has a negative lag, the values of the first series will be correlated with the values of the second series with a lag of x weeks. Instead, with a positive peak cross-correlation value, the second series precedes the first series by x weeks.[25]

R Statistical Computing Environment software has been used for all the analyses.[26]

No participants and no collection or processing of personal, health, or genetic data were involved in the study. Therefore, the General Data Protection Regulation (GDPR) is not applicable and approval was not required from the Ethics Committee of the National Institute of Health, in accordance with the Helsinki declaration.

RESULTS

The COVID-19 weekly incidence rate and the six indicators that were analysed during the study [between week 14/2020 (30 March to 05 April) and 25/2020 (15 to 21 June)] are shown in Table 1. The highest weekly number of emergency and inpatient episodes related to viral pneumonia was recorded one week before the highest COVID-19 weekly incidence rate.

The progression of the relationship between COVID-19 weekly incidence rate and primary care consultations related to COVID-19, emergency episodes related to COVID-19, emergency episodes related to viral pneumonia and hospitalisations related to viral pneumonia is shown in Fig. 1. Even though a similar trend has been found for these indicators, a small delay regarding the COVID-19 incidence rate has been found when compared to the progression of primary care consultations related to COVID-19 (Fig. 1A) and emergency episodes related to COVID-19 (Fig. 1B). On the other hand, both emergency episodes (Fig. 1C) and hospitalisations related to viral pneumonia (Fig. 1D) seem to precede variations in the COVID-19 incidence rate. The visual analyses were confirmed by the cross-correlation values shown in Table 2.

A strong correlation ($p > 0.7$) was found between the COVID-19 incidence rate and the indicators that were analysed: 1) number of primary care consultations related to COVID-19; 2) number of emergency episodes related to COVID-19; 3) number of emergency episodes related to viral pneumonia; 4) number of hospitalisations related to viral pneumonia; 5) proportion of emergency episodes related to viral pneumonia *vs.* total emergency episodes related to pneumonia (any aetiology) and 6) proportion of inpatient episodes related to viral pneumonia *vs.* total inpatient episodes related to pneumonia (any aetiology) (Table 3).

The cross-correlation values between the COVID-19 incidence rate and the number of primary care consultations, as well as the cross-correlation between the COVID-19 incidence rate and the number of emergency episodes related to COVID-19 showed that the incidence rate precedes these indicators by about one week (Table 2). However, the cross-correlation values between the COVID-19 incidence

Table 1 – Characteristics of COVID-19 incidence rate (100,000 population) and six indicators. Mainland Portugal, weeks 14/2020 (30 March to 5 April) to 25/2020 (15 to 21 June).

	COVID-19 incidence rate (100,000 population)	**Primary care consultations related to COVID-19** (N)	**Emergency episodes related to COVID-19** (N)	**Emergency episodes related to viral pneumonia** (N)	**Inpatient episodes related to viral pneumonia** (N)	**Emergency episodes related to viral pneumonia / total emergency episodes related to viral pneumonia** (%)	**Inpatient episodes related to viral pneumonia / total inpatient episodes related to viral pneumonia** (%)
Minimum (Year/Week)	18.35 (2020/21)	11 940 (2020/24)	171 (2020/24)	10 (2020/23)	0 (2020/19 and 2020/25)	2.87 (2020/24)	0.00 (2020/19 and 2020/25)
Maximum (Year/Week)	44.47 (2020/15)	48 543 (2020/16)	668 (2020/17)	209 (2020/14)	61 (2020/14)	24.88 (2020/14)	45.19 (2020/14)

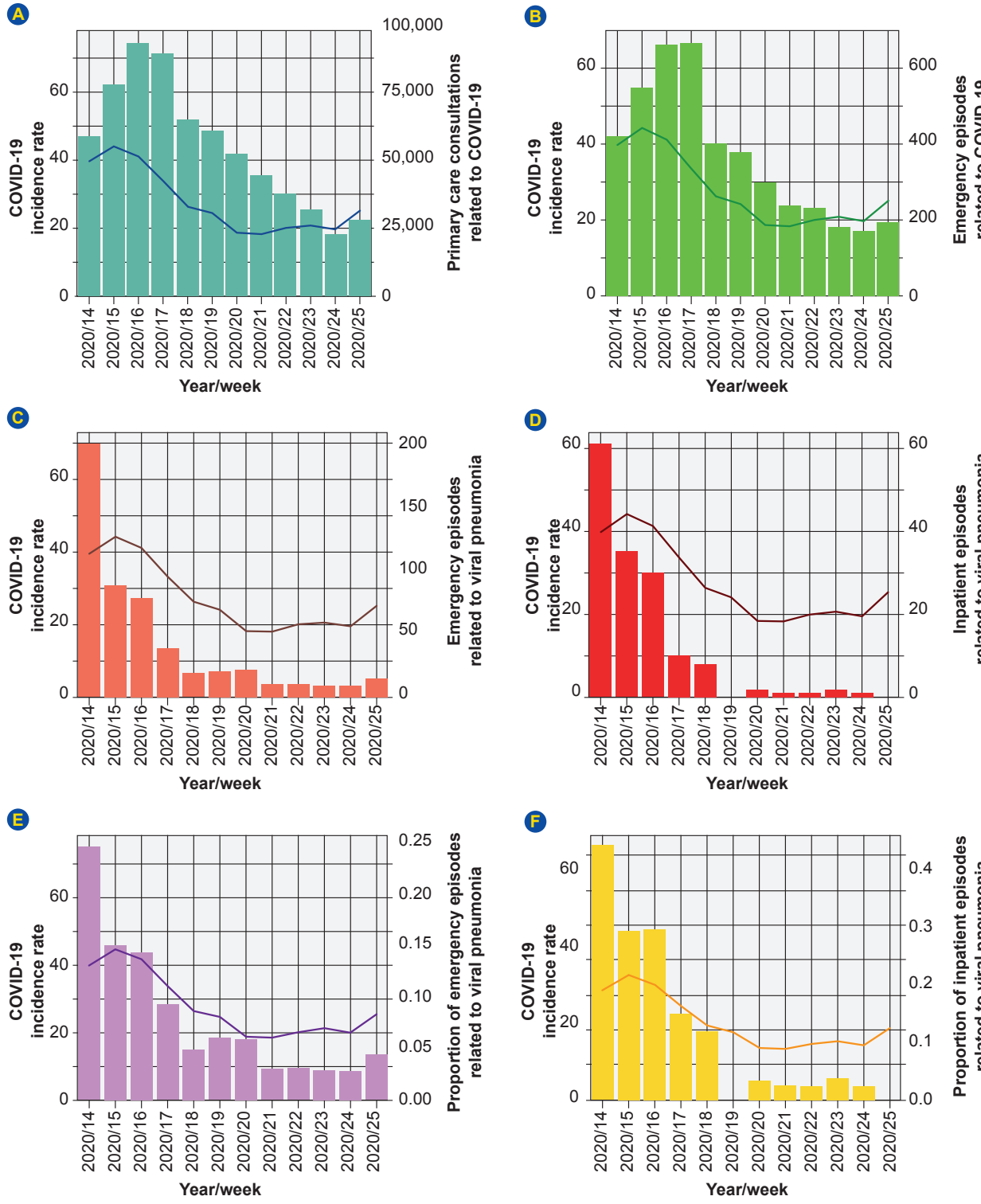

Figura 1 – (A) Weekly progression of COVID-19 incidence rate in mainland Portugal (line) and of the number of primary care consultations related to COVID-19 (bar); (B) weekly progression of COVID-19 incidence rate in mainland Portugal (line) and the number of emergency episodes related to COVID-19 (bar); (C) weekly progression of COVID-19 incidence rate in mainland Portugal (line) and of the number of emergency episodes related to viral pneumonia (bar); (D) Weekly progression of COVID-19 incidence rate in mainland Portugal (line) and of the number of inpatient episodes related to viral pneumonia (bar); (E) weekly progression of COVID-19 incidence rate in mainland Portugal (line) and of the proportion of emergency episodes related to viral pneumonia compared to the total number of emergency episodes related to pneumonia (any aetiology) (bar); (F) Weekly progression of the COVID-19 incidence rate in mainland Portugal (line) and of the proportion of inpatient episodes related to viral pneumonia vs. total inpatient episodes related to pneumonia (any aetiology) (bar).

rate and the number of emergency episodes related to viral pneumonia, as well as the cross-correlation between the COVID-19 incidence rate and the number of hospitalisations related to viral pneumonia showed that these indicators precede the incidence rate of COVID-19 by about one week (Table 2). Both the proportion of emergency episodes related to viral pneumonia *vs.* total emergency episodes related to pneumonia and the proportion of inpatient episodes related to viral pneumonia *vs.* total inpatient episodes related to pneumonia showed higher cross-correlation values for lag = 0, corresponding to a temporal alignment of these indicators with the progression of COVID-19 incidence rate (Table 2).

DISCUSSION

The pattern of progression of primary care consultations and emergency episodes related to COVID-19 is in line with the progression of COVID-19 weekly incidence rate, even though a delay of about one week has been found between these indicators and the progression of the disease in the community. This delay could have been related to the reorganisation of health services at the beginning of the epidemic: since the onset of *ADC-COMUNIDADE* and *ADC-SU*, at the start of the pandemic, unmet demand could have existed, namely in terms of primary care consultations related to COVID-19. It is worth mentioning that the onset of these programs had a preventive objective, aimed at preventing an increase in the number of cases of COVID-19, which was reinforced up to the downward trend of the disease. From this perspective, the areas dedicated to COVID-19 were expected to manage all COVID-19 cases throughout the study, even involving a slightly delayed approach, which is consistent with the pattern of progression of the indicators.

Table 2 – Cross correlation coefficients between COVID-19 incidence rate (100,000 population) and six indicators under analysis. Mainland Portugal, weeks 14/2020 (30 Mach to 05 April) to 25/2020 (15 to 21 June).

Lag	**Primary care consultations - COVID-19** (N)	**Emergency episodes - COVID-19** (N)	**Emergency episodes - viral pneumonia** (N)	**Inpatient episodes - viral pneumonia** (N)	**Emergency episodes – viral pneumonia / total emergency episodes – viral pneumonia** (%)	**Inpatient episodes – viral pneumonia / total inpatient episodes – viral pneumonia** (%)
-11	-0.13	-0.11	-0.06	-0.07	-0.06	-0.09
-10	-0.34	-0.28	-0.15	-0.17	-0.17	-0.21
-9	-0.48	-0.41	-0.23	-0.24	-0.28	-0.28
-8	-0.49	-0.44	-0.27	-0.27	-0.33	-0.30
-7	-0.37	-0.38	-0.27	-0.26	-0.34	-0.28
-6	-0.19	-0.27	-0.22	-0.24	-0.27	-0.25
-5	0.06	-0.05	-0.14	-0.19	-0.14	-0.21
-4	0.31	0.17	-0.07	-0.10	-0.03	-0.09
-3	0.58	0.50	0.02	0.01	0.10	0.08
-2	0.83	0.81	0.19	0.23	0.31	0.36
-1	**0.94***	**0.96***	0.40	0.50	0.56	0.64
0	0.76	0.82	0.77	0.84	**0.86***	**0.90***
1	0.39	0.47	**0.81***	**0.85***	0.82	0.84
2	0.07	0.15	0.60	0.60	0.57	0.55
3	-0.18	-0.12	0.29	0.27	0.24	0.22
4	-0.33	-0.30	0.00	-0.02	-0.07	-0.07
5	-0.38	-0.38	-0.14	-0.17	-0.21	-0.22
6	-0.35	-0.36	-0.31	-0.34	-0.34	-0.38
7	-0.31	-0.34	-0.33	-0.35	-0.36	-0.38
8	-0.23	-0.25	-0.30	-0.33	-0.32	-0.34
9	-0.12	-0.13	-0.26	-0.27	-0.26	-0.26
10	-0.03	-0.05	-0.23	-0.22	-0.21	-0.20
11	0.00	-0.01	-0.06	-0.06	-0.06	-0.05

* The highest values of cross correlation are highlighted in bold

Table 3 – Pearson's correlation between COVID-19 incidence rate (100,000 population) and six indicators under analysis. Mainland Portugal, week 14/2020 (30 March to 05 April) to 25/2020 (15 to 21 June).

	Primary care consultations - COVID-19 (N)	Emergency episodes - COVID-19 (N)	Emergency episodes - viral pneumonia (N)	Inpatient episodes - viral pneumonia (N)	Emergency episodes - viral pneumonia / total emergency episodes - viral pneumonia (%)	Inpatient episodes - viral pneumonia / total inpatient episodes - viral pneumonia (%)
COVID-19 incidence rate	0.76*	0.82*	0.77*	0.84**	0.86**	0.90**

* 99% significance level; ** 99.9% significance level

The timing of the development and availability of the codes regarding the reasons underlying the primary care and emergency episodes should also be considered to explain this delay. Even though the codes for consultations and emergency episodes related to COVID-19 became available even before the onset of the dedicated COVID-19 areas (the first records date back to 17 March 2020), a transition period may have existed in their use. As this is a disease whose symptoms are similar to those associated with an infection due to the influenza virus and other seasonal respiratory viruses, some of the patients who attended primary care or emergency care in March 2020 may have been registered as related to influenza.

The pattern of progression of emergency episodes and hospitalisations related to viral pneumonia is consistent with the progression of the COVID-19 weekly incidence rate. Variations in emergency episodes and hospitalisations related to viral pneumonia precede variations in COVID-19 incidence rate, which seems to indicate that these indicators may be useful for the early detection of COVID-19 outbreaks.

The progression of the rate of viral pneumonia *vs.* the total number of emergency and inpatient care episodes related to pneumonia is in line with the progression of COVID-19 weekly incidence rate, with no time lag. As a pattern similar to the one found for the previous indicators (precedence in relation to variations in COVID-19 incidence) would be expected, we assumed that some episodes related to viral pneumonia were classified throughout the study as related to an unknown aetiology, with an impact on its relative value.

We also cannot exclude that the codifications assigned to emergency or inpatient care episodes related to viral pneumonia have been less used after the development of the codes associated with COVID-19, having contributed to a reduction in the number of records of these episodes in the more advanced stages of the epidemic. Therefore, considering that this is an emerging health challenge, the progression of these indicators must be monitored, particularly in further epidemic waves. However, we hope that a longer time follow-up will increase the strength of the associations, which will subsequently improve the detection of variations in COVID-19 incidence rate.

This follow-up is particularly relevant in assessing whether the changes in the strategy regarding the use of diagnostic tests throughout the study have significantly influenced the progression of COVID-19 incidence rate (for example, through the prioritisation of testing symptomatic people at the beginning of the epidemic - Standard 004/2020 of 23/03/2020, updated on 25 April 2020 - to a more intensive screening strategy by the end of May, particularly in specific occupations).[3]

COVID-19 monitoring based on surveillance systems relying mainly on testing may not be the most appropriate strategy, particularly because these systems will always be limited by the availability of testing kits and reagents. The indicators that were used in this study are not significantly affected by variations in case definition and testing strategies, particularly in pneumonia, in addition to the absence of any logistical limitations.

These indicators have a strong correlation with COVID-19 incidence rate and are therefore useful for public health decision-making, particularly in the adequacy of testing strategies and allocation of health resources to communities more vulnerable to severe morbidity caused by COVID-19. The fact that viral pneumonia indicators may anticipate the detection of significant variations in the frequency of infection in the population suggests that they will be particularly suitable for targeting the testing strategy as a means to identify and isolate new cases of infection, preventing new outbreaks.

Additionally, syndromic surveillance has already been shown to be very relevant in the assessment of the introduction of vaccination programmes.[27,28] Therefore, in case that COVID-19 vaccines are widely applied to the Portuguese population, syndromic surveillance systems may play a crucial role in assessing their impact on community health.

Finally, the use of multiple surveillance systems with similar results increases the evidence of the findings. Therefore, surveillance systems that make use of clinical records for monitoring COVID-19 will be relevant in the current universal surveillance system for COVID-19 in Portugal, embedded into the SINAVE platform. It is also worth mentioning that, in case of overloaded epidemiological surveillance systems, there may be increasing underreporting of cases and the detection of signals in surveillance systems based on health records is more relevant.

Therefore, in case that a surveillance system based on these indicators is highly trustful, it may be an asset in the implementation of measures against COVID-19. Within the scope of this surveillance system, the detection of a sign that turns out to be a false positive could lead to a waste of resources (for example, in the validation of that sign). However, as different supplementary indicators are included in the system, it is expected that they will validate each other or validate with indicators from other systems and information sources, thus minimising this risk.

The surveillance system based on these indicators is aimed at the identification of an early sign of alert for an increasing COVID-19 incidence, rather than the definition of a predictive model and therefore it is not imperative to cancel the effect of other external indicators to confirm whether the relationship between the surveillance indicators and COVID-19 incidence holds. The signs that were found remain relevant, regardless of the causal relationships that may be identified.

CONCLUSION

The indicators analysed in the study have a strong correlation with COVID-19 incidence rate and are therefore useful for public health decision-making. Specifically, variations in the number of emergency and inpatient care episodes due to viral pneumonia precede variations in COVID-19 incidence rate, which seems to indicate that these indicators may be useful for the early detection of outbreaks of COVID-19 in the Portuguese population. Considering the hypothesis that there are cases related to viral pneumonia that were classified as pneumonia of unknown aetiology, the assessment of a composite indicator, with data on both viral pneumonia and pneumonia of unknown aetiology would be very relevant in COVID-19 monitoring.

HUMAN AND ANIMAL PROTECTION

The authors declare that this project complied with the regulations that were established by the Ethics and Clinical Research Committee, according to the 2013 update of the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

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